Tender Document for Works

(Two-Envelope Tendering Process Without Prequalification)

Procurement of:

C-2: Composite Contract Package in connection with laying of New BG Double Railway Line of HORC project for:

(i)Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from Km 55.60 to Km 61.50 and its connectivities to IR network from New Patli to Patli & New Patli to Sultanpur including modifications in Sultanpur station yard,

(ii) Design, Supply, Installation, Testing & Commissioning of OHE (1x25 kV) and General Electrical services from Km 49.70 to Km 61.50 and its connectivities to IR network from New Patli to Patli & New Patli to Sultanpur including modifications in Sultanpur station yard and

(iii) Design, Supply, Installation, Testing & Commissioning of Signalling & Telecommunication from Km 49.70 to Km 61.50 and its connectivities to IR network from Manesar to Patli and New Patli to Patli & New Patli to Sultanpur including modifications in Patli and Sultanpur station yards.

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Specific Procurement Notice (SPN)

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EMPLOYER'S REQUIREMENTS – GENERAL

1. INTRODUCTION

Employer's Requirements- General apply throughout the Contract.

2. DEFINITIONS AND INTERPRETATIONS

In addition to the words and expressions defined in the General Conditions of Contract, further following words and expressions shall have the meaning assigned to them except where the context otherwise requires:

- "**Availability**" shall mean the probability that an item will be in a state to perform a required function under given conditions at a given instant or over a given time interval assuming that the required external resources are provided.

- **"As-Built Drawings"** means those drawings produced by the Contractor and endorsed by its true records of construction of the Permanent Works and which have been given a consent from the Engineer.

- **"As-Built Documents"** mean the set of drawings and documents which are a true record of the construction of the Permanent Works prepared by the Contractor.

- **"CAD Standards"** means requirements for CAD, as specified in the Appendix 9 of Employer's Requirements.

- **"Charted Utilities"** mean identified Utilities listed in Employer's Requirements-Tender Drawings and Documents, which may be affected by the execution of the Works under the Contract.

- **Combined Services Drawings" (CSD):** means drawings showing the locations, layouts and sizes of all services including those of other contractors co-ordinated so as to eliminate all clashes.

- **"Construction Phase":** has the meaning identified in the Employer's Requirements - General.

- **"Construction Reference Drawings":** means those drawings referred in the Employer's Requirements - Design in respect of which a Notice has been issued.

- **"Construction Reference Drawings Submission":** means the submission of Construction Reference Drawings representing elements of the Permanent Works and for which the Contractor seeks a Notice.

- **"Contract Spares"** means any Spare Parts recommended by the Contractor for the operation and maintenance of the Permanent Works following the Taking Over of the Works.

- **"Contractor's Project Plan"** means the plan to provide a clear overview of the Contractor's organisation, management systems and the methods to be used for the execution and completion of the Works

- **"Construction/Installation and/or Manufacture Documents"** means the document which contain all drawings, calculations, computer software, samples, patterns, models, operation / maintenance manuals and other information to be submitted by the Contractor and approved by the Engineer.

- **"Consumables"** means those parts that are not repairable and usually have a relatively short life span.

- **"Critical Path Method"** means a schedule network analysis technique used to determine the amount of scheduling flexibility (the amount of float) on various logical network paths in the project schedule network, and to determine the minimum total project duration.

- **"Definitive Design Submission":** means the submission of documents which comprise the whole or parts of the proposed Definitive Design and for which the Contractor seeks a Notice.

- **"Design Criteria":** means the criteria defined in Employer's Requirements-Design and Outline Design Specifications.

- **"Design Manual":** means the manual to be prepared and submitted by The Contractor as part of the Definitive Design and as described in the Employer's Requirements - Design.

- **"DN Line"** means the down line of the HORC double line track route from Sonipat to Palwal.

- "**Final Design":** has the meaning identified in the Employer's Requirements – Design.

- **"Fixed Structure Gauge":** means the profile related to the designed normal co-ordinated axis of the track into which no part of any structures or fixed equipment may penetrate

- **"Interface Management Plan"** means the plan for all interface issues that may arise during the design, construction, testing and commissioning of the Works, in consultation with the Interfacing Contractors/ Interfacing Parties and the Engineer.

- **"Isolation"** means isolating and earthing of the electrical equipment, by disconnection of the respective section from all incoming sources of electricity supply and also outgoing connections.

- **"Independent Laboratory"** means a laboratory, submitted by the Contractor to the Engineer for approval, that is free from outside control and not subject

to direct or indirect influence or authority of the Employer, the Engineer, or the Contractor

- **"Inspection and Test Plan"** means a document that states inspection and testing requirements and actions provisioned for the Works, related process, Plant, or Materials. It is used to control, check, monitor and record; testing procedures that are required for quality assurance and to achieve the agreed quality requirements for the Works.

- **"Installation Tests"** means the tests to be performed to verify the conformity of completion of an installation/assembly to the design documents approved by the Engineer prior to the start of Commissioning, and they must be successfully completed before the Tests on Completion.

- **"Interface Coordinator"** means the person who has the responsibility, and authority with substantial experience to resolve interface matters to the satisfaction of the Engineer and provide the necessary support team for the Interface Management System as specified in Appendix 5B

- **"Interfacing Contractor"** means the Contractor engaged by the Employer or other agencies having an interface issue with the Contractor for the Works.

- **"Interfacing Parties"** comprises the interfacing contractors / consultants / service providers, who are engaged in part of the works, relevant authorities and public utility agency.

- **"Interface Table"** means the table that describes the relationships between the Contractor and Interfacing Contractors / Interfacing Parties and their roles and responsibilities is a key document.

- **"Kick-Off Meeting"** means the meeting held by the Engineer to formally notify all parties concerned under the Contract that the project has commenced and to ensure that every party has a common understanding of their role from the Commencement Date up until issuance of the Performance Certificate.

- **"Maintainability"** means a characteristic expressed as the probability that an item will be retained in or restored to a specified condition within a given period, when the maintenance is performed in accordance with prescribed procedures and resources.

- **"Maintenance Manuals"** means the manuals providing detailed instructions for the maintenance of infrastructure and maintenance facilities.

- **"Method Statement"** means a document that states the way a particular work, task, or process along with various associated aspects such as quality, safety, environment protection, time and resources; are planned to be directly controlled by the Contractor or its Subcontractor.

- **"Monthly Progress Meeting"** means the meeting specified under Appendix 7 of the Employer's Requirements.

- **"Monthly Progress Report"** means the report that the Contractor shall prepare and submit to the Engineer.

- **"Nonconformity Report"** means a report documenting non-fulfilment of a requirement, with objective evidence, the location and time of occurrence or detection, and provision for its proper resolution by the concerned responsible.

- **"Notice":** means a Notice of No Objection.

- **"Notice of Objection"** means a category of Engineer's response, issued by the Engineer to the Contractor.

- **"Not Reviewed"** means a category of Engineer's response, issued by the Engineer to the Contractor .

- **"On-Site Laboratory"** means Contractor's own laboratory submitted by the Contractor to the Engineer for approval as specified in Appendix 12 of the Employer's Requirements.

- **"Operation and Maintenance Manuals (O&M Manuals)"** means the manual that will be indicating the provisions which are required for maintenance of various assets created under the Contract by the Employer under their operation phase.

- **"Priority Section"** means the section from Km 49.7 to Km 55.6 of HORC Main line and connectivity line from Manesar station on HORC and Patli station on Delhi-Rewari section of Indian Railway Network.

- **"Programme Analysis Report"** means the report submitted to the Engineer that shall, in narrative format, describe the basis and assumptions used to develop each programme.

- **"Project"** means the project named as "Haryana Orbital Rail Corridor (HORC)".

- **"Project Management Plan"** refers to the plan that will be established by the Contractor for the management of activities related to design, procurement, manufacture, execution/construction, delivery, installation, testing and commissioning.

- **"Project Management Information System"** means a document, information and communication technology system (platform) that is to be implemented by the Contractor so that the management of information between the Contractor, the Employer and the Engineer is efficient, reliable, and secure.

- **"Preliminary Design":** means the submission of documents which comprise the initial stage of the design phase.

- **"Indian Railway"** means the rail tracks of the Indian Railway or any other organization and any ancillary areas of Indian Railway such as the depots, sidings, stations, terminus, traction power stations, etc.

- "**Request for Inspection"** means the form used to give notice by the Contractor to the Engineer.

- **"Railway Representative"** means a person, or persons, nominated by the Employer / Engineer to liaise with the Contractor and the Engineer on matters affecting the operation of Indian Railway.

- **"Restriction"** means speed restriction, which is a limitation of the normal permitted speed of rail traffic over a specified length of the Railway.

- **"Tender Drawings and Documents"** means the drawings and documents prepared by the Employer for reference purposes only and included in the Tender Documents.

- **"Reliability"** means the probability that an item/equipment/system can perform a required function under given conditions for a given time interval.

- **"Routine Test"** means the test which is required to perform or undergo on each Plant, Contractor's Equipment and Materials during or after manufacture to ascertain that it complies with specified criteria.

- **"Right of Way"** means the land area of the Project, either acquired by the Employer or for which the Employer has the permission of the Stakeholder to construct the embankment & bridges, etc. over their area.

- **"Environmental, Social, Health and Safety Management Plan"** means the plan in accordance with the requirements of Appendix 13 of the Employer's Requirements.

- "**Safety**" freedom from unacceptable risk of harm.

- "**Safety Integrity Level**" One of a number of defined discrete levels for specifying the safety integrity requirements of the safety functions to be allocated to the safety related systems. Safety Integrity Level with the highest figure has the highest level of safety integrity.

- **"Safety-Critical"** means failure of the system, sub-system or equipment that directly leads to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss.

- **"Software Related Items"** comprises (but not limited to) erasable programmable read only memory (EPROM), digital versatile disc (DVD),

other related items which are the most updated items used in relation to the Works, and those to be supplied by Subcontractors of any tiers

- **"Site Offices"** means Site Office for Employer's/Engineer's Personnel constructed by the Contractor.

- **"Spare Parts"** means those parts which are generally repairable and have normally a service life of several years.

- **"Specification":** has the meaning identified in the Employer's Requirements - General.

- **"Sub-system"** Each system comprises of sub systems. Signalling System comprise sub systems of Electronic Interlocking System, Train Detection System, Point Operation System, Absolute Block Working with BPAC, Power Supply System etc. Telecommunication System comprise sub systems of Optical Fiber Communication System, Quad cable system, Data Networking System, Telephone System, Emergency Communication System, VHF Communication System, Master Clock System, Integrated train platform announcement and display system and 48 volt DC Battery Backup System etc.

- **"Temporary Benchmarks (TBM)"** means the benchmarks provided by the Employer, used to locate & confirm the Right of Way (ROW) and its co-ordinates including levels.

- **"Three Months Rolling Programme"** means the programme which the Contractor shall prepare and update monthly as per Appendix 6 of the Employer's Requirements.

- **"Three Weeks Rolling Programme"** means the programme which the Contractor shall prepare and update weekly per Appendix 6 of the Employer's Requirements.

- **"Time Bar Chart",** known as "Gantt Chart" too is a type of bar chart which illustrates a project schedule. i.e. the start and finish dates of the activities and summary elements of a project

- **"Uncharted Utilities"** mean Utilities other than Charted Utilities which are identified during a survey conducted by the Contractor or encountered during excavation/ other works.

- **"UP Line"** means the up line of the HORC double line track route from Palwal to Sonipat.

- **"Utilities"** means the electricity, lighting, traffic control, telephone and/or communication cables, gas, water, sewage and drainage pipes, including all associated protection, supports, ancillary structures, fittings and equipment.

- **"Working Drawing"** means additional drawings developed by the Contractor as necessary to supplement the Drawings and to specify additional details and

procedures for construction of the Works, such as shop drawings, fabrication drawings, erection drawings, Temporary Works drawings, bar bending schedules, bar reference drawings. All such drawings shall comply with the requirements of the Contract.

- **"Works Areas"** means the areas of the Site within the Right of Way and any additional areas which may be obtained by the Contractor and agreed by the Engineer as additional working area.

- **"Works Programme"** means the time-scaled and resource-loaded critical path network, updated from time to time in accordance with the General Conditions of Contract and Employer's Requirements, depicting activities, durations, sequences and interrelationships that represent the Contractor's work plan, work breakdown, schedule structure for constructing and completing the Works, distributed over the Time for Completion of the Contract.

- **Abbreviations**

AC	**:**	**Alternating Current**
ACB	**:**	**Air Circuit Breaker**
AIIB	**:**	**Asian Infrastructure Investment Bank**
ALARP	**:**	**As Low As Reasonably Practicable**
ASLI	**:**	**Automatic Safe Load Indicator**
BG	**:**	**Broad Gauge**
BIS	**:**	**Bureau Of Indian Standards**
BOCW	**:**	**Building Or Other Construction Work**
BS	**:**	**British Standards**
CAD	**:**	**Computer Aided Design**
CCTV	**:**	**Closed Circuit Television**
CD	**:**	**Compact Disc**
CIF	**:**	**Cost, Insurance And Freight**
CIP	**:**	**Co-Ordinated Installation Plan**
CP	**:**	**Contract Package**
CPCB	**:**	**Centre Pollution Control Board**
CPM	**:**	**Critical Path Method**

CRS	**:**	**Commissioner Of Railway Safety**
CSD	**:**	**Combined Service Drawings**
CTC	**:**	**Centralized Traffic Control**
CV	**:**	**Curriculum Vitae**
D&B	**:**	**Drill And Blast**
DB	**:**	**Decibel**
DB	**:**	**Distribution Box**
DC	**:**	**Direct Current**
DCN	**:**	**Design Change Notice**
DDF	**:**	**Digital Distribution Frame**
DFC	**:**	**Dedicated Freight Corridor**
DFCCIL	**:**	**Dedicated Freight Corridor Corporation Of India Limited**
DG	**:**	**Diesel Generator**
DGPS	**:**	**Differential Global Positioning System**
DIN	**:**	**Deutsche Industrial Norms**
DL	**:**	**Double Line**
DNP	**:**	**Defect Notification Period**
DP	**:**	**Detection Point**
DPI	**:**	**Dots Per Inch**
DPR	**:**	**Daily Progress Report**
DSS	**:**	**Distribution Substation**
DT	**:**	**Down Time**
DTN	**:**	**Data Transmission Network**
DVD	**:**	**Digital Versatile Disc**
DVT	**:**	**Design Verification Table**
E&M	**:**	**Electrical & Mechanical**
EIA	**:**	**Environmental Impact Assessment**

ELCB	**:**	**Earth Leakage Circuit Breaker**
EMC	**:**	**Electro Magnetic Compatibility**
EMI	**:**	**Electro Magnetic Interference**
EPROM	**:**	**Erasable Programmable Read Only Memory**
ERP	**:**	**Enterprise Resource Planning**
ESHS	**:**	**Environmental, Social, Health And Safety**
FAT	**:**	**Factory Acceptance Test(S)**
FCN	**:**	**Field Change Notice**
FFL	**:**	**Finished Floor Level**
FL	**:**	**Formation Level**
FMECA	**:**	**Failure Modes Effect and Criticality Analysis**
FRACAS	**:**	**Failure Report and Corrective Action System**
FTA	**:**	**Fault Tree Analysis**
GAD	**:**	**General Arrangement Drawing**
GCC	**:**	**General Conditions Of Contract**
GE	**:**	**Geotechnical Engineering**
GFL	**:**	**Ground Floor Level**
GIS	**:**	**Geographical Information System**
GL	**:**	**Ground Level**
GNSS	**:**	**Global Navigation Satellite System**
GOI	**:**	**Government Of India**
GPR	**:**	**Ground Penetrating Radar**
GPS	**:**	**Global Positioning System**
GRC	**:**	**Grievance Redress Committee**
GRM	**:**	**Grievance Redress Mechanism**
GS	**:**	**General Specifications**

GSM-R	**:**	**Global System For Mobile Communication - Railway**
HDPE	**:**	**High Density Polyethylene**
HFL	**:**	**Highest Flood Level**
HORC	**:**	**Haryana Orbital Rail Corridor**
HP/BHP	**:**	**Horse Power / Brake Horse Power**
HT	**:**	**High Tension**
HTML	**:**	**Hyper Text Markup Language**
HV	**:**	**High Voltage**
HVAC	**:**	**Heating, Ventilation And Air Conditioning**
Hz	**:**	**Hertz**
IC	**:**	**Integrated Circuit**
ICD	**:**	**Interface Co-Ordination Document**
ID	**:**	**Identification**
IEC	**:**	**International Electro – Technical Commission**
IHA	**:**	**Interface Hazard Analysis**
IISWBM	**:**	**Indian Institute Of Social Welfare & Business Management**
IMD	**:**	**Integrated Maintenance Depot**
IMP	**:**	**Interface Management Plan**
INR	**:**	**Indian Rupee**
IP	**:**	**Point Of Intersection**
IPS	**:**	**Integrated Power Supply**
IR	**:**	**Indian Railways**
IRC	**:**	**Indian Road Congress**
IRJ	**:**	**Insulated Rail Joints**
IRS	**:**	**Indian Railway Standards**

IRSEM	**:**	**Indian Railway Signal Engineering Manual**
IS	**:**	**Indian Standards**
ISO	**:**	**International Organization For Standardization**
IT	**:**	**Information Technology**
ITP	**:**	**Inspection And Test Plan**
ITT	**:**	**Instruction To Tenderers**
KM / KM	**:**	**Kilo meter**
kV	**:**	**Kilo Volt**
LAN	**:**	**Local Area Network**
LCD	**:**	**Liquid Crystal Display**
LCX	**:**	**Leaky Coaxial Cable**
LED	**:**	**Light Emitting Diode**
LRU	**:**	**Line Replaceable Units**
LT	**:**	**Low Tension**
LV	**:**	**Low Voltage**
LWL	**:**	**Lowest Water Level**
MC	**:**	**Municipal Corporation**
MCB/LV	**:**	**Miniature Circuit Breaker / Low Voltage**
MCCB	**:**	**Moulded Case Circuit Breaker**
MCIL	**:**	**Maintainability Critical Items List**
MDR	**:**	**Major District Roads**
MMI	**:**	**Man Machine Interface**
MOR	**:**	**Ministry Of Railway**
MPR	**:**	**Monthly Progress Report**
MQR	**:**	**Monthly Quality Report**
MS	**:**	**Method Statement**

MSDS	**:**	**Material Safety Data Sheet**
MSL	**:**	**Mean Sea Level**
MTBF	**:**	**Mean Time Between Failure**
MTBSAF	**:**	**Mean Time Between Service Affecting Failure**
MTTR	**:**	**Mean Time To Repair**
MTTR	**:**	**Mean Time To Restore**
NABL	**:**	**National Accreditation Board For Testing And Calibration Laboratories**
NATM	**:**	**New Austrian Tunnelling Method**
NCR	**:**	**Nonconformity Report**
NFPA	**:**	**National Fire Protection Association**
NGO	**:**	**Non-Governmental Organization**
NH	**:**	**National Highway**
NHAI	**:**	**National Highway Authority Of India**
NOC	**:**	**No Objection Certificate**
NONO	**:**	**Notice Of No Objection**
NONOC	**:**	**Notice Of No Objection With Comments**
NOO	**:**	**Notice Of Objection**
NR	**:**	**Not Reviewed**
O&M	**:**	**Operation And Maintenance**
O&SHA	**:**	**Operating And Support Hazard Analysis**
OCS	**:**	**Overhead Catenary System**
ODBC	**:**	**Open Data Base Connectivity**
ODF	**:**	**Optical Equipment Manufacturer**
ODR	**:**	**Other District Roads**
OEM	**:**	**Original Equipment Manufacturer**
OFC	**:**	**Optical Fibre Cable**

OHE	**:**	**Over Head Electrification**
OHSAS	**:**	**Occupational Health And Safety Assessment Series**
OHTL	**:**	**Over Head Transmission Lines**
OPM	**:**	**Other Preventive Measures**
PCC	**:**	**Particular Conditions Of Contract**
PDF	**:**	**Portable Document Format**
PHA	**:**	**Preliminary Hazard Analysis**
PMIS	**:**	**Project Management Information System**
PPE	**:**	**Personal Protective Equipment**
PR	**:**	**Public Relation**
PS	**:**	**Particular Specifications**
PVC	**:**	**Polyvinyl Chloride**
PWD	**:**	**Public Works Department**
QA	**:**	**Quality Assurance**
RAMS	**:**	**Reliability, Availability, Maintainability And Safety**
RAP	**:**	**Resettlement Action Plan**
RBD	**:**	**Reliability Block Diagram**
RC	**:**	**Reinforced Concrete**
RCC	**:**	**Reinforced Cement Concrete**
RCIL	**:**	**Reliability Critical Item List**
RDSO	**:**	**Research Designs And Standards Organization**
RDT	**:**	**Reliability Demonstration Testing**
RFI	**:**	**Request For Inspection**
RFO	**:**	**Rail Fly Over**
RINL	**:**	**Rashtriya Ispat Nigam Limited**
RL	**:**	**Rail Level**

ROB	**:**	**Road Over Bridge**
ROM	**:**	**Read Only Memory**
ROW	**:**	**Right Of Way**
RUB	**:**	**Road Under Bridge**
S&T	**:**	**Signalling And Telecommunication**
SAIL	**:**	**Steel Authority Of India Limited**
SAT	**:**	**System Acceptance Test(S)**
SCADA	**:**	**Supervisory Control And Data Acquisition**
SCC	**:**	**Sectional Control Centre**
SCIL	**:**	**Safety Critical Items List**
SER	**:**	**Signalling Equipment Room**
SH	**:**	**State Highway**
SI	**:**	**International System Of Units**
SIL	**:**	**Safety Integrity Level**
SL	**:**	**Single Line**
SM	**:**	**Station Master**
SOD	**:**	**Schedule Of Dimensions**
SP	**:**	**Sectioning Post**
SRR	**:**	**Submission Review Request**
SRS	**:**	**System Requirement Specifications**
SSHA	**:**	**Subsystem Hazard Analysis**
SSP	**:**	**Sub-Sectioning Post**
SWR	**:**	**Station Working Rules**
TCAS	**:**	**Train Collision Avoidance System**
TCP	**:**	**Traffic Control Plan**
TER	**:**	**Telecommunication Equipment Room**
TMS	**:**	**Train Management System**

TOT	**:**	**Transfer Of Technology**
TSS	**:**	**Traction Substation**
UG	**:**	**Under Ground**
UPS	**:**	**Uninterrupted Power Supply**
USB	**:**	**Universal Serial Bus**
UTM	**:**	**Universal Transverse Mercator**
VDU	**:**	**Video Display Unit**
VHF	**:**	**Very High Frequency**
VN	**:**	**Variation Notice**
WGS84	**:**	**World Geodetic System 84**
WHO	**:**	**World Health Organization**
WQMP	**:**	**Works Quality Management Plan**
XLPE	**:**	**Cross Linked Polyethylene**

3 RELEVANT DOCUMENTS

The Design Criteria shall be read in conjunction with the General Conditions of Contract (GCC), the Particular Conditions of Contract (PCC), the Employer's Requirements, the drawings and any other document forming part of the Contract.

Notwithstanding the precedence specified above the Contractor shall always immediately seek advice from the Engineer in the event of conflicts between Specifications.

In case of conflict in Design Criteria in various Sub-Sections of Section VII, Employer's Requirement the order of precedence shall be as follows :

CIVIL

- Outline Design Specifications
- Outline Construction Specification
- Tender Drawings
- Functional, Design, Construction, General
- Appendices
- Indian and other International Standards referenced herein.
- Indian and other International Standards.

ELECTRICAL and SIGNALLING & TELECOMMUNICATION

- Particular Specifications

- General Specifications
- Tender Drawings
- General
- Appendices

4 PHASES (DESIGN AND CONSTRUCTION)

a) The Contractor shall execute the Works in two phases, the Design Phase and the Construction Phase.

b) The Design Phase shall commence upon the date of Letter of Acceptance (LOA). This phase shall include the preparation and submission of:

i. the Preliminary Design,

ii. the Definitive Design;

iii. The Construction Reference Drawings.

iv. The Design Phase will be complete upon the issue of a Notice in respect of the comprehensive and complete Construction Reference Drawings Submission for the whole of the Permanent Works.

c) The requirements for the Preliminary Design, Definitive Design and Construction Reference Drawings are stated in Clause 2 of the Employer's Requirements -Design.

d) The Construction Phase for the whole or a part of the Permanent Works shall commence immediately upon the issue of a Notice by the Engineer/Employer in respect of the relevant Construction Reference Drawings Submission. Such Notice may be issued by the Engineer in respect of a Construction Reference Drawing Submission covering a major and distinctive part of the Permanent Works. However, construction shall not be commenced until the appropriate Working Drawings have been endorsed:

(a) by the Contractor as "Good for Construction"; and

(b) by the Engineer that he has no objections to the drawing.

The Construction Phase shall include the completion and submission of the Final Design and the preparation and submission of the As Built Drawings and other records as specified.

e) Notwithstanding Clause 4 b (iv) above, for those elements identified under Clause 2(vi) of the Employer's Requirements - Design, the Construction Phase may commence immediately upon the issue of the Notice in respect of the Definitive Design Submission in respect of each such element subject to availability of the site in accordance with agreed programme.

f) The Contractor shall furnish Contractor's Warranty in the format approved by the Employer given in Section X – Contract Forms.

5. SPECIFICATIONS

In accordance with the provisions of these Employer's Requirements (Section VII-1 to Section VII-12), the Contract Specification contained in the Contract shall be developed during the design stage and submitted as part of the Definitive Design Submission. When the Specification has received a Notice of No Objection from the Engineer it shall become the Particular Specifications and shall take precedence over

the other Specifications for construction purposes.

6. SPECIFICATIONS IN METRIC AND IMPERIAL UNITS

a) The Contract shall utilise the SI system of units. Codes and Standards in imperial units shall not be used unless the Engineer has given his consent.

b) Conversion between metric units and imperial units shall be in accordance with the relevant Indian Standards.

7. WORKS PROGRAMME

a) The Key Dates are defined in Appendix 2 to these Employer's Requirements.

b) The Contractor shall prepare and submit its Works Programme and three-month rolling programmes and the detailed requirements contained in Appendix 6 to these Employer's Requirements.

c) In compiling its Works Programme and in all subsequent updating and reporting, the Contractor shall make provision for the time required for co-ordinating and completing the design, testing, commissioning and integrated testing of the Works, including, inter alia, design co-ordination periods during which the Contractor shall co-ordinate its design with those of Interfacing Contractors, the review procedures, determining and complying with the requirements of all Government Departments and all others whose consent, permissions, authority or licence is required prior to the execution of any work.

d) The Works Programme shall take full account of the Design Submission Programme.

8. MONITORING OF PROGRESS

a) Project Monitoring shall be done by Integrated Project Monitoring Software (IPMS). The contractor has to prepare Primavera P6 schedule as per the Programme Requirements provided in Appendix 6.

b) The Contractor shall submit to the Engineer three copies (along with an additional copy in digital format) of a Monthly Progress Report (MPR), as described in Appendix 7 to these Employer's Requirements, describing the progress and current status of the Works. The MPR shall address the matters set out in the Works Programme.

c) The MPR shall be submitted by the end of each calendar month. It shall account for all works actually performed in the current month.

d) The MPR shall be divided into two sections. The first section shall cover progress and current status relating to design and the second section shall cover progress and current status relating to construction.

e) A monthly meeting to monitor & review the progress of the project shall be convened by the Engineer. Contractor's site Representative & Designer Representative of Contractor and site representative of all Interfacing Contractors shall also attend the meeting. The Employer may also be present in the meeting.

f) The Engineer or Employer may also conduct progress review meetings and Interface meetings on weekly /bi-weekly intervals depending upon the requirements or urgency of works. In these review meetings Engineer may call

Contractor's Supplier/Sub-Contractor/Designer etc. as per the requirements.

9. QUALITY ASSURANCE

The Contractor shall establish and maintain a Quality Assurance System in accordance with Appendix 11 to these Employer's Requirements for design and construction procedures and the interfaces between them. This Quality Assurance system shall be applied without prejudice to, or without in any way limiting, any Quality Assurance Systems that the Contractor already maintains.

10 SOFTWARE SUPPORT

10.1 GENERAL

a) The Contractor shall provide full support to the Engineer for all computer programs provided by the Contractor under the Contract.

b) The Contractor shall submit a software support plan at least 90 days before commencement of software installation. This plan shall require the Contractor to provide all changes, bug fixes, updates, modifications, amendments, and new versions of the program as required by the Engineer.

c) The Contractor shall provide all tools, equipment, manuals and training necessary for the Employer / Engineer to maintain and re-configure all the software provided under the Contract.

d) The Contractor shall submit all new versions to the Engineer for review at least 2 weeks prior to their installation. New Versions of any program shall not result in any non-conformance with the Specification, or degrade the operation of the System. The Contractor shall:

i. Ensure that all new versions are fully tested and validated on the simulation and development system prior to installation.

ii. Ensure that all new versions are fully tested and commissioned once installed on the Site.

iii. Deliver to the Employer/Engineer any new version, together with the updated Operation and Maintenance Manuals.

e) The Engineer shall not be obliged to use any new version and that shall not relieve the Contractor of any of its obligations. Any effect upon the performance or operation of the computer-controlled system that may be caused by a new version shall be brought to the Engineer attention including updating the files to suit new version.

10.2 IMPLEMENTATION OF SOFTWARE BASED BILLING & PROJECT MANAGEMENT SYSTEMS

The contractor shall perform all billing processes through the software-based billing system as and when introduced by HORC. The Contractor shall also introduce appropriate Project Management Systems during the project execution phase.

10.3 ERROR CORRECTION

a) When a fault is discovered within delivered software or documentation, the Contractor shall take necessary steps to rectify errors or faults at the earliest.

b) The Contractor shall provide written details as to the nature of the proposed

correction to the Engineer.

c) The Contractor shall notify the Employer promptly of any fixes or patches that are available to correct or patch faults.

d) The Contractor shall detail any effect such fixes or patches are expected to have, upon the applications.

10.4 TRAINING

The Contractor shall provide training for the Employer's/Engineer's staff to enable the Employer/Engineer to make proper use of any software and its new versions. In case Contractor fails or unable to provide training, the Engineer may ask for proposal.

11. CO-ORDINATION WITH INTERFACTING CONTRACTORS

11.1 General

a) The Contractor is responsible for detailed co-ordination of his design and construction activities with Interfacing Contractors. Such co-ordination responsibilities of the Contractor shall include the following:

i. To provide all information reasonably required by the Interfacing Contractors in a timely and professional manner to allow them to proceed with their design or construction activities, and specifically to meet their contractual obligations.

ii. To ensure that the Contractor's requirements are provided to all other Interfacing Contractors before the cut-off dates to be identified in the Interface Management Plan (IMP).

iii. To obtain from the Interfacing Contractors information reasonably required to enable the Contractor to meet the design submission dates as identified in Appendix 2.

iv. Where the execution of the work of the Interfacing Contractors depends upon the site management or information to be given by the Contractor, the Contractor shall provide to such Interfacing Contractors the services or correct and accurate information required to enable them to meet their own programme or construct their work.

v. To attend regular co-ordination meetings convened by the Engineer with the Interfacing Contractors. The Contractor shall conduct separate meetings with the Interfacing Contractors as necessary to clarify particular aspects of the interfacing requirements of the Works. The party who convenes the meeting shall prepare minutes recording all matters discussed and agreed at the meeting.

vi. To ensure that copies of all correspondence, drawings, meeting minutes, programmes, etc. relating to the Contractor's co-ordination with the Interfacing Contractors are issued to all concerned parties and the Engineer no later than two (2) calendar days from the date of such correspondence and meetings.

b) The Contractor, shall in carrying out his co-ordination responsibilities, raise in good time and provide sufficient information for the Engineer to decide on any disagreement between the Contractor and the Interfacing Contractors as to the extent of services or information required to pass between them. If such disagreement cannot be resolved by the Contractor despite having taken all

reasonable efforts, then the decision of the Engineer shall be final and binding on the Contractor.

c) Where an Interfacing Contract is yet to be awarded the Contractor shall proceed with the co-ordination activities with the Engineer until such time when the Interfacing Contractor is available. The Contractor shall provide the Interfacing Contractor with all information necessary to enable the Interfacing Contractor to follow-on and proceed with their co-ordination.

d) The cut-off dates to be identified in the IMP are the latest dates. Any claim of additional costs by the Interfacing Contractors as a result of the Contractor's failure in adhering to these dates shall be borne by the Contractor. The Contractor shall note that the information exchange is an iterative process requiring the exchange and update of information at the earliest opportunity and shall be carried out on a regular and progressive basis so that the process is completed for each design stage by the cut-off dates.

e) The Contractor shall co-ordinate with the Engineer on all matters relating to works that may affect the Operation & Maintenance of the already operational Section corridor of the of Employer in general. Such work shall be subject to the rules and regulations imposed by the Employer.

11.2 Design & Construction Interface

a) The dates shown in Employer's Requirements Appendix 2 are critical to the timely completion of the project. The Contractor shall commence design interface with the Interfacing Contractors as soon as he has been notified by the Engineer that such Interfacing Contract has been awarded. In the case of utility agencies and other statutory boards, interface shall commence as soon as it is practicable. Where no design interface date has been established whether because the Interfacing Contractor(s) have not been identified or for whatever reason, the Contractor shall liase with such Interfacing Contractor/s as soon as they have been awarded.

b) The Contractor shall immediately upon award of the Contract gather all necessary information and develop his design to a level where meaningful interaction can take place as soon as the Interfacing Contracts are available. The Contractor shall submit together with each of his Design Submissions a joint statement from the Contractor and the relevant Interfacing Contractor confirming that design co-ordination has been completed and that they have jointly reviewed the appropriate document to ensure that a consistent design is being presented.

c) The design interface is an iterative process requiring regular exchange and update of interfacing information. The Contractor shall ensure that the information he requires from the Interfacing Contractors is made known at the outset of each design interface and vice versa so that the information can be provided in time for the Contractor and the Interfacing Contractors to complete their design to meet their various design submission stages.

11.3 Construction Interface

a) Construction interface will be necessary throughout the duration of the Works commencing from the time the Contractor mobilises to the Site to the completion of the Works. Construction interface will overlap design interface, involving cast-in and buried items such as pipes for electrical and mechanical

services, supports, brackets, plinths, ducts, service buildings, openings, cableways, trenches etc. that are to be incorporated at the early stage of the construction up to provision of attendance during the testing and commissioning stage.

b) The Contractor shall ensure that there is no interference with the Works of the Interfacing Contractors and shall maintain close co-ordination with them to ensure that his work progresses in a smooth and orderly manner. The Contractor shall carry out and complete the Works, or any part thereof, in such order as may be agreed by the Engineer or in such revised order as may be requested by the Engineer from time to time. The Contractor shall, unless otherwise provided, be liable for and shall indemnify the Employer against all costs, charges, expenses and the like resulting from failure of the Contractor to co-ordinate the Works as specified.

12. SURVEY AND SITE INVESTIGATIONS

a) The datum used for the Contract shall be Mean Sea Level Datum

b) The Contractor shall carry out all further site investigations (such as detailed utility identification, detailed geo technical investigation etc.) necessary for the design of the Permanent Works and to enable the determination of the methods of construction and the nature, extent and design of the Temporary Works.

c) The Contractor shall carry out geotechnical investigation using conventional method of boreholes and geo-physical methods for the entire alignment.

13. CLIMATIC CONDITIONS

a) The entire section of HORC with connecting IR Station is situated in the state of Haryana. During summer months the temperature can be as high as 45°C with a high level of humidity, nights can be relatively cool with temperatures dipping to 30°C. Torrential rains and high humidity accompany the monsoon in late June to early September. In the winter months temperatures can vary from a high of 21°C during day to a low of 2°C during night.

b) The information given above is only indicative. The contractor shall obtain detailed climatic data in respect of minimum & maximum temperatures, rain, relative humidity, sun shine, and wind velocity/pressure etc. from "India Meteorological Department publications" and the same shall be taken into account by the Contractor when designing any part of the Permanent Works. The Contractor shall ensure that due allowance is made for more severe local conditions when Permanent Works are required to operate, for example, with restricted ventilation that may lead to higher local ambient temperatures, and any other factors that may affect the operating environment in any way.

c) Unless specific figures are provided elsewhere, the Permanent Works will generally be required to function at its rated value with the values of ambient temperature and relative humidity appropriate to the location of the equipment within the classifications shown in Table given below. Certain parts of the Permanent Works may need to be rated for more or less onerous conditions as required by the PS.

d) The Contractor's attention is drawn to the more severe environmental conditions that may exist during the construction/installation period and shall

take adequate measures to protect the Permanent works against any deleterious effects of such conditions during the time between installation and final completion of the project. Also, Air throughout the project will contain considerable moisture content, hence the permanent works shall be tropicalized and vermin proof.

14. PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS)

The Contractor shall utilise an available PMIS such that all documents generated by the Contractor can be transmitted to the Engineer by electronic means (and vice versa) and that all documents generated by either party are electronically captured at the point of origin and can be reproduced later, electronically and in hard copy. A similar link shall also be provided between the Engineer office at site and the Employer's Office by the Contractor. In case of non-availability, the Contractor may devise a PMIS of its own.

15. CONTRACTOR'S PROJECT ORGANISATION

a) The Contractor shall have a competent team of Managers, Engineers, Technical staff etc so as to complete the work satisfactory as per various requirements of the Contract.

b) The designations of the various project organisations team members shall be got approved by the Engineer before adoption so as to avoid any duplication of the designations with those of the Employer or the Engineer.

16. CONTRACTOR'S CERTIFICATE

The Contractor shall provide his registration details for GST Registration, EPF registration, ESI registration, Statutory Certificate, Certificate as per ESHS Manual etc. as required for the execution and completion of the Works.

Section VII: Employer's Requirements

Section VII-2: Functional

EMPLOYER'S REQUIREMENTS – FUNCTIONAL (CIVIL)

Objective

The objective of the Contract is the design, construction, completion, testing and commissioning of the permanent works by the Contractor (including without limitation, the design, construction and removal of the Temporary Works) and the rectification of defects appearing in Permanent Works in the manner and to the standards and within the time stipulated by the Contract. In full recognition of this objective, and with full acceptance of the obligations, liabilities and risks which may be involved, the Contractor shall undertake the execution of the Works.

1. GENERAL

1.1 The design and performance of the Permanent Works shall comply with the specific core requirements contained in these Employer's Requirements – Functional.

1.2 The design of the Permanent Works shall be developed in accordance with these Employer's Requirements - Functional, and the other requirements of the Contract.

1.3 The Permanent Works shall be designed and constructed to the highest standards available using proven up-to-date good Engineering practices. The Specification shall in any case not specify standards which, in the Engineer's opinion, are less than or inferior to those described in the Outline Design Specifications (Design Criteria) and Outline Construction Specifications. Construction shall be carried out employing the procedures established by the Contractor as per approved quality assurance plan and Environmental, Social, Health and Safety (ESHS) Manual.

1.4 The Contractor shall be responsible for obtaining all necessary approvals from the relevant Public/Government/Local/Statutory or any agencies in the design and construction of the Works.

1.5 Employer's Requirements- Functional (Civil) shall be read in conjunction with Employer's Requirements -Design, Construction, Outline Design specification, Outline Construction Specifications and other requirements of the Contract.

2. SCOPE OF WORK

2.1 Scope under Lump Sum Price (Schedule A):

2.2 The Lumpsum scope of work in brief is given below but the scope also includes all other requirements stipulated in various parts/sections of the Contract Document including Appendices and Annexures. Lump sum scope of the work (Schedule A of BOQ) includes all items as per details in clause 2.1 to 2.9 & 3 to 11 unless otherwise stated. The items/ works which are not covered in the lump sum price of Schedule-A of BOQ shall be paid in the relevant items under Schedule B & C as mentioned in the clause 2.10 of Employer's Requirements (Functional).

a) Design and construction of railway formation

The Contractor shall design and construct railway formation as per RDSO Specifications "Comprehensive Guidelines and specifications for Railway Formation-Specification No. RDSO/2020/GE: IRS-0004, Sept 2020" as shown in L-section and tender drawings and shall include earthwork in cutting/filling, subgrade, prepared subgrade and blanketing including compaction, protection of slopes by turfing/pitching, design and construction of longitudinal precast RCC drains on berms/cuttings including

water chutes from berms to ground level for safe disposal of rain water, protection on the approaches of bridges as shown in GAD and tender drawings.

The Contractor shall arrange borrow areas for earthwork in embankment at its own cost.

b) Design and construction of minor bridges

The Contractor shall design and construct minor bridges (RUBs and waterway bridges) as per list in **Annexure-F-1.** Minor bridges shall include all components of bridges such as RCC box, wing wall, return wall, curtain/drop wall, flooring, ground improvement if required, protection of approach embankment slopes, boulder backing, granular backfill, inspection steps and other incidental works to complete the bridge in all respects. In addition to above, RUBs shall also include provision of height gauges on approach road, drainage arrangement, repairs to approach road, as required.

c) Design and construction of major bridges

The Contractor shall design and construct major bridges as per **Annexure- F-2**. Superstructure of all the above major bridges shall be as per standard RDSO drawings. However, Open Web Girders (OWG) and Composite Girders shall be provided with spherical bearings. Major bridges shall include all components of bridges such as foundation, abutment/pier, bearings, girders, wing/return wall, ground improvement if required, protection of approach embankment slopes, boulder backing & granular back fill behind abutment/wing/return wall, side pathway as per RDSO drawing No. CBS 0045, access ladder & inspection platforms for abutments/piers, trolly refuge, inspection steps, inspection arrangements for connections of top chord of OWG, height gauges on approach road, bridge boards, bridge plaques and other incidental works to complete the bridges in all respects.

d) Linking of track on Open Web Girders (OWG)

The Contractor shall supply H- beam sleepers including track fittings and link track on OWG including providing and fixing guard rails and gang pathway.

Rails for linking of track shall be supplied free of cost by employer. Transportation of rails upto bridge site shall be paid in respective Schedule B & Schedule C of BOQ.

e) Design and construction of stations

The Contractor shall design and construct stations as per **Annexure- F-3**.

f) Design and construction of yard drainage system

The Contractor shall design and construct yard drainage at New Patli and Sultanpur station consisting of covered/underground longitudinal as shown in tender drawings.

g) Design & construction of RCC precast fencing at end platforms at New Patli and Sultanpur stations.

h) Design & construction of RCC retaining wall for retaining earth of line No.05 at entrance of New Patli station as shown in tender drawing.

i) Design and construction of S&T huts at New Patli and Sultanpur stations on both ends of station yard as shown in tender drawings.

j) Design and construction of RCC hume pipe(NP-4) of 450 mm dia in the embankment at approximately 500m interval for crossing utilities in future.

k) Design of precast and cast in-situ retaining wall.

l) Design of circulating area including land scaping, traffic movement plan, parking space, storm water drainage of circulating area.

m) Traffic management along the work site including construction works required in connection with traffic management like road works, footpaths, drains and other services etc. and repair and maintenance of these construction works during construction period. Any road widening / diversion along with associated drainage system required to facilitate the movement of traffic and their repair & maintenance is also included in the lump sum scope of contract. It also includes reinstatement of land/structure/services etc. to original condition wherever road diversion has been made outside original road including reconstruction of structure demolished for traffic management. Materials and other specification related to traffic control devices shall conform to IRC standards.

n) Providing one deep tube-well of 12,000-15,000 litre/hr yield with pump house and overhead gantry for lowering-taking out pumps for each station, providing & installing submersible pumps of required capacity with all accessories including panels, cables distribution boxes, electrical cable upto main control panel in stations, GI pipe line including connecting them to underground & overhead water storage tanks of stations, pump for pumping from underground tank to overhead tank.

o) Water proofing of subway and underground water storage tanks.

p) Design & construction of temporary structures including construction methodology and getting it approved from third party.

q) The Contractor shall provide and maintain during progress of works barricading around the work area with all safety measures as shown in tender drawings. The excavations near habitations/public movement areas and all works along the roads shall be provided with proper caution signs and marked with red lights, reflectors at night to avoid accidents near public places to ensure safety of public

r) Reinstatement/Restoration of roads and services with new material of similar specification as per codal requirement after completion of work for the area disturbed by the contractor during construction activities. However, reinstatement of roads and its drainage system will be as per current standards being used by the roads/service owning agency for similar roads. Proper survey to be done before dismantling of any of the above services along with extensive Photographs, Videos & sample of these services by the contractor & get it verified by the representative of Engineer so as to ascertain the extent of these existing services and its specification.

2.2.1 There is possibility of some of the items not getting mentioned in the above list of works. Contractors are requested to go through the tender drawings also in details as the works listed in 2.1 above as well as indicated in the tender drawings would be considered inclusive in the scope of work under lump sum quoted price except the items mentioned in Sub-Clause 2.10 below. Engineer's decision shall be final in this regard in case of dispute.

2.2.2 DELETED

2.2.3 The work content against the lump sum component of the work shall also include but not limited to, the following:

a) Site clearance and dismantling of obstructions etc., before commencement of work as specified or as directed;

b) True and proper setting out and layout of the Works, benchmarks and provision of all necessary labour, instruments and appliances in connection therewith as specified or as directed;

c) All aspects of quality assurance, including testing of materials as per the approved inspection and test plan and other components of the work, as specified or as directed;

d) Day to day cleaning of worksite throughout the execution period;

e) Maintenance of the completed Work during the period as specified;

f) Submission of completion (i.e., 'As-Built') drawings 06 (Six) sets in A-1 size and all other related documents as specified including scanned and AutoCAD copy with soft copies in both formats of all As-built drawings & documents.

g) Preparing detailed designs, general drawings and working drawings for various components of the works and obtaining approval in respect thereof from the Engineer, inclusive of incorporation of all modifications, alterations, changes, etc. that may be required to be carried as directed;

h) Requirements of Environmental, Social, Health and Safety (ESHS) manual.

i) Following facilities shall be provided in the casting/fabrication yard.

- All portion where vehicles will ply shall be paved.
- Proper and effective drainage system to be constructed along road boundaries, batching plant etc.

i. Results of sub-surface investigations conducted at project site are enclosed with the tender document. This information about the soil and sub-soil water conditions is being made available to the contractor in good faith and the contractor shall have to obtain the details of sub soil investigation independently. No claim whatsoever on account of any discrepancy about the soil and sub soil water conditions that may be actually encountered at the time of execution of the work and those given in these tender documents shall be admissible to the contractor under any circumstances.

2.3 Other Works under Lump Sum

The Interface management Document as per Appendix- 5 B of Employer's Requirements shall also be complied**.**

2.4 STRUCTURES

Alignment is passing adjacent to KMP Expressway/IR Tracks. The Contractor should ensure that the design and construction should be carried out with adequate measures for the safety & protection of KMP/IR structures. Any of the construction activity shall be planned without affecting the operations of the existing system. It should be ensured that no damage is caused to any such element/person/ property and Engineer/ Employer shall be indemnified against such damage at no extra cost.

2.5 DESIGN CRITERIA

Design criteria shall be as per Outline Design Specifications.

2.6 REFERENCE TO THE STANDARD CODES OF PRACTICE

2.6.1 All Standards, Outline Construction Specifications, Technical Specifications and Codes of practice referred to shall be latest editions including all applicable official amendments and revisions. The Contractor shall make available at site all relevant Indian Standard Codes of practice, IRS, IS, IRC, UIC, as applicable.

2.6.2 Wherever Indian Standards do not cover some particular aspects of design/ construction, relevant International Standards will be referred to. The Contractor shall make available at site such standard codes of practice.

2.6.3 In case of discrepancy among Standard codes of practice and Outline Construction Specifications, the order of precedence will be as below:

a. Outline Design Specifications and Outline Construction Specifications.

b. Standard Codes of Practice. In case of discrepancy among Standard Codes of Practice, the order of precedence will be IRS, IS, IRC, other International codes

c. Indian Railway Unified Standard Specifications,

d. CPWD specifications,

e. NBC 2016,

f. MORTH Specification for road & Bridges,

2.7 DIMENSIONS

As regards errors, omissions and discrepancies in Specifications and Drawings, relevant clause of Particular Specification will apply.

The levels, measurements and other information concerning the existing site as shown on the conceptual / layout drawings are believed to be correct, but the Contractor should verify them for himself and also examine the nature of the ground as no claim or allowance whatsoever will be entertained on account of any errors or omissions in the levels or strata turning out different from what is shown on the drawings.

2.8 ASSOCIATED WORKS

Works to be performed shall also include all general works, preparatory works for the construction and works of any kind necessary for the design and satisfactory construction, completion and maintenance of the works to the intent and meaning of the drawings adopted and Outline Construction Specifications , to best Engineering standards and orders that may be issued by the Engineer from time to time, compliance by the agency with all Conditions of Contract, supply of all materials, apparatus, plants, equipment, tools, fuel, water, strutting, timbering, transport, offices, stores, workshop, staff, labour and the provision of proper and sufficient protective works, diversion, temporary fencing, lighting and watching required for the safety of the public and protection of works on adjoining land; first-aid equipment, sanitary accommodation for the staff and workmen, effecting and maintenance of all insurances, the payment of all wages, salaries, fees, royalties, duties or the other charges arising out of the erection of works and the regular clearance of rubbish, clearing up, leaving the site perfect and tidy on completion.

2.9 CONTRACTOR's FACILITIES & SITE OFFICE

For batching plant, field quality control laboratory, site office and other activities (excluding labour camps) a plot of land of approx. 20,000 Sq. m (approx.) will be made available by the Employer on as is where is basis free of cost. This land shall be made good for such offsite

activities as needed by the Contractor at no extra cost to the Employer. The land shall be cleared from debris, all structures made by the contractor including, RCC footings and rafts etc. and reinstated to the line, level and to the same conditions as existed before the work started before handing over back to the Employer within 91 days after Taking over Certificate. The final bill shall be released to the contractor after all structures from the construction depot are removed & clearance of site. The cost of setting of yard & reinstatement is included in lump sum price in schedule 'A'.

2.10 TIME SCHEDULE & MONITORING OF PROGRESS

a) The agency shall submit with the bid "Time Schedule" for completion of various portions of works. This schedule is to be within the overall completion period. The detailed programme in the form of a quantified bar chart or CPM network shall include all activities starting from design to completion.

b) In compiling its Works Programme and in all subsequent updating and reporting, the Contractor shall make provision for the time required for coordinating and completing the design, testing, commissioning and integrated testing of the Works, including, inter alia, design co-ordination periods during which the Contractor shall co-ordinate its design with those of Designated Contractors, the review procedures, determining and complying with the requirements of all Government Departments and all others whose consent, permissions, authority or license is required prior to the execution of any work.

The Contractor shall submit to the Engineer four copies of a Monthly Progress Report (MPR), describing the progress and current status of the Works. The MPR shall address the matters set out in the Works Programme. Videography by drone shall also be done at all work places every one month as per Outline Construction Specifications

2.11 **Scope of Work Schedule B & C of BOQ**

a) Procurement, supply and installation (including joining and grouting) of precast retaining wall for heights upto 6m from ground level.

b) Construction of cast in-situ retaining wall where precast wall not used.

c) Diversion of all uncharted utilities, if required, as per approved plan.

d) Development of circulating area, parking space, storm water disposal of circulating area etc.

e) Tree cutting, plantation, and any other horticulture work.

f) Transportation of Rails for linking of track on OWG.

g) Construction of roads, footpath and Structures other than covered in Lump Sum schedule of Employer's Requirements.

h) Any other item as directed by Engineer related to the work.

3. **INSPECTION**

The Employer may appoint an independent agency to ensure the quality checking of design, supply, fabrication, erection and construction of all works under scope of work. The Contractor shall ensure the complete co-operation with the agency to perform their work satisfactorily. In addition, the Employer also reserves right to undertake quality check and inspection directly by itself.

4. **ALIGNMENT OF TRACKS**

a) The alignment shall be as shown in the tender drawings. The alignment has been developed by the Employer to meet operational and technical criteria. The Contractor is not required to

evaluate the alignment for compliance with these criteria but shall review it with respect to his own design and construction proposals and shall satisfy himself that it suites to the available land width and there is no conflict with the clearances at proposed structures.

b) The Contractor is permitted to propose minor deviations in alignment to suit his construction proposals, but he must demonstrate that any such deviations shall comply with good design practice and the alignment requirement of the Design Criteria. Such deviations shall require prior approval of the Employer subject to following conditions:

i. There is no extra cost to the employer.

ii. Changes proposed are essentially required to suit the contractor's specific design.

iii. There is no change at the contract boundaries or if there is any, the same is agreed by the Contractor of the adjoining section without any extra cost to the employer**.**

5. DURABILITY AND MAINTENANCE

The Permanent Works shall be designed and constructed such that, if maintained reasonably and in accordance with the Contractor's statement of maintainability contained in the Contract, they shall endure in a serviceable condition throughout their minimum lives as described in Outline Design Specifications .

The Permanent Works shall be designed and constructed so as to minimise the cost of maintenance whilst not compromising the performance characteristics and ride quality of the railway.

6. OPERATIONAL REQUIREMENTS

a) The vertical and horizontal alignments for the main and connectivity line shall comply with the conditions laid in para 4. (i) & (ii) above.

b) During construction the contractor shall be responsible for providing and maintaining adequate flood protection to ensure protection of the works.

c) In the design and construction of the Works, the Contractor shall, as a fundamental objective and as a priority, ensure that passengers, staff and the public will, throughout the operational period of the HORC, and within the confines thereof, be provided with safe environment as is reasonably possible. The Contractor's attention is drawn to Clause 10 of this Employer's Requirements - Functional, concerning the role of the Commissioner of Railway Safety (CRS).

7. FUNCTIONAL REQUIREMENTS OF PUMPING INSTALLATIONS

Water pump installations shall be designed for unmanned operation, controlled through liquid level controllers, capable of pumping the requisite amount of water to the utility or to the ground / overhead tanks.

The pumping installation shall withstand the corrosive effects of normal water supply and serve for the anticipated life of the equipment.

The pipe line size should be such that the velocity head does not exceed the normal static head except for the fire pump which is governed by separate criteria. The valve controls and regulating mechanisms shall be designed for automatic operation.

8. ENVIRONMENTAL CONSIDERATIONS

All provisions and conditions contained in the Environmental, Social, Health and Safety (ESHS) manual as per Appendix 13 shall be strictly complied with.

9. TRAFFIC MANAGEMENT

The Contractor shall carry out the Works so as to minimise disruption to road and pedestrian traffic. The Contractor shall prepare his traffic management plan based on his proposed construction methodology in co-ordination with Engineer and in conjunction with the concerned road authority as per Appendix 10 D. He shall comply strictly with the approved plan during construction of his works.

10. CRS INSPECTION

The Contractor shall note that the Commissioner for Railway Safety (CRS) will inspect the Works from time to time for the purpose of determining whether the HORC Project complies in terms of operational and infra structural safety in accordance with the Laws of India. The contractor shall note that CRS approval is mandatory for commissioning the system. Notwithstanding other provisions of the Contract, the Contractor shall ensure that the Works comply with the requirements of CRS in terms of construction to the drawings and shall make all necessary arrangements and assist the representatives of O&M of HRIDC and CRS in carrying out their inspection duties and also comply with their instructions regarding rectifying any defects and making good any deficiencies. Contractor shall prepare and make available all drawings, documents, sketches, photographs etc. as required for submission of application for inspection of CRS as instructed by the Engineer.

11. STANDARDS

Equipment, materials and systems shall be designed, manufactured and tested in accordance with the latest issue of National and/or International codes and standards. The Contractor shall submit hard copies in original to the Engineer of all codes and standards used for the work.

Reference to standards or to materials and equipment of a particular manufacturer shall be regarded as followed by the words "or equivalent". The Contractor may propose alternative standard materials, or equipment that shall be equal to or better than those specified. If the Contractor for any reason proposes alternatives to or deviations from the specified standards, or desires to use materials or equipment not covered by the specified standards, the Contractor shall apply for the consent of the Engineer. The Contractor shall state the exact nature of the change, the reason for making the change and relevant specifications of the materials and equipment in the English language. The decision of the Engineer in the matter of quality will be final.

ANNEXURE-F-1

LIST OF MINOR BRIDGES

MAIN LINE							
S.No.	**Br. No.**	***Chainage**	**Type of Crossing**	**Type of Bridge**	**SPAN No. x L(in m) xH (in m)**	**Skew (Y/N)**	**No. of Tracks**
1	137	56118.3	Balancing Culvert	RCC Box	1X2X2	N	2
2	138	56291.6	RUB	RCC Box	1X5X3	Y	2
3	139	56466	Balancing Culvert	RCC Box	1X2X2	N	2
4	140	56756	Balancing Culvert	RCC Box	1X2X2	N	2
5	141	57168.9	RUB+ Culvert	RCC Box	1X5X3+1X2X2	Y	2
6	142	57546.9	Balancing Culvert	RCC Box	1X2X2	N	4
7	143	57671.7	RUB	RCC Box	2X7X5	Y	5
8	144	57988	Balancing Culvert	RCC Box	1X2X2	N	5
9	145	58204.1	Balancing Culvert	RCC Box	1X5X3	N	5
10	146	58565.9	Balancing Culvert	RCC Box	1X2X2	N	4
11	149	59885.9	RUB	RCC Box	1X10X5	N	2
12	150	60162.3	RUB+ Balancing Culvert	RCC Box	1X5X3+1X2X2	N	2
13	151A	60454.484	Road Crossing (RUB)	RCC Box with piers	(5.5+8+5.5)X5.5	Y	2
	151B	60566.384			(5.5+8+5.5)X5.5	Y	2

MAIN LINE							
S.No.	**Br. No.**	***Chainage**	**Type of Crossing**	**Type of Bridge**	**SPAN No. x L(in m) xH (in m)**	**Skew (Y/N)**	**No. of Tracks**
	151C	60642.158		instead of central wall	(5.5+8+5.5)X5.5	Y	2
	1518	60760.328			(5.5+8+5.5)X5.5	Y	2
14	152	61164.4	Balancing Culvert	RCC Box	1X2X2	N	2
*Chainages start from Prithla station of HORC.							
CONNECTING LINES							
S.N	**Br. No.**	**Chainage From New Patli**	**Type Of Crossing**	**Type of Bridge**	**SPAN No. x L(in m) xH (in m)**	**Skew (Y/N)**	**No. of Tracks**
NEW PATLI TO PATLI							
1	3	898.787	RUB	RCC Box	1X5X3	Y	1
2	4	1153.19	Balancing Culvert	RCC Box	1X2X2	Y	1
3	5	1858.92	RUB	RCC Box	1X5X3	Y	1
4	6	2391.11	RUB	RCC Box	1X5X5	Y	1
5	7	2560.49	Balancing Culvert	RCC Box	1X2.5X3	Y	1
NEW PATLI TO FARUKHNAGAR/SULTANPUR							
1	1	1698.05	Balancing Culvert	RCC Box	1X2X2	N	1
2	2	1912.7	RUB	RCC Box	1X5X3	Y	1
3	3	2807.82	Balancing Culvert	RCC Box	1X2X2	N	1

MAIN LINE							
S.No.	**Br. No.**	***Chainage**	**Type of Crossing**	**Type of Bridge**	**SPAN No. x L(in m) xH (in m)**	**Skew (Y/N)**	**No. of Tracks**
4	4	2972.71	RUB	RCC Box	1X5X4	Y	1

ANNEXURE-F-2

LIST OF MAJOR BRIDGES

S. No	Br. No.	*Chainage	Type of Crossing	Type of Bridge Superstructure	Span Arrangement		No. of Tracks
					Number of Span	Span (in m)	
1	136	55719.028	Rail Fly Over (RFO)	OWG	1	76.2	2
2	147	59107.01	Road Crossing (RUB)	OWG	1	45.7	2
	New Patli to Farukhnagar (Sultanpur)						
3	147(A)	-	Road Crossing (RUB)	OWG	1	45.7	1

*Chainages start from Prithla station of HORC.

ANNEXURE-F-3
LIST OF PASSENGER FACILITIES

The contractor shall design and construct two stations namely New Patli & Sultanpur as shown in tender drawings. Passenger facilities to be provided at each station are given in the table below. The Contractor shall also provide station building, RCC underground water storage tank, RCC overhead water storage tank, water supply distribution system from overhead water storage tanks to station building and platforms, 01 No. septic tank at each station of suitable capacity along with sewer lines, rain water harvesting of surface runoff from platforms, station approach road, barbed wire fencing with RCC posts at ROW, firefighting system as shown in tender drawings.

S. No	Passenger Facilities	New Patli	Sultanpur
1.	Platform	01 No. island platform and 01 No. end platform as per tender drawings	01 No end platform as per tender drawings
2.	Drinking Water Booths	05 Nos on each platform	05 Nos on each platform
3.	Waiting Hall	As per tender drawings	As per tender drawings
4.	PF shelter	20 m (two nos.) on each platform for entire width.	-
5.	PF mini shelter	04 Nos on each platform as per tender drawings.	04 Nos on each platform as per tender drawings
6.	Toilet block	01 on each platform as per tender drawings.	01 on each platform as per tender drawings
7.	Seating arrangement	50 Nos stainless steel seats on each platform	20 Nos stainless steel seats on each platform
8.	Subway with staircase	01 No. as per tender drawings	-
9.	Lifts	03 Nos	-
10.	MS Station name board at platform	At each end of platform	At each end of platform
11.	RCC underground storage tank of net capacity (cum)	50	25
12.	RCC overhead water storage tank of net capacity (cum)	20	10
13.	Septic tank	As per tender drawing 01 No. at each platform for 50 users and 01 No. at station building for 100 users.	As per tender drawing 01 No. at each platform for 50 users and 01 No. at station building for 50 users.

Section VII: Employer's Requirements

Section VII-3: Design (Civil)

EMPLOYER'S REQUIREMENTS – DESIGN (CIVIL)

1. INTRODUCTION

1.1 The Employer's Requirements - Design, specifies the procedural requirements for the preparation of the design of the Permanent Works. These requirements are subdivided into those that are to occur during the Design Phase, those that are to occur during the Construction Phase, and those that are of general application.

1.2 In addition to the express requirements herein, the Contractor shall, whenever the Engineer so requests, provide information and participate in discussions that relate to design matters.

1.3 The Contractor shall engage the Designer who shall undertake and prepare the design of the Permanent Works and Temporary Works. The Contractor shall place his core design team at Gurgaon.

1.4 The Contractor shall ensure presence of Design team at Gurgaon at all times by staff whose seniority and experience are to the satisfaction of the Engineer and whose representative is available on the Site as necessary or as required by the Engineer.

1.5 The Contractor shall submit his Quality Assurance Plan as required at Appendix 11 for the design required by the Contract.

1.6 The Contractor shall furnish Designer's Warranty in the format approved by the Employer.

1.7 The Design and Construction Standards shall be in conformity with the requirements of "Rules for Opening of a Railway or a Section of a Railway for Public Carriage of Passengers" and to the satisfaction of the Commissioner of Railway Safety whose sanction is mandatory for commissioning of the System.

2. REQUIREMENTS DURING DESIGN PHASE

2.1 The principal requirements of the Design Phase are the production of the Preliminary Design and General Arrangement Drawings, the Definitive Design and the Construction Reference Drawings.

2.2 Preliminary Design and General Arrangement Drawings

The Preliminary Design shall define the main structural elements. In addition, General arrangement drawing, general construction methods and documentation needed to develop the Definitive Design shall be submitted.

2.3 Definitive Design shall be the design developed to the stage at which all elements of the structures are fully defined and specified and in particular:

a) Calculation and analysis are complete;

b) All main and all other significant elements are delineated;

c) All tests and trials and all selection of materials and equipment are

complete;

d) Shall take full account of the effect on the Permanent Works of the proposed methods of construction and of the Temporary Works.

2.4 During the preparation of the Definitive Design, the Contractor shall complete all surveys investigations and testing necessary to complete the design of the Permanent Works.

2.5 The Contractor shall sub-divide the proposed Definitive Design into Design Packages to be submitted in advance of the Definitive Design Submission and to be identified in the Design Submission Programme. The Design Packages are to relate to the significant and clearly identifiable parts of the proposed Definitive Design and shall address the design requirements as described herein. The Design Packages shall facilitate the review and understanding of the Definitive Design as a whole and shall be produced and submitted in an orderly, sequential and progressive manner.

2.6 Separate Definitive Design Submissions may be prepared for those major elements to be procured by sub-contract and which sub-contracts include design. Where such work is to be procured by the Contractor on the basis of outline design, design briefs and performance specifications, such documents may be submitted as Definitive Design Submissions.

2.7 Upon issue of the Notice in respect of the Definitive Design Submission, the Contractor shall complete the design in all respects and produce the Construction Reference Drawings, the purpose of which is to illustrate all the Permanent Works and to be the drawings governing construction.

2.8 Construction Reference Drawings shall fully detail for the construction of the elements covered by the Definitive Design and shall show in full the works to be constructed.

3. REQUIREMENTS DURING CONSTRUCTION PHASE

3.1 The principal requirements relating to design during the Construction Phase are the production of Working Drawings, the preparation of technical submissions as required under the Contract, the compilation of the Final Design and the production of the As-Built Drawings.

3.2 Working Drawings shall be prepared as required under the Contract. They shall be endorsed by the Contractor as being in accordance with the Construction Reference Drawings.

3.3 The Contractor shall endorse the submissions required under the contract that "all effects of the design comprising the submission on the design of adjacent or other

3.4 parts of the works have been fully taken into account in the design of these parts"

3.5 At least 3 months but not more than 6 months prior to the anticipated date of substantial completion of the Works, the Contractor shall submit the Final Design to the Engineer.

3.6 The Final Design is the design of the Permanent Works embodied in:

a) the latest revisions of the documents comprised in the Definitive Design, taking account of comments in the schedules appended to Notices of No Objection

b) the latest revisions of the Construction Reference Drawings;

c) the calculations (see Clause 11 herein); and

d) such other documents as may be submitted by the Contractor at the request of the Engineer to illustrate and describe the Permanent Works and for which a Notice has been issued.

3.7 The Contractor shall maintain all records necessary for the preparation of the As-Built Drawings. Upon completion of the Works or at such time as agreed to or required by the Engineer, the Contractor shall prepare drawings which, subject to the Engineer's agreement, shall become the As-Built Drawings. All such drawings shall be endorsed by the Contractor as true records of the construction of the Permanent Works and of all temporary works that are to remain on the site. The Contractor shall also show the locations of utilities exposed, and retained as directed.

4. DESIGN INTERFACES WITH INTERFACING CONTRACTORs

The Contractor shall co-ordinate all design and installation work with the Interfacing Contractors,i.e. C-1,T-1,Br-1 and C-6 . The Contractor shall co-ordinate with all Interfacing Contractors to produce a detailed programme of access dates, equipment delivery routes and occupation periods for each work area. . DESIGN SUBMISSIONS: -

4.1 PRELIMINARY DESIGN and GAD SUBMISSION

GENERAL

The preliminary design shall provide initial design documents for review and shall be sufficiently detailed to show the element of the design main and documents required for preparation of the definitive design. It shall also include:

a) the quality assurance plan for design

b) a review of the outline design criteria

c) the submission of design manuals

d) the submission of two licensed copies of proposed software

e) the preliminary equipment layouts and details

f) the preliminary maintenance analysis

g) the preliminary on site testing recommendation

h) the submission of specifications proposed for the work

i) the identification of design codes and standards

j) the CAD procedures

k) preliminary station sizing

l) an alignment reviews

m) the preliminary construction methodology

n) the design submission programme (update)

o) the utility diversion plan

p) proposed site surveys and other field surveys

q) a review of permanent land requirement

r) the preliminary ground treatment and building protection proposal.

s) GAD of bridges and architectural drawings of stations

t) The preliminary reinstatement drawings.

u) Deleted

4.2 DEFINITIVE DESIGN SUBMISSION

a) GENERAL

The Definitive Design Submission shall be a coherent and complete set of documents properly consolidated and indexed and shall fully describe the proposed Definitive Design. In particular, and where appropriate, it shall define:

a) the dimensions of all major features, structural elements and members;

b) all materials;

c) potential forces and movements due to all possible loadings and actions on the structures, and their accommodation;

d) all second order effects;

e) the layout and typical details of reinforcement in structural concrete members;

f) the locations and nature of all relevant joints and connections and details thereof;

g) Standard details;

h) location, geometry and setting-out of all main elements and features;

i) electrical and mechanical services and equipment and their interaction with the structures;

j) provisions and proposals for construction interfacing with the Designated Contractors;

k) Erection / launching scheme;

l) utilities to be diverted /supported;

m) Traffic or other civic service affected.

b) DRAWINGS

The Definitive Design Submission shall include drawings that shall illustrate the proposed Definitive Design and in particular shall include, without limitation:

a) general arrangements;

b) layouts and details of structural elements;

c) associated fittings;

d) slopes and earthworks;

e) structural and surface drainage;

f) existing and proposed utilities;

g) road works and works related to traffic management including decking.

c) CONTRACT SPECIFICATION

The Specification included in theOutline Design Specifications and Outline Construction Specifications for Civil Works shall be amplified so as to specify comprehensively the design and construction of the Permanent Works.

d) DESIGN MANUAL

The Design Manual shall incorporate all design requirements, standards, codes, loading cases, permissible movements and deflections, limit states, design stresses and strains, material properties and all other documents or matters which are relevant to and govern the design. The Design Manual shall refer to all materials, codes and standards used, making clear their specific applications. The Design Manual shall be produced so that it can be used by those involved in the preparation or review of the design of the Permanent Works as a comprehensive reference text and efficient working document.

e) INTERFACE REPORT ON INTERFACING CONTRACTORS

This will include the following:

Details of the design and construction of the Works adjacent to other contracts. Details of provisions for the Interfacing Contractors, indicating arrangements for accesses, fixings, casting-in, openings, supports, decks, manholes, trenches and the

like; updated interface management plan relating to design integration and co-ordination.

f) TESTING AND COMMISSIONING REPORT

Details of proposals for testing and commissioning procedures for all relevant elements and equipment contained in the Permanent Works.

g) STATION PLANNING REPORT

Detailed report with the planning of the station and other amenities required for proper functioning of the station.

h) SUPPORTING DOCUMENTS

The Definitive Design Submission shall be accompanied by the following documents, which will be considered by the Engineer in his review of the Definitive Design Submission. Where relevant or required, these documents shall be accompanied by a design note stating clearly how information has been used in the design of the Permanent Works.

i) GEOTECHNICAL INTERPRETATIVE REPORT

A report including site investigation results and covering the geotechnical interpretation of site investigation work including that undertaken by the Contractor in sufficient detail to confirm and justify parameters used in the bridges and other structures foundation and geotechnical designs. The report shall include the full logs and descriptions of confirmatory boreholes drilled by the Contractor.

j) SURVEY REPORT

A report on all survey work undertaken by the Contractor, including checks on mapping, survey stations, co-ordinates and setting-out. Updated topographical and survey drawings shall also be included.

k) UTILITIES REPORT

A report giving details of arrangements and working methods in respect of the existing utilities, including protection measures, diversions, reinstatements and programme allowances.

l) TEMPORARY WORKS DESIGN REPORT

A report which provides sufficient information on the design of the Temporary Works to allow the Engineer to assess their effects on the Permanent Works and to enable these to be taken into account in the review of the Definitive Design.

m) **INSTALLATION ANALYSIS REPORT**

A report containing a stage-by-stage construction / installation sequence for all structures / equipment.

n) CONSTRUCTION METHOD STATEMENT

A report which provides sufficient information on the methods of construction and Contractor's Equipment to allow the Engineer to assess their effects on the Permanent Works and to enable these to be taken into account in the review of the Definitive Design**.**

o) PROJECT SCHEDULE REVIEW

i. The Contractor shall, prior to submitting the Definitive Design Submission, review the Project Schedule against the current version of the Design Submission Programme.

ii. In the event that the Contractor considers that there are any discrepancies or inconsistencies between the Design Submission Programme and the Project Schedule, the Contractor shall submit with the Definitive Design Submission its proposed revisions to the Project Schedule such that the discrepancies or inconsistencies are removed.

iii. The Contractor shall provide details of submissions of the proposed Working Drawings and their anticipated timing during the Construction Phase and shall identify information required from or actions to be undertaken by the Employer or others which are necessary to permit the completion of the design of the Permanent Works and the Working Drawings. Desired Dates for the receipt required by the Contractor of such information or for the completion of such actions shall be included with appropriate justification.

p) NOTICES ON DEFINITIVE DESIGN SUBMISSION

The Contractor may make Definitive Design Submissions and seek separate Notices in respect of:

i. The temporary works for construction of the bridges

ii. Major elements as identified under Clause 2.6 herein.

The issue of such separate Notices under (a) and (b) above shall be conditional upon the Contractor having demonstrated, to the satisfaction of the Engineer, that the effect of each structure on other structures, utilities, etc., has been fully accommodated in the design.

5. DESIGN SUBMISSIONS - CONSTRUCTION REFERENCE DRAWINGS SUBMISSIONS

5.1 The Construction Reference Drawings shall be derived directly from the Definitive Design and shall detail and illustrate in full the Permanent Works. The Construction Reference Drawings shall form part of the Working Drawings to be used for construction purposes.

5.2 Prior to any Construction Reference Drawings Submission, the Contractor shall prepare a full list of Construction Reference Drawings in order to demonstrate, to the satisfaction of the Engineer, that such Construction Reference Drawings will be sufficient in extent to cover the construction of the whole of the Permanent Works.

5.3 Unless otherwise required by the Engineer, the Construction Reference Drawings need not include bar bending schedules, bar reference drawings, fabrication or shop drawings as well as other schedules or erection drawings which are to be provided by the Contractor during the Construction Phase.

6. DESIGN SUBMISSIONS - CONSTRUCTION PHASE

6.1 On the issue of a Notice in respect of the Construction Reference Drawings the Contractor shall produce the proposed Working Drawings. These shall either be identical to the Construction Reference Drawings or shall be further drawings developed in accordance with the Construction Reference Drawings such as site sketches, bar bending schedules, bar reference drawings, fabrication and shop drawings, construction erection sequences and the like. All such drawings shall comply with the requirements of the Contract.

6.2 Prior to submission of the proposed Working Drawings, the Contractor shall endorse the appropriate original paper drawings as "Good for Construction". If the Engineer so requires, the endorsed original shall be submitted to the Engineer who shall, if he has no objection to the contents of the submission, further endorse the original by stating that he has no objection to the proposed Working Drawings. On the endorsement by the Engineer, the original will forthwith be returned to the Contractor as the Working Drawings.

6.3 Only the Working Drawings endorsed as in 7(ii) above or those that the Engineer has expressly stated as not requiring his endorsement shall be issued to the Site. The Construction of the Works shall be strictly in accordance with these Working Drawings.

6.4 The Contractor shall finalise details of the proposed method of construction and submit such finalised details to the Engineer for review. The proposed method shall have no adverse effects on the partially completed Permanent Works and shall ensure the Works are statically and, if appropriate, aerodynamically stable.

6.5 The Contractor shall undertake and submit a stage-by-stage construction sequence and the effect of any Temporary Works and the Contractor's Equipment on the Permanent Works. This analysis shall be in sufficient detail to demonstrate that the Contractor's proposals are safe and have no adverse effects upon any parts of the Permanent Works.

6.6 As-Built Drawings, endorsed by the Contractor shall be submitted to the Engineer for agreement

7. DESIGN SUBMISSIONS - REVIEW PROCEDURES

7.1 Submissions of Design Data shall be made and reviewed by the Engineer. The form and detail of the review shall be as determined by the Engineer and will not release or remove the contractor's responsibility for the design under the contract.

7.2 The issue of a Notice shall be without prejudice to the issue of any future Notices.

7.3 The Contractor shall, prior to the submission of the Design Data, obtain all required and/or statutory approvals that relate to that submission including, where appropriate,

the approval of the Concerned Government Authorities and utility undertakings, and demonstrate that all required approvals have been obtained.

7.4 All submissions shall be accompanied by two original copies of a `Design Certificate' as set out in Attachment D1 hereto and signed by the Contractor and the Designer.

8. DESIGN SUBMISSION PROGRAMME

8.1 The Contractor shall prepare the Design Submission Programme which is to set out fully the Contractor's anticipated programme for the preparation, submission and review of the Design Packages, the Definitive Design Submission and the Construction Reference Drawings Submissions and for the issue of Notices in relation thereto.

8.2 The Design Submission Programme shall:

a) be consistent with and its principal features integrated into the Works Programme, and show all relevant Key Dates;

b) identify dates and subjects by which the Engineer's decisions should be made;

c) make adequate allowance for periods of time for review by the Engineer and other review bodies;

d) make adequate allowance for the design and development of specialist works;

e) include a schedule identifying, describing, cross-referencing and explaining the Design Packages into which the Contractor intends to divide the Definitive Design and Construction Reference Drawings; and

f) indicate the Design Interface and Co-ordination periods for each Interfacing Contractor.

8.3 The Contractor shall submit the Design Submission Programme to the Engineer within thirty (30) days of the date of commencement., and thereafter up-dated versions thereof at intervals of not more than one (1) month throughout the Design Phase.

9. PROGRAMME FOR SUBMISSIONS DURING THE CONSTRUCTION PHASE

In accordance with Clause 4 of the Employer's Requirements - General, the Contractor shall identify submissions required during the Construction Phase.

10. CALCULATIONS

10.1 Unless otherwise required by the Engineer, calculations relevant to the Definitive Design and Construction Reference Drawings shall be submitted for review with the respective Design Packages or Submissions. The Engineer may require the submission of applicable software including in house software programmes/ worksheets developed by the Contractor, computer input and programme logic for its review prior to the acceptance of the computer output.

10.2 The Contractor shall prepare and submit a comprehensive set of calculations for the Definitive Design in a form acceptable to the Engineer. Should the design of the Permanent Works be revised thereafter and such revision renders the calculations as submitted obsolete or inaccurate, the Contractor shall prepare and submit the revised calculations.

10.3 Similarly, the Contractor shall submit such further calculations as have been prepared in connection with the Construction Reference Drawings.

10.4 Calculations to be included as part of the submission herein shall comprise the up-to-date calculations in respect of the Definitive Design, the Construction Reference Drawings and such further calculations which the Contractor has prepared during the production of Working Drawings.

10.5 The Contractor shall submit all calculations necessary to support proposals relating to the construction methods.

11. DOCUMENTS REQUIREMENTS

11.1 Drawings shall be prepared generally to A1 size, but to A0 size where appropriate.

11.2 The Contractor shall submit 03 copies of his design and/or drawings for review by the Engineer. After receipt of "No Objection" from the Engineer's Representative, the Contractor shall submit 06 copies of design and/or drawing for the use of the Engineer.

11.3 The submission of drawings should be as per Appendix 9 of the the Employer's Requirements.

11.4 The contractor to provide two licensed working software copy being used by its DDC to Employer/Engineer's design department maintained for the entire contract period.

ATTACHMENT D 1

DESIGN CERTIFICATE

This Design Certificate refers to design submission no. ..... , which comprises of Definitive Design submission / Construction Reference Drawings submission, working drawing submission scheduled in the attached transmittal, in respect of:

(Description of Permanent Works to which the submission refers)

DESIGNER'S STATEMENT:

We certify that:

a) the outline designs, design briefs and performance specifications of those elements of the Permanent works as illustrated and described in the documents scheduled in the attached transmittal, complies with the Outline Design Specifications and other contract provisions.

b) an in-house check has been undertaken and completed in accordance to approved Quality Assurance Plan (QAP) to confirm the completeness, adequacy and validity of the design of the Permanent Works as illustrated and described in the documents scheduled in the attached transmittal.

c) all necessary and required approval relating to the design of the Permanent Works, as illustrated and described in the documents listed in the attached transmittal, have been obtained.

d) all effects of the design comprising the submission on the design of adjacent or other parts of the works have been fully taken into account in the design of those parts.

Signed by Designer's Authorised Representative

Name : .....

Position : .....

Date : .....

CONTRACTOR'S CERTIFICATE:

The Certifies that all design has been performed utilizing the skill and care to be expected of a professionally qualified and competent designer, experienced in work of similar nature and scope. This further certifies that all works relating to the preparation, review, checking and certification of design has been verified by us and the design proposed by the designer has been accepted by us.

Signed by Contractor's authorised representative

Name : .....

Position : .....

Date : .....

Note 1

The Contractor shall insert one of the following, as applicable:

(i) the Contractor's Technical Proposals

(ii) the Contractor's Technical Proposals and Design Packages Nos. ..... for which a Notice of No Objection has been issued.

(iii) Design Packages Nos. .....….. for which a Notice of No Objection has been issued if such Design Packages develop and amplify the Contractor's Technical Proposals.

(iv) The Definitive Design

SAMPLE DESIGN/DRAWING TEMPLATE

(a) 'Design Quality Assurance' by designer & contractor:

DESIGN QUALITY ASSURANCE			
The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.			
By Designer			**By Contractor**
Sig. :	Sig. :	Sig. :	Sig. :
Date. :	Date. :	Date. :	Date. :
Name :	Name :	Name :	Name :
Designed by	Checked by	Approved by	Accepted By

(b) Notice of 'No Objection' from the Engineer:

Notice of 'No Objections' from the Engineer			
Notice of "No Objections" from the Engineer is being accorded for design Principles. However, the overall responsibility for the detailing and design accuracy lies with Design and Build Contractor.			
	REMARKS		
Design Engineer (GC/HORC)	Reviewed		
Senior Design Expert (GC/HORC)	Reviewed		
Chief Design Expert (GC/HORC)	Reviewed		
DPD (GC/HORC)	Reviewed & comments as marked on drawing		

Section C

[Contractor to attach copies of necessary and required approvals]

MINIMUM REQUIREMENT OF THE DDC'S ORGANIZATIONAL STRUCTURE

The DDC shall submit an Organisation Chart together with clear description of the responsibilities of each member within the overall works programme.

Sr.NO	Designation	Experience
1	Team Leader	Graduate degree in Civil Engineering having experience not less than 10 years and would have handled minimum 02 projects as Team Leader of similar nature & complexity
2	Bridge Expert	Graduate degree in Civil Engineering and minimum 7 years of relevant experience in the concerned field and would have handled minimum 01 project of similar nature & complexity as Expert
3	Embankment Expert	

NOTE:

1. Sufficient documentary proof to substantiate the qualification and work experience shall be submitted.The Contractor shall submit proposal of DDC experts having experience as mentioned above to the Engineer for approval before deployment. The work is to be designed, constructed and maintained as per relevant codes, Outline Construction Specifications, Outline Design Specifications and drawings and/or as directed by the Engineer.

Section VII: Employer's Requirements

Section VII-4: Construction (Civil)

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EMPLOYER'S REQUIREMENTS – CONSTRUCTION (Civil)

1. CONTRACTOR'S SUPERINTENDENCE

The Contractor shall submit a Staff Organisation Plan in accordance with the Attachment C-1

This plan shall be updated and resubmitted whenever there are changes to the staff. The plan shall show the management structure and state clearly the duties, responsibilities and authority of each staff member.

The contractor's representative and his associates/supervisors shall have experience and qualification appropriate to the type and magnitude of the Works as per Attachment C-2. Full details shall be submitted of the qualifications and experience of all proposed staff to the Engineer for his approval.

2. CONTRACTOR'S TEMPORARY WORKS DESIGN

The Contractor shall, prior to commencing the construction of the Temporary Works, submit a certificate to the Engineer signed by him certifying that the Temporary Works have been properly and safely designed and checked and that the Contractor has checked the effect of the Temporary Works on the Permanent Works and has found this to be satisfactory.

2.1 UTILITIES

a) Refer Employer's Requirements - Functional and Appendix-12 of Employer Requirements.

2.2 STRUCTURES, ROADS AND OTHER PROPERTIES

a) The Contractor shall immediately inform the Engineer of any damage to structures, roads or other properties.

2.3 SITE LABORATORIES

a) The Contractor shall provide, erect and maintain in a clean, stable and secure condition a laboratory, equipped for the routine testing of cement, aggregate, concrete and soil samples and for the storage and curing of concrete cubes or cylinders only. This laboratory shall be located at the Contractor's principal work site or at a location agreed to by the Engineer. Detailed requirements for this laboratory are set out in Appendix 14 to these Employer's Requirements.

3. TESTING

3.1 GENERAL

a) The Contractor shall provide and perform all forms of testing procedures applicable to the Works and various components and the interfacing of the Works with the other Contract works and shall conduct all necessary factory, site and acceptance tests.

b) Deleted

c) All testing procedures shall be submitted at least thirty (30) days prior to conducting any Test. The Testing procedures shall show unambiguously the extent of testing covered by

each submission, the method of testing, the Acceptance Criteria, the relevant drawing (or modification) status and the location.

d) The testing Procedures shall be submitted, as required, by the Contractor during the duration of the contract to reflect changes in system design or the identification of additional testing requirements.

e) The Engineer shall have the facilities for monitoring all tests and have access to all testing records. Ample time shall be allowed within the testing programmes for necessary alterations to equipment, systems and designs to be undertaken, together with re-testing prior to final commissioning.

f) The Contractor is reminded that at some point, the High Voltage Power Supply system will be energised and the additional precautions for the safety of staff and co-ordination of activities after power-on shall be anticipated in its testing and commissioning programmes.

g) All costs associated with the Testing shall be borne by the Contractor, unless otherwise specified, including the services of any specialised personnel or independent assessors. The Contractor shall also bear any expenses incurred due to resetting caused by defects or failure of equipment to meet the requirements of the Contract in the first instance. No such testing shall relieve the Contractor from any obligation or responsibility

h) Unless agreed in writing by the Engineer, the personnel engaged on testing shall be independent of those directly engaged in the design or installation of the same equipment.

i) All testing equipment shall carry an appropriate and valid calibration labels.

3.2 BATCHES, SAMPLES AND SPECIMENS

a) A batch of material is a specified quantity of the material that satisfies the specified conditions. If one of the specified conditions is that the material is delivered to the Site at the same time, then material delivered to the Site over a period of a few days may be considered as part of the same batch if in the opinion of the Engineer there is sufficient proof that the other specified conditions applying to the batch apply to all of the material delivered over the period.

b) A sample is a specified quantity of material that is taken from a batch for testing and which consists of a specified amount, or a specified number of pieces or units, of the material.

c) A specimen is the portion of a sample that is to be tested.

3.3 SAMPLES FOR TESTING

a) Samples shall be of sufficient size and in accordance with relevant Standards to carry out all specified tests.

b) Samples taken on the Site shall be selected by, and taken in the presence of, the Engineer and shall be suitably marked for their identification. An identification marking system should be evolved at the start of works in consultation with the Engineer.

c) Samples shall be protected, handled and stored in such a manner that they are not damaged or contaminated and such that the properties of the sample do not change.

d) Samples shall be delivered by the Contractor, under the supervision of the Engineer, to the specified place of testing. Samples on which non-destructive tests have been carried out shall be collected from the place of testing after testing and delivered to the Site or other locations instructed by the Engineer.

e) (Samples which have been tested may be incorporated in the Permanent Works provided that:

I. the sample complies with the specified requirements;

II. the sample is not damaged; and

III. the sample is not required to be retained under any other provision of the Contract.

f) Additional samples shall be provided for testing if in the opinion of the Engineer :

I. material previously tested no longer complies with the specified requirements; or

II. material has been handled or stored in such a manner that it may not comply with the specified requirements.

3.4 TESTING

a) The Contractor shall be responsible for all on-site and off-site testing and for all in-situ testing. All appropriate laboratory tests shall be carried out in the Contractor's laboratory, unless otherwise permitted or required by the Engineer. Where the laboratory is not appropriately equipped and/or staffed for some tests, or if agreed to by the Engineer, tests may be carried out in other laboratories provided that:

i. they are accredited for the relevant work to a standard acceptable to the Engineer; and

ii. particulars of the proposed laboratory are submitted to the Engineer for his consent.

b) In-situ tests shall be done in the presence of the Engineer.

c) Equipment, apparatus and materials for in-situ tests and laboratory compliance tests carried out by the Contractor shall be provided by the Contractor. The equipment and apparatus shall be maintained by the Contractor and shall be calibrated before the testing starts and at regular intervals as permitted by the Engineer. The equipment, apparatus and materials for in-the situ tests shall be removed by the Contractor as soon as practicable after the testing is complete.

d) The Contractor shall be entitled in all cases to attend the testing carried out in the Employer's or other laboratories, to inspect the calibration certificates of the testing machines and to undertake the testing on counterpart samples. Testing of such samples shall be undertaken in laboratories and particulars of the laboratory proposed shall be submitted to the Engineer for consent prior to the testing.

e) Attendance on tests, including that by the Engineer, Contractor and Designer, shall be as laid down in the Quality Assurance procedures.

3.5 COMPLIANCE OF BATCH

a) The results of tests on samples or specimens shall be considered to represent the whole batch from which the sample was taken.

b) A batch shall be considered as complying with the specified requirements for a material if the results of specific tests for of the specified properties comply with the specified requirements for the properties.

c) If additional tests are permitted or required by the Engineer but separate compliance criteria for the additional tests are not stated in the Contract, the Engineer shall determine if the batch complies with the specified requirements for the material on the basis of the results of all tests, including the additional tests, for every properties.

3.6 RECORDS OF TESTS

a) Records of in-situ tests and laboratory compliance tests carried out by the Contractor shall be kept by the Contractor on the Site and a report shall be submitted to the Engineer within seven (7) days, or such other time stated in the Contract or in the Quality Assurance Programme, after completion of each test. In addition to any other requirements, the report shall contain the following details:

i. material or part of the Works tested;

ii. location of the batch from which the samples were taken or location of the part of the Works;

iii. place of testing;

iv. date and time of tests;

v. weather conditions in the case of in-situ tests;

vi. technical personnel supervising or carrying out the tests;

vii. size and description of samples and specimens;

viii. method of sampling;

ix. properties tested;

x. method of testing;

xi. readings and measurements taken during the tests;

xii. test results, including any calculations and graphs;

xiii. specified acceptance criteria; and

xiv. other details stated in the Contract.

b) Reports of tests shall be signed by the site agent or his assistant, or by another representative authorised by the Contractor.

c) If requested, records of tests carried out by the Employer's staff or by the Engineer shall be given to the Contractor.

4. RECORDS

4.1 DRAWINGS PRODUCED BY THE CONTRACTOR

a) Drawings produced by the Contractor including drawings of site layouts, Temporary Works, etc. for submission to the Engineer shall generally be to A1 size. They shall display a title block with the information as detailed in Appendix 9 to these Employer's

Requirements. The number of copies to be submitted to the Engineer shall be as stated in the Contract, or as required by Engineer.

4.2 PROGRESS PHOTOGRAPHS

a) The Contractor shall provide monthly progress photographs which have been properly recorded to show the progress of the works to the Engineer. The photographs shall be taken on locations agreed with the Engineer to record the exact progress of the Works.

b) The Contractor shall mount each set of each month's progress photographs in a separate album of a type to which the Engineer has given his consent, and shall provide for each photograph two typed self-adhesive labels, one of which shall be mounted immediately below the photograph and one on the back of the photograph. Each label shall record the location, a brief description of the progress recorded and the date on which the photograph was taken.

c) All photographs shall be taken by a skilled photographer whose name and experience shall be submitted to the Engineer for consent and approval received. Processing shall be carried out by a competent processing firm to the satisfaction of the Engineer.

d) The Contractor shall ensure that no photography is permitted on the Site without the agreement of the Engineer. Contractor should be aware of the local regulations and conditions with regard to Photography.

5. MATERIALS

a) Materials and goods for inclusion in the Permanent Works shall be new unless the Engineer has consented otherwise. Preference shall be given to local materials where available. Approved Manufacturers/Suppliers of few important items have been given in Appendix 10 of this document. These materials shall be procured only for these manufacturers/Suppliers.

b) Certificates of tests by manufacturers which are to be submitted to the Engineer shall be current and shall relate to the batch of material delivered to the Site. Certified true copies of certificates may be submitted if the original certificates could not be obtained from the manufacturer.

c) Parts of materials which are to be assembled on the Site shall be marked to identify the different parts.

d) Materials which are specified by means of trade or proprietary names may be substituted by materials from a different manufacturer which has received the consent of the Engineer provided that the materials are of the same or better quality and comply with the specified requirements.

e) Samples of materials submitted to the Engineer for information or consent shall be kept on the Site and shall not be returned to the Contractor or used in the Permanent Works unless permitted by the Engineer. The samples shall be used as a mean of comparison which the Engineer shall use to determine the quality of the materials subsequently delivered. Materials delivered to the Site for use in the Permanent Works shall be of the same or better quality as the samples which have received consent.

6. PROVISIONS FOR INTERFACING CONTRACTORS

Interface responsibilities mentioned in Appendix–5 B, shall be followed by the Contractor.

7. RESTORATION OF AREAS DISTURBED BY CONSTRUCTION.

Unless otherwise directed by the Engineer, any areas disturbed by the construction activity, either inside or outside the Project Right of Way, shall be reinstated as follows:

All areas affected by the construction work shall be reinstated to their original condition, with new materials, including but not necessarily limited to, sidewalks, parking lots, access roads, roads, adjacent roads properties, footpath, kerb stone, boundary wall, grill, fencing, grill, any type of structures (underground & above ground), bore well, horticulture and landscaping. Grass cover shall be provided for any bare earth surface areas, along with proper provisions for surface drainage.

8. TAKING OVER OF WORKS / SECTIONS

8.1 Inspection

a) General

Within seven (7) days of receipt of the Contractor's written application for a Taking-Over Certificate, pursuant to Sub-Clause 10.1 of the General Conditions of Contract, the Engineer, in the company of the Contractor, will inspect the Works or Section covered by the application, as per the requirements described in this Sub-Clause. During the joint inspection, the Works or Section will be examined and relevant documentation will be reviewed. The Engineer will prepare a written list of outstanding items, if any, to be completed or corrected before issuance of the Taking-Over Certificate and a separate written list of items to be completed or corrected during the remainder of the Contract or the Defects Notification Period. The list shall include an agreed date of correction for each deficiency.

The Contractor shall also obtain written confirmation from all applicable Interfacing Contractors that all interfacing matters have been concluded.

If there are no outstanding items to be completed or corrected before the Taking Over of the Works or a Section, the Contractor shall submit to the Engineer all guarantees, warranties, final certifications or similar documents or both as are required under the Contract.

b) Static Inspection

The inspection listed in the following table shall be conducted by the Engineer, in coordination with Interfacing Contractors as necessary.

The Contractor shall prepare and submit for review and approval by the Engineer a Static Inspection Plan detailing and explaining how the Contractor will plan, perform and document all tests and inspections that shall be conducted to verify and validate the Works. The Static Inspection Plan shall consist of a narrative description supported by graphics, diagrams and tabulations as required.

Structure	Inspection Item		Inspection Method		
			Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check
Earthwork	Formation width	At every 100m on straight line, at every 20m on curved line, at each terminal point of structures	✓		✓
	Rail Road cross section	Drawings	✓		
	Retaining wall	List of location of retaining walls	✓	✓	
	Construction	Soil compaction records, deformation modulus (Ev_2) records, construction photos	✓		
	Structures Crossing	List of structures crossing the Railway (earth cover, overhead clearance, etc.)	✓		✓
	Drainage system	Drainage works at embankment, drainage diagram	✓		✓
Bridges	Formation width	At each bridge	✓		✓
	Construction	Quality records of aggregate used, reinforcement, concrete quality control data, measurement records of cast-in-situ piles/ open foundation etc.	✓		

Structure	Inspection Item		Inspection Method		
			Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check
	Repairing of structures	Records of repaired parts of structures	✓	✓	
	Rebar cover	Records of measurement of rebar cover	✓		
	Clearance under girder/slab	Above roads/rail	✓		✓
	Abutment/ pier structures/ RCC box etc.	All Structural drawings	✓	✓	
	Concrete strength	Schmidt hammer tests	✓		✓
	List of bridges	List of bridges	✓	✓	
	Pile load test	Pile load test parameters	✓		
	Load test	Load test parameters of superstructure (OWG/CG/PSC girders)	✓		
		Load test parameters of skew RCC box	✓		
Station	Platform length, width	At every 10m on straight line, at every 5m on curved line, control points of curve	✓		✓

Structure	Inspection Item		Inspection Method		
			Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check
	Clearance of isolated and continuous structures on platform as per SOD	All structures	✓		✓
	Staircase and pavement	Results of stair width measurement	✓	✓	
	Drainage slope of platform	At every 20m	✓		✓
	Safety fence, etc.	List of facilities (clearance from platform end to fixed/movable fence, etc.)	✓	✓	
Protective facilities	Fire protection	Fire extinguisher layout and numbers	✓	✓	
	Abutment/ Pier protection	Drawings	✓	✓	
	Slope protection works	List, location and Drawings of slope protection works	✓	✓	

Superstructure and Bearings:-

	Inspection Method

Inspection Item	Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check	Dead load Camber
Steel Girder	✓		✓	✓
Bearings	✓	✓		
Track at every sleeper location parameters	✓		✓	

After Static Inspection of the Works as mentioned above the Contractor shall submit the Inspection Report in the agreed format in four (4) signed copies to the Engineer for review and approval.

8.2 Remedial Action and Re-inspection

Within twenty-eight (28) days of receipt of a written application for a Taking-Over Certificate,the Engineer shall proceed in accordance with Sub-Clause 10.1 of the General Conditions of Contract.

8.3 Taking Over Certificate

If the Engineer does not issue a Taking-Over Certificate, but gives instructions in accordance with sub-paragraph (ii) of Sub-Clause 10.1 of the General Conditions of Contract, the Contractor shall, when he considers the work specified by the Engineer completed, give written notice to the Engineer and the Contractor.

The Contractor shall submit documents required by Commissioner of Railway Safety (CRS) and shall accompany him during his inspection along with necessary records.

Attachment - C-1

MINIMUM ORGANISATION STRUCTURE REQUIRED

The figures indicated in Table 1 below are the minimum number of Project-Personnel required which are to be deployed as per the minimum level of supervision. The qualification/experience of such Project personnel is given under Annexure-C-2

TABLE-1 LIST OF MINIMUM ORGANISATION STRUCTURE REQUIRED

S.No.	Designation of Project Personnel	Minimum no. of Project-Personnel required	Penalty for Non-deployment per week or part thereof per person
1.	Project Manager (Team Leader)	1	Rs 50,000/-
2.	Planning Engineer	1	Rs 40,000/-
3.	Quality Assurance /Quality Control Expert	1	Rs 50,000/-
4.	Safety, Health & Environment Expert	1	Rs 50,000/-
5.	Surveyor	1	Rs 30,000/-
6.	Deputy Project Manager (Formation)	1	-
7.	Deputy Project Manager (Bridges & station)	1	-
8.	Civil Engineer (Formation)	3	-
9.	Civil Engineer (Bridge)	2	-
10.	Civil Engineer (Station)	1	-
11.	Civil Engineer (Fabrication & launching of steel OWG)	1	-
12.	Procurement Manager	1	-

NOTES:-

i. The Contractor shall deploy resources as per the above-mentioned table. The Contractor shall also confirm to deploy manpower over and above the minimum numbers indicated above, if the work so requires.

ii. The performance of project personnel deployed will be evaluated periodically by the Engineer during the contract period. In case the performance of any of the project personnel is not satisfactory, the Contractor shall replace them with good personnel immediately as per directions of the Engineer.

iii. The resources indicated in table above are for peak requirement. All resources need not be mobilized simultaneously for entire duration of the contract. The Contractor shall mobilize the resources as per the deployment programme approved by the Engineer.

iv. In case of non-deployment of project personnel, the penalty shall be imposed as indicated above and deducted from Contractor's running / final bills. The decision of the Engineer in this regard shall be final and binding.

UNDERTAKING:

i. We confirm to deploy project-personnel required to achieve progress of work as per construction work program submitted along with the tender or as approved by the Engineer.

ii. We confirm to deploy manpower over and above the minimum numbers, if the work so requires.

SIGNATURE OF AUTHORIZED SIGNATORY OF CONTRACTOR

Annexure-2

MINIMUM ORGANISATION STRUCTURE REQUIRED

Minimum level of supervision & qualification/ experience of site staff is as follows:

S. No.	DESIGNATION	QUALIFICATION	EXPERIENCE LEVEL
1.	Project Manager (Team Leader)	Graduate in Civil Engg.	Minimum total experience of 15 years out of which, minimum 10 years as In-charge in Infrastructure projects.
2.	Dy. Project Manager (Formation)	Graduate/Diploma in Civil Engg.	Minimum total experience of 10/12 years out of which minimum 05/08 years in Infrastructure projects
3.	Dy. Project Manager (Bridges & station)	Graduate/Diploma in Civil Engg.	Minimum total experience of 10/12 years out of which minimum 05/08 years in Infrastructure projects
4.	Civil Engineer (Formation)	Graduate or Diploma in Civil Engineering	Minimum total experience of 5 years for Degree & 8 years for Diploma out of which 2 year experience in relevant field in Infrastructure projects
5.	Civil Engineer (Bridge)	Graduate or Diploma in Civil Engineering	Minimum total experience of 5 years for Degree & 8 years for Diploma out of which 2 year experience in relevant field in Infrastructure projects.
6.	Civil Engineer (Station)	Graduate or Diploma in Civil Engineering	Minimum total experience of years for out of which a 2 year experience in relevant field in Infrastructure projects.
7.	Civil Engineer (Fabrication & launching of steel OWG)	Graduate or Diploma in Civil Engineering	Minimum total experience of 5 years for Degree & 8 years for Diploma out of which 2 year experience in relevant field in Infrastructure projects.
8.	Planning Engineer	Graduate in Civil Engg. With certification Primavera software	Minimum total experience of 10 years out of which minimum 05 years in in relevant field inPlanning of Infrastructure projects.
9.	Quality Assurance (QA) /Quality control Expert	Graduate/Diploma in Civil Engg.	Minimum Total Experience Of 10/13 out of which minimum 05 Yrs. In QA (Field) And At Least One Year as In-Charge in Infrastructure Project
10.	Procurement Manager	Graduate in Engineering / Diploma in procurement	Minimum Total Experience Of 05/08 in Procurement in Infrasturcture Project.

11.	Safety, Health & Environment Expert	Graduate in Engineering/Science with Diploma in Industrial safety	Minimum Total Experience of 06/08 with relevant experience of 3 years in Infrastructure projects*.
12.	Surveyor	Diploma in Civil Engineering / ITI	Minimum Total Experience Of 05/08 Years in Survey Work for Infrastructure project

NOTES:

i. Infrastructure project includes Railway, DFC, Metro, RRTS and Highway projects.

SIGNATURE OF AUTHORIZED SIGNATORY OF CONTRACTOR

Attachment C-3

RESOURCES PROPOSED FOR THE PROJECT- PLANTS & EQUIPMENTS

The figures indicated below are the minimum number of equipment required.

S. No.	Types of Equipment Required for the Work	Minimum No. of Unit of Equipment Required for the Work
1	Construction Equipment	
a)	Excavator (75 cum/hr)	03
b)	Grader	02
c)	Dozer (150 Cum/hr)	04
d)	Vibratory Roller (10 T)	04
e)	Tippers	50
f)	Pugmil/Crusherl(200MT/hr)	01
g)	Concrete Batching Plant	02; Min. capacity of batching plant 30 cum/hr
h)	Concrete Pumps (36 cum/hr)	02
i)	Transit mixtures	6
j)	Survey Instruments (Total Station)	1
k)	Lab Testing equipment- fully equipped for site tests.	Appendix 12
l)	Digital Level (Leica, Sokia)	2

Note:

i. These resources are for peak period of each activity. All plants and equipment need not to be mobilized simultaneously. Plants and equipment's as required as per the progress of the work shall be brought at site in advance as directed by the Engineer.

ii. The Tenderer must demonstrate that it has a tie up for fabrication of steel bridge girders included in this tender with RDSO approved plant/workshop in Part-A.

UNDERTAKING:

We confirm to deploy resources as per the above-mentioned minimum requirement and also confirm to deploy plants & equipment over and above the minimum numbers indicated above, if the work requires so.

SIGNATURE OF AUTHORIZED SIGNATORY OF CONTRACTOR

Section VII: Employer's Requirements

Section VII-5: Outline Design Specifications (Civil)

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1. INTRODUCTION

Haryana Orbital Rail Corridor (HORC) from Palwal to Sonipat is 130Km long corridor passing through Sohna, Manesar, Kharkhoda and Harsana Kalan. It involves the design and construction of various civil structures like embankments, major and minor bridges, stations and retaining walls etc.

This part lays down the specifications/criteria for design of civil structures i.e., bridges, stations, embankments, retaining walls and other structures.

The broad parameters covered in these specifications are listed below:

1. Material Parameters (Concrete, Reinforcement steel & Structural Steel etc.)
2. Design Parameters
3. Loading Consideration (Dead Load, Super imposed Dead Load, Footpath Live Load, Railway Vehicular Load, Temperature Loads, etc.)
4. Load Combinations
5. Allowable stresses
6. Design Methodology
7. List of Design Codes and Standards

2. OUTLINE DESIGN SPECIFICATIONS- GENERAL

2.1 General

The bridges, stations and other structures to be designed in C-2 Package are mentioned in the Scope of Works The structures are categorised in groups based upon the type of structural requirement.

The design works include the preparation and approval of GADs/architectural drawings, Definitive Design and Construction Design for structures as per the Employer's requirement-Design.

GADs shall be prepared by the Contractor based on preliminary design and feasible construction methodology and submitted to the Engineer along with the preliminary design calculations and drawings. After approval of the Engineer, GADs shall be submitted to the stakeholders for approval. Getting approval of GAD from the concerned stakeholders is the responsibility of the Contractor. The Contractor shall address all the queries of the stakeholders. However, the Employer will assist the Contractor in obtaining approval from the concerned stakeholders. The Contractor shall attend any meeting/presentation/joint site visit with stakeholders, as per the requirement, for the approval of GADs. After approval of the stakeholders, the GAD shall be finally approved by the Employer.

2.2 Employer's Inputs

The Employer shall furnish following documents to the Contractor: -

a) Plan and L-section of the main line

b) Plan and L-section of the connectivities

c) ESP of station yards

d) Conceptual GAD of bridges

e) Conceptual layout plan for station

f) Preliminary Geo-technical investigation reports

2.3 Codes & Standards

For loadings, load combinations, analysis, and design of structures, all relevant IRS, IS, IRC and other relevant codes shall be followed.

The list of relevant codes and standards, listed in these specifications, is only tentative. The Contractor shall follow provisions of appropriate codes and standards in force for items which are not covered in the foregoing paras.

All codes & standards shall be of latest revision including all amendments & corrections.

2.4 Design Life

The design life of a structure is that period for which it shall be designed to fulfill its intended function.

The Contractor is required to submit a report demonstrating the approach in design, construction and selection of material so as to achieve the design life as specified.

The design life of each structure, facilities and systems shall be as follows:

a) Structures of the Civil works for Railway/Road Loading

The design life of bridges shall be 100 years.

b) Structures of the Building works

The design life of all building and structures shall be 50 years.

c) Mechanical, Electrical and Plumbing (MEP)

The design life of MEP services including water supply, drainage services and fire protection services etc shall be 20 years.

d) Ventilation and Air-conditioning (VAC)

The design life of all VAC facilities, systems and services shall be 10 years. The design life of window AC shall be 5 years.

2.5 Maximum Moving Dimensions (MMD) and Clearances

The bridges and other structures shall be designed to cater for double stack container train. The Maximum Moving Dimensions, Structure Gauge and Clearances shall be as per IR Schedule of Dimensions for Broad Gauge. MMD is attached as Annexure- A.

2.6 Soil Parameters

Preliminary Geo-technical investigation reports shared with the Tender Document are indicative in nature and the Contractor shall carry out independent detailed GT investigations as per codal provisions. However, if there is a wide variation (>15%) in the design soil parameters compared to the parameters as per GT report of nearest bore hole given in the tender document, the same shall be brought to the knowledge of the Engineer and a confirmatory (repeat) bore bole shall be done to ascertain design soil parameters.

a) Liquefaction

Liquefaction shall be considered as per IS 1893-Part-1. The design ground water table shall be used for liquefaction potential calculation. The moment magnitude Mw to be taken in design shall be 7.0. The factor of safety shall be more than 1.0 to ascertain that the strata is not liquefiable.

b) Design Ground Water Table

The ground water table (Base value) shall be considered as maximum (in terms of RL) of ground water table data published by

(a) Central Ground Water Board (CGWB),

(b) Ground water table reported in Geotechnical report provided in Tender Documents,

(c) Ground water table encountered by the Contractor during GT investigation.

The design ground water table shall be taken as minimum3.0m higher than the Base value for evaluation of effects for liquefaction design purposes.

2.7 Differential Settlement

Differential Settlement between two adjacent bridge piers shall be as follows.

a) 12mm for Long Term Settlement;

b) 6mm for Short Term Settlement

Differential settlement shall be considered only in the design of continuous structures, if any.

2.8 General Design Requirements

a) The Project entails construction of BG double-track electrified railway lines capable of handling "25t loading -2008" double stack container for maximum train speed of upto 160 km/h. The project is a feeder route to DFC also. The embankment and cutting shall be designed for "DFC loading (32.5t axle load)". Bridge substructure shall be designed for "DFC loading (32.5t axle load)"and superstructure shall be designed for "25t loading – 2008" unless specified otherwise in the Contract.

b) All levels shall be quoted in meters correct to three decimal places and shall be to Mean Sea Level (MSL) Datum India. The rail level on a track shall refer to the top of the inner rail of the UP Line i.e. line going from New Prithala to Sonipat.

c) The Contractor shall comply with the provisions of IR Schedule of Dimensions, with regard to the clearance over the existing IR network.

d) The Contractor shall refer to the Standard Specifications and Code of Practice published by the Indian Roads Congress and/or consult with the competent authority to maintain the appropriate clearance over the road as required accordingly.

e) Horizontal and vertical alignment has been given in the Final Alignment Drawings. Proposed Right of Way (ROW) has been also marked on the Alignment Drawings. The contractor should check the feasibility at site and may propose any minor modification, if required.

f) All structures shall be designed and detailed to withstand earthquake forces for Seismic Zone IV.

g) Exposure conditions shall be considered as moderate for all type of structures/bridges. However, in case of Nallah crossing (upto 50m on either side of the edge of Nallah), the exposure condition may be treated as "Severe".

h) Minimum Grade of reinforcement steel shall be Fe 500D conforming to IS 1786.

i) Backfill on bridge approaches shall be placed in accordance with IRS Substructure Code.

j) Approach slab minimum 4 m long shall be provided on both ends of all un-ballasted bridges.

k) The data like bridge length, size, barrel length, type of crossing, high flood level (HFL), total waterway and indicative span configuration etc. in respect of the proposed road/ waterway bridges has been shown in the conceptual GAD of the bridges. While designing the bridges, it shall be obligatory that in case of parallel section, the total bridge length, Box opening and/or HFL for an individual bridge for HORC tracks shall not be less than that of the corresponding KMP/DFC bridge. Also, the span configuration for the proposed bridges shall match the span configuration of the corresponding KMP/DFC bridge, to the maximum extent possible, to avoid obstruction and to bring the abutment/piers in line with the existing abutment/piers. Deviation from above shall be in consultation and with approval of the Engineer.

l) CC drain shall be provided, where existing KMP and new HORC embankment overlaps, for drainage of storm water from embankments.

m) In case of pile foundation, bored cast in-situ concrete piles of diameter 1.2m shall be provided.

n) Inspection platform all-round the abutment caps/pier caps shall be provided along with access ladder.

o) Trolley ~~& man~~ refuge on bridges shall be provided as per provisions of IRSOD/IRPWM.

p) In case, the bridge is at a location where the Right of Way is restricted, special type of abutment / pier / return wall / wing wall shall be proposed subject to approval of the Engineer.

q) The embankment on approaches of bridges shall be protected by stone pitching/CC blocks of suitable sizes, over 15cm thick consolidated gravel bed, encased in cast in-situ RCC grid frames of suitable cross section having opening size of 3mX3m, for a length of 30m for major bridges & 15m for RCC boxes. Toe wall shall be provided at the end of the embankment slope. Adequate drainage arrangement shall also be provided.

r) Inspection steps (1m wide) on either side of formation shall be provided with CC of M15 grade.

s) Adequate provision shall be kept for inspection and replacement of bearings without major disruption to railway operations or any activity underneath the bridge.

t) Necessary provisions for OHE mast shall be kept on bridges.

u) Precast retaining walls shall be used upto 6m height. Beyond 6m height, cast in-situ retaining wall may be used. Reinforced Earth wall (RE wall) shall not be permitted.

v) In station area, general earth filling of about 1m height shall be done in complete ROW. This standard of earth filling shall be similar to that of earthwork in formation.

w) NP-4 pipe of 450mm diameter, conforming to IS 458, shall be provided at about 500m interval throughout the alignment for the purpose of utilities. Installation conditions for the pipe shall be designed as per the IS-783, according to the fill height.

3. OUTLINE DESIGN SPECIFICATIONS - EARTHWORK IN FORMATION

3.1 General

This part lays down criteria for design of formation in embankment.

3.2 Details of Structures to be designed

The Contractor shall design formation in embankment for various heights that are coming in C2 Package.

Design of embankment shall include, but not limited to, the following: -–

a) Design of formation for "DFC loading (32.5t axle load)"

b) Slope stability analysis and protection measures including erosion control

c) Drainage system- longitudinal and cross drains

d) Trolley refuge

e) Any other item which is required for complete design of formation in embankment/cutting

3.3 Design Criteria

For design of embankment, the "Comprehensive Guidelines and Specifications for Railway Formation: RDSO/2020/GE: IRS 0004", issued by RDSO (hereinafter written as RDSO Guidelines) shall be followed. The geometric parameters of embankment shall also conform to Indian Railway Schedule of Dimensions (IRSOD) and Indian Railway Permanent Way Manual (IRPWM).

The design criteria for design of embankment slopes shall be as under-

a) A minimum side slope of 2H:1V for embankment shall be adopted up to 6m height. For higher embankments (more than 6m height.), the slopes shall be designed, however side slope shall not be steeper than 2H:1V.

b) Both 'End-of-Construction' (EOC) and 'Long-Term' (LT) stability with most adverse drainage conditions shall be considered, in design of slope.

c) Design shall be done using effective stress analysis method both for EOC and LT stability conditions, adopting realistic values of shear strength and pore water pressure parameters.

d) Erosion Control

i. The slopes of embankments and cuts shall be protected against erosion by providing a protective vegetative cover comprising perennial turf forming grass.

ii. The species of grass should be compatible with the local soil and climatic conditions.

iii. The materials and techniques proposed by the Contractor shall be suitable for the slope height and angle, soil type and climatic conditions and shall perform its function with minimum maintenance requirements.

iv. The sod shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter.

v. At the time sod is cut, the grass on sod shall have a length of about 50 mm and the sod shall be free from debris.

vi. Thickness of the sod shall be as uniform as possible, with minimum 50-80 mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grasses is retained in the sod strip.

vii. The sods shall be cut in rectangular strips of uniform width, not less than about 250mm x 300mm in size but not so large that it is inconvenient to handle and transport them without damage.

viii. Sods shall be delivered in healthy condition and be free from weed and disease.

ix. The contractor shall water and maintain the vegetation cover provided on slopes for a period of 6 months.

x. Flyover, approaches of bridges & high embankments shall be designed with the provision of slope protection work to be approved by the Engineer.

e) Before taking up turfing/slope protection works, extra earthwork on embankment slopes shall be cut to design profile and compacted with vibratory roller.

f) Width of berm shall be adequate to suit the mechanical compaction of earth with heavy rollers. However, berm width shall be kept minimum 2m.

g) Blanket material shall conform to RDSO Guidelines.

h) Drainage Arrangement

i. Top of the formation shall be finished to cross slope of 1 in 30 from centre of formation to both sides in case of single/ double line. However, in case of multiple lines, the cross slope shall be from one end to the other towards cess/drain provided in between.

ii. In the double track section, the longitudinal drain between two tracks shall not be provided. However, in case of parallel Section, if toe of the new embankment overlaps the toe of the existing KMP embankment, longitudinal CC saucer drain of suitable capacity, for satisfactory evacuation of storm water, shall be provided between new HORC embankment and existing KMP embankment.

iii. In station yard a system of covered/underground pucca longitudinal and cross drains of adequate section shall be provided to ensure efficient drainage as shown in tender drawings. The Contractor shall submit a drainage plan for approval of the Engineer. Such plans should be sufficiently detailed. The longitudinal drains shall be extended as necessary to lead the water clear of the Works to natural drainage courses, culverts or any other suitable outlets.

iv. In high embankments (height > 6m), a system of CC longitudinal drain along the toe of berm and chute (at about 30 m interval) to collect and lead the surface runoff safely away from the toe of embankment shall be provided.

v. All the drains shall be lined with CC of M20 grade.

vi. All the drains shall slope towards the nearest culvert or natural low ground or natural outlets existing nearby where the water shall be discharged with appropriately designed outfall arrangement duly consented by the Engineer.

i) NP-4 pipe of 450mm diameter conforming to IS 458 shall be provided under the embankment, at an approximate interval of 500m. Installation conditions for the pipe shall be adopted as per the design requirement of IS-783 for various heights of fill.

3.4 Submittals

Prior to the start of construction operations, the Contractor shall submit to the Engineer all relevant documents, drawings, calculations and data including, but not limited to the following, and shall obtain the approval of the Engineer for the proposed materials, design, construction methods and quality control procedures

a) Geotechnical investigation reports and evaluation of sub-surface conditions along the alignment.

b) The Contractor shall submit the report detailing the identification of borrow areas for formation, blanket material, prepared subgrade. Geotechnical investigation reports for borrow areas duly indicating the soil properties of the proposed borrow areas.

c) Details of earthwork balance (cut & fill), properties of materials to be imported/exported, and management of excess materials. Material test reports for embankment fill, prepared sub-grade and blanket.

d) Cross-section of embankment/cutting along the alignment, at every 50 m interval in straight, at 20 m interval on curve and at junction with the structures

e) Slope stability calculations. Analysis of the stability and settlement of formation and design of remedial measures if required. Details of earthwork design solutions and criteria used

f) Details of proposed instrumentation and monitoring

g) Details of construction equipment.

4. OUTLINE DESIGN SPECIFICATIONS -: BRIDGES

4.1 General

This part lays down specifications for design of bridges.

The Bridges in HORC Project comprises of simply supported Prestressed Girders (I/U)/ Steel Composite Girders / Open Web Girders (OWG) or RCC Box Bridges/Culverts with RCC sub-structure and open/deep foundation.

Minimum Centre to Centre distance between two tracks has been kept as 5.3m according to IR-SOD(BG). Maximum length of the track is ballasted except at OWG locations.

4.2 Details of Structures to be designed

The details of the items to be designed in this group are described as follows:

a) Bridges with superstructure of Steel Open Web Girder (OWG)

This group includes the bridges having steel OWG superstructure. Following standard RDSO drawings of OWG for 45.7m and 76.2m span for "DFC loading (32.5t Axle load)" shall be used:

S.No.	Span	Reference RDSO Drawings
		DFC loading (32.5t Axle load)
1	45.7 m	B-17081 to B-17098
2	76.2 m	B-17101 to B-17118

Note: The above drawings are available in the office of the Engineer for reference.

All connection in OWG shall be HSFG bolted connections instead of rivets as shown in the drawings. Grade of bolts to be used shall be HR 8.8.

Spherical bearings shall be used instead of roller rocker bearings.

Side pathway for maintenance shall be provided as per RDSO drawing No.: CBS-0045, on one side of the truss. Arrangement for prevention of train droppings on road/rail users underneath the track shall be provided.

The Contractor shall design substructure and foundation of these bridges.

The substructure of these bridges shall be designed for "DFC loading (32.5T axle load)". Bridge elements to be designed by the Contractor includes, but not limited to, the following: -

i. Abutments & abutment caps including foundations & wing/return walls

ii. Piers & pier caps including foundations

iii. Load on bearings, design and drawings of bearings including bearing pedestals, inspection platforms including arrangements for access from track. Spherical bearings shall be used.

iv. Provision of jacking arrangements on abutment caps & pier caps for lifting of superstructure

v. Seismic arrestors in pier/abutment cap

vi. Trolley refuge and man refuse on bridges as per latest IR standards

vii. Provision of supports for placing OHE mast for traction system

viii. Protection works of abutments

ix. Inspection steps on approaches of bridges

x. Side pathway on bridges for maintenance

xi. Drainage arrangements

xii. Arrangement for supporting signalling & telecom cables and other utilities

xiii. Arrangement for prevention of train droppings on road/rail users' underneath track

xiv. Ground improvement technique/procedures, if required according to the GT data and design requirements along with the method of verification of the bearing capacity after implementation of ground improvement technique.

xv. Construction methodology

xvi. Any other item which is required for complete design and construction of substructure.

b) Bridges with superstructure of Composite Girder (CG)

This group includes the bridges having superstructure of steel CG. Standard RDSO drawings for "25t Loading-2008" will be used for superstructure of CG. However, the Contractor shall verify the adequacy of RDSO standard drawings of CG for double stack containers. The Contractor is required to design foundation and substructure for these bridges for "DFC loading (32.5T axle load)".

Bridge elements to be designed by the Contractor includes, but not limited to, the following: -

i. Abutments & abutment caps including foundations & wing/return walls

ii. Piers & pier caps including foundations

iii. Load on bearings, design and drawings of bearings including bearing pedestals, inspection platforms including arrangements for access from track. Elastomeric bearings shall be used.

iv. Provision of jacking arrangements on abutment caps & pier caps for lifting of superstructure

v. Seismic arrestors in pier/abutment cap

vi. Trolley refuge and man refuse on bridges as per latest IR standards

vii. Provision of supports for placing OHE mast for traction system

viii. Protection works of abutments

ix. Inspection steps on approaches of bridges

x. Side pathway on bridges for maintenance (Arrangement for pathway shall be provided as per RDSO drawings No. CBS-0046.

xi. Drainage arrangements

xii. Arrangement for supporting signalling & telecom cables and other utilities

xiii. Ground improvement technique/procedures, if required according to the GT data and design requirements along with the method of verification of the bearing capacity after implementation of ground improvement technique.

xiv. Construction methodology

xv. Any other item which is required for complete design and construction of the bridges.

c) RCC Box Bridges

This group includes the bridges with RCC Box fit for "DFC loading (32.5t axle load)".

Bridge elements to be designed by the Contractor includes, but not limited to, the following: -

i. RCC Box

ii. Wing wall, return wall, drop wall, curtain wall, protection works

iii. Inspection steps at approaches of bridges

iv. Ground improvement technique/procedures, if required according to the GT data and design requirements along with the method of verification of the bearing capacity after implementation of ground improvement technique.

v. Construction methodology

vi. Any other item which is required for complete design of RCC box bridge

Standard RDSO drawing for box culvert shall be followed to the maximum extent. If standard RDSO drawing is not available for desired sizes/fill height, box shall be designed by the Contractor. However, thickness and reinforcement of the box shall not be less than the closest available box size & fill height of RDSO drawing.

RDSO box culvert for double track are available upto 2m fill height. In case of higher fill heights, the size and reinforcement of box shall not be less than the that of box for single track with fill height of 2m more than actual fill height.

Any variation from the above, if required due to site constraints shall be adopted after the prior approval of the Engineer.

4.3 Design Requirements

For loadings, load combinations, analysis, and design of structures, all relevant IRS, IS, IRC and other relevant codes shall be followed as per Appendix- I.

The superstructure/bearing, sub-structure and foundation will be checked for one track loaded condition as well as multiple/all track loaded conditions as well as for single span and two adjacent spans loaded conditions, as the case may be.

Design of structures shall take into account construction methodology/ construction sequence to be adopted during execution.

The analysis and design will be carried out for all possible cases of rolling train loads. All the supporting structures such as superstructure, bearings, substructure and foundations shall be checked for the most onerous cases.

a) Railway Bridges

i. Superstructure and bearings shall conform to standard RDSO drawings for "25t Loading-2008" except for OWG bridges. Standard RDSO drawings for "DFC loading (32.5t Axle load)" shall be used for OWG.

ii. Substructure and foundation of bridges shall be designed for DFC loading (32.5T loading) as per IRS Bridge Rules and other relevant codes.

iii. Bridges shall be designed to accommodate curvature of the track alignment, wherever required.

iv. All ballasted deck bridges shall be capable of carrying long/continuously welded rail (LWR / CWR) as per the provisions of "UIC-774(3R) and RDSO guidelines.

v. Side pathway with hand railing shall be provided on bridges on outer side of Up & Down track.

vi. Hand railing shall be provided for trolley/man refuge and inspection platforms on bridges. The design shall be such that it can be easily maintained and replaced, if required.

vii. Adequate arrangement shall be made on the bridges for providing electrical/ telecommunication cables and other utilities as required. Specifications and guidelines of the owning agencies in such cases shall be followed.

viii. Arrangements for enabling inspection of superstructure and bearings of OWG and CG shall be provided as per RDSO report BS-113.

ix. Bridge bearings shall be as per corresponding standard RDSO drawings for bearings. All bearings shall be replaceable without major disruption to railway operations or to any activity underneath the bridge. Bearings shall be placed on bearing pedestals designed in accordance with applicable codes. Appropriate jacking points, on the pier/abutment cap in consideration with the requirements of the superstructure for lifting, shall also be provided. The bearings shall be sandwiched between two true horizontal surfaces. Steel Wedge shall be provided to cater to longitudinal slope of superstructure, wherever required.

x. Expansion/Movement Joints and other necessary measures to control shrinkage and thermal effects shall be incorporated in the structural design so that the performance of the bridge/structures are not adversely affected during normal working conditions. Movement joints shall be designed to be easily maintained and replaceable.

b) RCC Box Bridges

i. Bridges shall be designed for "DFC loading (32.5t axle load)". In addition, the design shall consider the loading standards as applicable to the type of the crossing/existing road or Class A/Class 70R loading as per IRC 6-2017, as the case may be.

ii. Size of the Box openings has been shown in the conceptual GADs. The Contractor shall adopt the same. However, any variation, due to site constraints, shall be done with the consent of the Engineer

iii. Barrel length of the culvert shall be decided based on the fill height and ROW.

iv. The clear inner dimension of the box shall cater to the requirements of type of crossing. The height of box shall include the thickness of wearing coat provided inside the box.

v. Fill Depth shall be the height of fill from the bottom of the sleepers to the top of the box and shall be inclusive of depth of ballast and depth of soil fill as per IRS Concrete Bridge Code (CBC).

vi. All bridges shall be protected by a well-designed flooring system. The concrete floor shall be protected by curtain wall at upstream side and drop wall at downstream side, wherever applicable.

vii. Other Requirements:

a. All RUBs shall be provided with 1m wide walkway on one side of the carriageway.

b. The approaches / approach ramps to the RUBs shall be of concrete of M25 grade.

c. Suitable Height Gauges shall be provided on both sides of RUBs.

d. Crash Barriers / medians / footpaths / railings shall be provided as per the requirements of IRC Codes.

e. Inspection Steps shall be provided wherever required.

f. Provision for lighting shall be kept.

g. Provision for signages shall be kept on both side of RUBs.

h. Suitable drainage system including sump and discharge arrangement (as required) and protection works / ancillary works shall be designed.

i. Protection works need to be detailed with CC grid and CC blocks with compacted gravel bed.

Detailed Design criteria for of the Bridges shall be as per the design criteria given below laid down in Appendix- II (Outline design specifications for Bridges).

4.4 Outline Design Specifications Criteria

This Outline Design criteria pertains to the Bridges for HORC Project.

a) ROADWAY AND RAILWAY CLEARANCES

The alignment of HORC crosses several existing roadways and existing railways. The general clearance requirements for these crossings shall be as follows:

b) CLEARANCES FOR ROAD TRAFFIC

Vertical clearance for road traffic shall generally be as per clause 104.4.2 of IRC: 5.

General Arrangement Drawings at road crossings shall be approved by the relevant authorities/stake holders.

c) CLEARANCES FOR ROLLING STOCK

Clearance for railway traffic shall be as per Schedule of Dimensions of Indian Railways. General Arrangement Drawing at railway crossings shall be approved by the relevant Railway Authority.

d) MATERIALS PARAMETERS

i. CONCRETE

1) Grade of Concrete & Cover

Minimum grade of concrete and cover to reinforcement shall be as per IRS-CBC. For exposure conditions, refer Clause-5.4.1 of IRS-CBC.

In case of foundation, cover shall be taken as 75mm for all conditions of exposure.

2) Cement

The minimum cementitious material content, maximum water-cement ratio, total chloride content by weight of cement shall be as per IRS-CBC.

3) Density

Density of concrete shall be 25 kN/m3 for PSC and RCC, 25 kN/m3 for Plain cement concrete and 26 kN/m3 for Wet concrete.

4) Poisson's Ratio

Poisson's ratio for all grades of concrete shall be 0.15.

5) Thermal Expansion Coefficient

Coefficient of thermal expansion shall be considered as 11.7 x10-6 oC in accordance with IRS-Bridge Rules.

6) Time-Dependent Characteristics of Materials

Long-term losses should be calculated in accordance with IRS- CBC.

The design shall be done according to construction sequence to be adopted in site.

ii. REINFORCEMENT STEEL (REBARS)

High strength deformed (HYSD) reinforcement bars of minimum Fe-500D grade, conforming to IS 1786 and IRS-CBC shall be used.

Young's Modulus	=	200,000 Mpa
Yield Stress(fy)	=	500 MPa.

Density = 78.5 kN/m3

iii. STRUCTURAL STEEL (FOR OPEN WEB /COMPOSITE BRIDGES & OTHER STRUCTURES IF ANY)

Structural steel shall be used for OWG, composite girders and for miscellaneous use such as railing, supporting utilities, coverings etc.

1) Structural Steel for Miscellaneous Use

The design of miscellaneous structure shall be done as per IS: 800 and related provisions.

Hollow steel sections for structural use shall be as per IS: 4923.

Steel tubes for structural purpose shall be as per IS: 1161.

Steel for General Structural Purposes (Grade E250, E350 – B0) shall be as per IS: 2062.

2) Structural Steel for Open Web/Composite Bridges

(a) General

Structural steel conforming to IS: 2062(Grade E250, E350 – B0) shall be adopted.

Fabrication shall be done as per provisions of IRS B1 (Fabrication Code).

Design of steel structures shall be done as per IRS steel Bridge Code.

IRC Code: 22 shall be referred for steel-RCC composite construction.

Welding shall be done following IRS Steel Bridge Code, IRS welded Bridge code or relevant IS codes for welding.

(b) Young's Modulus shall be taken as 21,100kg/mm2 as per IRS- Steel Bridge Code.

(c) Density: 7850 kg/m3

(d) Poisson's Ratio: 0.30 as per IRC: 24-2010.

(e) Thermal Expansion Coefficient: 12x10-6 as per IRC: 24-2010

Note: In case design of any component/member is done using foreign code, material shall confirm to the specifications of the relevant foreign code.

e) LOADS TO BE CONSIDERED FOR DESIGN

Following are the various loads to be taken into consideration for analysis and design of structures as prescribed in IRS-Bridge Rules up to latest up-to-date correction slip.

i. DEAD LOAD

Dead load shall be based on the actual cross section area and unit weights of materials and shall include the weight of the materials that are structural components of the bridge and permanent in nature.

ii. SUPER IMPOSED DEAD LOAD (SIDL)

Superimposed dead loads include all the weights of materials on the structure that are not structural elements but are permanent. It includes weight of track form

ballast/sleepers/rails/ fasteners/ cables/parapet/ hand-rail OHE mast/ cable trough/ Signaling equipment etc.

iii. SHRINKAGE & CREEP

Shrinkage and Creep effects will be calculated as per IRS CBC.

iv. LIVE LOAD (LL)

(a) Railway Vehicular Load

Live load shall be followed as per clause 2.3 of IRS Bridge Rules.

(b) Dynamic Augmentation

CDA will be considered as specified in IRS Bridge Rule.

(c) Footpath Live Load

Footpath live load shall be taken as 490 kg/sqm. as per IRS Bridge Rules

(d) Longitudinal Force

Longitudinal force shall be followed as per clause 2.8 of IRS Bridge Rules.

Tractive force of one track and braking force of another track will be taken in the same direction to produce worst condition of loading.

As per IRS-Bridge Rules, in transverse / longitudinal seismic condition, only 50% of gross tractive effort/braking force will be considered.

Dispersion, of longitudinal forces is not allowed as per IRS Bridge Rules except during checking of Rail stress.

(e) Centrifugal Forces Due to Curvature of Superstructure

The horizontal centrifugal force due to moving load in curved superstructure is to be considered as per IRS: Bridge Rules.

C= (Wv^2)/127R

Where W is Live load & C is Centrifugal force (unit of C & W shall be same), v is maximum design speed in km/h and R is radius of curvature in m. This force shall be assumed to act at a height of 3m (same as in case of DFC loading) above rail top level on the safer side as cg is not defined for double stack containers.

For sharper curves, speed restrictions as per SOD shall be followed.

(f) Racking Force

The horizontal transverse force due to racking as specified in IRS-Bridge Rules is applicable to design.

v. Earth/Surcharge load

Earth pressure and surcharge load/pressure shall be taken as per the provisions of IRS Substructure & Foundation Code.

vi. TEMPERATURE EFFECTS

(a) Temperature

- Overall Temperature (OT)

  The loads shall be considered as per IRS-Bridge Rules and IRC:6. Temperature variation of + 35°C shall be considered, details of which are given below

  Maximum Temperature considered as per Annex. F of IRC 6: +49°C

  Minimum Temperature considered as per Annex. F of IRC 6: -0.4°C

  Temperature variation as per clause 215.2 of IRC 6 will be = (49-(-0.4)/2+10=34.7°C say 35°C.

- Differential Temperature (DT)

  The provision given in IRC 6, shall be considered to compute effect of differential temperature gradient in the absence of any provisions in IRS code.

(b) Rail Structure Interaction (LWR Forces)

A rail structure interaction [RSI] analysis for continuing Continuous Welded Rail/Long Welded Rail over ballasted bridge decks shall be done as per provisions of "RDSO Guidelines for carrying out Rail-Structure Interaction studies on Indian Railways (BS 114 (version-2))".

- The following shall be adhered to:

a. Track resistance in loaded and unloaded conditions shall be obtained from cl. 3.2.6 Track Stiffness of BS 114 (version-2). As per the clause, the recommended values for track stiffness for ballasted tracks are 60kN/m and 20kN/m for loaded and unloaded track respectively. The elastic limit is 2 mm for ballasted tracks. No change in track stiffness is permitted on account of actual track behavior.

b. The temperature variations, to be used for analysis, shall be taken as per provisions of cl. 3.2.8 Temperature Variations of "BS 114 (version-2)". The following shall be used for analysis:

   - -The temperature of the bridge does not deviate from the reference temperature by more than + 35 0C
   - -The temperature of the rail does not deviate by more than + 500C.
   - -The difference in temperature between deck and track does not exceed + 200C.
   - -The reference temperature is the temperature of the deck and the rail when the rail is fixed.

c. Maximum additional stresses in rail in tension as well as compression on account of rail-structure interaction shall be within the permissible limits as prescribed in cl. 3.3.1 of "BS 114 (version-2)" for additional stresses in Rails The limit prescribed in the document shall be used as it is and no benefit on account of lesser axle load of actual rolling stock shall be permitted.

d. The provisions of cl. 3.3.2 of "BS 114 (version-2)" Displacements of Bridge Elements shall be adhered to.

e. Checks must be performed for break in rail continuity due to unusual conditions such as fractures or for maintenance purposes. The provisions of cl. 4.7 of "BS 114 (version-2)" for Rail Gap Analysis shall be followed.

f. Minimum (unfactored) LWR force of 1.6t/m of span length shall be considered for design irrespective of number of tracks.

- Software and general methodology to be used for carrying out Rail Structure interaction analysis must be validated before adopting the same. A well-established document such as UIC 774-3R may be used for validation.
- Representative stretches must be chosen for carrying out Rail-Structure interaction which shall include special spans. The same shall be got approved from the engineer.

Note- In the present C-2 tender package all major bridges are non-ballasted and therefore, RSI study for continuing CWR/LWR over bridge is not required to be carried out.

vii. WIND LOAD (WL)

The wind load shall be calculated as per IRS: Bridge Rules and IS: 875 (Part 3).

Vb = Basic wind speed = 47 47 m/s for Delhi Zone (as per IS 875 IS 87).

viii. SEISMIC FORCE (EQ)

The purpose of this section is to summarize the methodology and the assumptions that shall be used for the seismic analysis.

(a) Seismic Design

Seismic design philosophy as stated in IRS Seismic Code shall be considered. HORC project area lies in Seismic Zone IV of seismic map of India. The peak ground acceleration denoted as zone factor is taken as 0.24 for zone IV.

(b) Definition of Seismic Input

Spectral Acceleration (Sa/g vsT) as prescribed in IRS Seismic code, shall be used for seismic load computation.

(c) Horizontal Seismic Coefficient

The horizontal seismic design coefficient shall be calculated as per following expression

Ah = (Z/2) * (I/R) * (Sa/g)

Where,

Ah	=	horizontal seismic coefficient to be considered in design
Z	=	peak ground acceleration or zone factor = 0.24
I	=	importance factor = 1.5

R = response modification factor as per Table 3

Sa/g = normalized pseudo spectral acceleration for corresponding to relevant damping of load resisting elements (pier/columns) depending upon the fundamental period of vibration T

(d) Response Reduction Factor

Response Reduction Factor "R" shall be as per IRS Seismic code Table -3.

Note: In addition to the response reduction factor, reinforcement detailing of Piers/Portal Piers and joints with pier cap and foundations shall conform to ductility/capacity design requirements as per Annexure-B of IRS Seismic Code.

(e) Vertical Seismic Coefficient

The vertical seismic coefficient shall be 2/3 of horizontal seismic coefficient.

(f) Computation of Fundamental period of vibration

The fundamental time period shall be calculated by any rational method of analysis. Each pier is considered as a single degree of freedom oscillator with mass placed at the Centre of Gravity (COG) of the deck.

The time period can also be calculated as per IRS Seismic Code.

(g) Direction Combinations

The seismic forces shall be assumed to come from any horizontal direction. For this purpose, two separate analyses shall be performed for design seismic forces acting along two orthogonal horizontal directions. The design seismic force resultant (that is axial force, bending moment, shear force and torsion) at any cross section of abridge component resulting from the analysis in the two orthogonal horizontal directions shall be combined according to the expressions given below.

± 〖EL〗_X 〖 ± 0.3EL〗_Y

± 〖.3EL〗_X ± 〖0.3EL〗_Y

ELX = Force resultant due to full seismic force along X direction, and

ELY = Force resultant due to full seismic force along Y direction

When vertical seismic forces are also considered, the design seismic force resultants at any cross-section of a bridge component shall be combined as below:

± 〖EL〗_X ± 〖0.3EL〗_Y± 〖.3EL〗_Z

± 〖.3EL〗_X ± 〖EL〗_Y± 〖.3EL〗_Z

±.3 〖EL〗_X ± 〖0.3EL〗_Y± 〖EL〗_Z

Where ELX and ELY are as defined above and ELZ is the force resultant due to full seismic force along vertical direction.

Seismic on soil mass behind the abutment and confined between the retaining wall shall be considered in addition to dynamic increment in earth pressure.

(h) ERECTION TEMPORARY LOADS (ETL)

Erection forces and effects shall be considered as per IRS-Bridge Rules.

The weight of all permanent and temporary materials together with all other forces and effects which can operate on any part of structure during erection shall be considered in design. The loads arising from most onerous conditions of the construction methods adopted is awaited from the Contractor.

Special care shall be taken that no damage is caused by the construction contractor to the permanent structure. In case of any hole etc., drilled in permanent structural element, the same will be made good by using non-shrink, expansive, high strength grout and its strength shall be better than the structural element and will have to be demonstrated.

(i) DERAILMENT LOADS (DR)

Check shall be made in accordance with the IRS-Bridge Rules.

(j) FORCES ON PARAPET

The parapets shall be designed to resist lateral horizontal force & a vertical force of 1.50 kg/m applied simultaneously at the top of the parapet as per Clause 2.10 of IRS Bridge Rules.

(k) DIFFERENTIAL SETTLEMENT (DS)

Differential Settlement (post construction) between two adjacent bridge piers shall be as follows.

12mm for Long Term Settlement

6mm for Short Term Settlement

Differential settlement shall be considered only in the design of continuous structures, if any.

(l) BUOYANCY LOADS

The design of the foundation shall be done considering design ground water table as per Division 1000 (General) of Design Requirement Criteria

In case of river bridges, stability check and calculation of base pressure, full buoyancy shall be considered on submerged portion of substructure and foundation up to HFL or LWL as the case may be, irrespective of the type of soil on which the foundation will rest.

Hydro dynamic forces will be considered as per IRS Seismic code.

(m)WATER CURRENT FORCES

Water current force in submerged portion of substructures and foundations shall be calculated as per IRS Bridge Substructure & Foundation Code.

(n) VEHICLE COLLISION LOAD (VCL)

The vehicle collision load on piers: as per of IRC: 6.

Rules specifying the loads for design of superstructure and sub-structure of bridges and for assessment of the strength of existing bridges should be done as per IRS: Bridge Rules.

All structure near railway track shall be checked for accidental impact from derailed trains as per IRS Bridge Rules as per Addendum & Corrigendum Slip No. 48 dated 22.06.2017.

(o) VIBRATION EFFECT

Effect of vibration due to movement of train on bridge structure will be taken into consideration. This will be checked in dynamic analysis.

f) LOAD COMBINATIONS

Provisions of IRS-CBC shall be followed. The partial load factors and load combinations shall be as per IRS-CBC.

Notes:

ULS-Ultimate Limit state.

SLS-Serviceability Limit state

Wind load and earth quake loads shall not be assumed to be acting simultaneously.

Load combination for Vehicle collision shall be as per IRC 6 but design of members under vehicle collision load combination shall be carried out as per IRS CBC.

i. The Superstructure/bearing, sub-structure and foundation will be checked for one track loaded condition as well as multiple/all track loaded condition, for single span and both spans loaded conditions, as the case may be.

ii. Design of bridge shall be done considering the construction methodology/ construction sequence to be adopted during execution.

iii. The analysis and design will be carried out for all possible cases of rolling train loads. All the structures, such as superstructure, bearings, substructure and foundations shall be checked for the most onerous cases.

g) DESIGN **CHECK** FOR REINFORCED CONCRETE STRUCTURE

Design of all RCC structures shall be done as per IRS CBC for Serviceability Limit States (SLS) and Ultimate Limit State (ULS)

If prestressing is to be used in any structural member then it shall be checked as per relevant clauses of CBC.

h) DESIGN CHECK FOR STEEL/COMPOSITE STRUCTURE

The design of steel structure shall be done as per IRS Steel Bridge Code/IRS-Welded Bridge Code. In case of steel structure, IRS-steel bridge code shall be followed. While designing for composite action IRC :22 shall be referred.

i) DURABILITY & CRACK WIDTH

(a) DURABILITY

Provision of IRS-CBC shall be followed. The exposure condition is Moderate and in case of Nallah crossing the exposure condition may be treated as "Severe".

(b) CRACK WIDTH CHECK

For SLS Combination, crack width in reinforced concrete members shall be calculated as per IRS-CBC.

The allowable crack width shall be as per exposure conditions given in IRS-CBC.

(c) DEFLECTION

Deflections shall be taken into account as per IRS: CBC while checking appearance, efficiency of the structure and minimum specified clearances. Clause no. 13 of IRS CBC shall be kept in view while calculating deflection/deformation. Permissible values of deformation shall be in accordance with provision of UIC-776-3R.

j) FATIGUE

Fatigue phenomenon shall be analyzed for those structural elements that are subjected to repetition of significant stress variation (under traffic load).

(a) PRESTRESSED/REINFORCED CONCRETE STRUCTURE

The fatigue shall be checked as per IRS-CBC. However, fatigue check for prestressed concrete structures does not need to be performed as long as the whole section (from top to bottom fiber) remains under compression under SLS load combination.

(b) STEEL/STEEL COMPOSITE STRUCTURES

IRS-Steel Bridge Code (up to latest correction slip) / IRS-Welded Bridge code shall be adopted for fatigue check of structural steel members and connections.

Annual Traffic Density for fatigue checks shall be considered as 50 GMT (Gross Million Tonnes per annum) per track (i.e. 100GMT for two tracks).

Simplified approach method given in Cl.14 of Appendix-G (Fatigue Assessment of steel bridges) shall be followed for fatigue assessment.

4.5 Drainage

The drainage of deck shall be designed to cater the maximum envisaged rainfall intensity and suitable longitudinal and transverse slope should be provided. Moreover the provisions of Clauses-10.4.1.1 & 15.2.2 of IRS-CBC shall be followed.

The top of soffit slab will be profiled so as to collect the run-off water at multiple points by providing a cross slope of 2.5%. Drainage pipes will be provided to collect the run-off.

The drain pipe of double wall HDPE corrugated pipes with water collection box at top, shall be provided to discharge the water along pier with most pleasant aesthetics.

a) BEARING SYSTEM

(a) Type of Bearing System

Spherical bearings for OWGs or any non-standard superstructure shall be designed as per IRC: 83 part-IV.

In case of RDSO girders, standard bearing drawings shall be followed.

(b) Replaceability of Bearings

While finalizing the proposed bearing system, it shall be kept in mind that accessibility and replacement of each part of bearing are of paramount importance as the design life of bearings is shorter than that of the structure. Keeping in view the above cited criteria, all the bearings, pedestals and pier caps will be detailed for replacement of bearings in the future. The girders/end diaphragms shall be designed to facilitate the operations of jacks during maintenance as per clause IRS-CBC.

(c) Uplift

If required a holding-down device connecting the deck and the pier head shall be placed in order to prevent the deck from overturning. The holding-down device may be integrated in the bearing system or be a separate system constituted of bars embedded in pier cap and bridge with appropriate details, permitting translation/rotation. Other systems can also be foreseen.

Due to the lack of appropriate guidelines in Indian codes, the design criteria for holding down device (upward force limit requiring holding down device, design formulas) will be taken from the latest international practice.

b) SUBSTRUCTURE SYSTEM

(a) Pier Cap

For designing the pier cap as corbel the provisions of IRS-CBC should be followed. In case of shear span to effective depth ratio being more than 0.6, pier cap will be designed as flexural member.

Height of pedestal should be in between 150mm and 500mm as per IRC: 78.

The Pier cap shape shall be suitable at transition pier supporting different types of superstructure instead of providing raised/column pedestal over pier cap.

(b) Piers

The effective length of a cantilever pier for the purpose of slenderness ratio calculation will be taken as per IRS-CBC. Ductile detailing is mandatory.

The design of pier shall be done IRS CBC.

Shear reinforcement & ductile detailing shall be done as that of RCC column. In all SLS combinations, column shall remain in compression.

c) FOUNDATION SYSTEM

Foundation shall be designed as per IRS Bridge Substructure & Foundation Code, IRS Concrete Bridge Code, IRC-78, Manual on the design and construction of well foundation, IS- 2911.

Open foundation has been contemplated as first choice. Soil replacement may also be resorted, if the difference of bearing pressure and bearing capacity is upto 30%, keeping other practical aspect and site conditions in mind.

4.6 Pile Foundation

Foundation analysis and design will be based on IRS Code for Substructure & IRC-78. The forces applied by the pier are transferred to the bottom of the pile cap for this purpose. Reactions in pile are calculated using Rivet theory. The various specific assumptions made for the pile and pile cap design are as follows:

a. Bored-cast-in-situ multiple pile groups will be adopted.

b. Minimum 1.2m diameter (unless specified otherwise in tender drawing) bored cast-in-situ vertical piles in soil/rock have been contemplated for the foundation of piers. Minimum number of pile in each pile cap shall not be less than 4.

c. For piles and pile caps, load combinations shall be considered as per IRS-CBC, Table-12. The various specific assumptions made for the pile and pile cap design including pile load testing shall be as per IS: 2911, IRC-78 and IRS-Bridge Sub-structure and Foundation Code.

d. For pile bearing capacity, all SLS Load combinations as per IRS-CBC will be considered.

e. Increase in vertical load capacity of pile shall be done as per Table-1 of IS 1893-Part-1.

f. The lateral load capacity of pile shall be evaluated by using empirical formulae given in IS: 2911 (Part-1/ section-2) .

g. Initial load tests (not on working pile) will be conducted as per IS: 2911 - Part IV. Initial test is proposed to be conducted for a load of 2.5 times as per the safe load based on static formula.

h. The working load on pile for vertical and horizontal loads shall be verified through routine load tests during construction.

i. In case of multiple pile system, spacing between the piles shall not be less than 3 times the diameter of pile in soil and 2.5 times the diameter when founded on rock.

j. In general, the top of pile cap shall be kept about min 500mm below the existing ground level and weight of the earth cover will be applied on top of pile cap when unfavorable. The earth cover on pile cap for any favorable effect (stability, soil horizontal capacity.) will be neglected.

k. In case the location of foundation (all types) is within Load Impact Line of nearby passing load(rail/road) then the effect of surcharge (dead load + live load) corresponding to that passing load shall be taken into account.

Structural Design

a. Pile design shall be done according to IRS CBC. However, for crack control in piles, it will be clarified that actual axial load will be considered to act simultaneously.

b. Where there is a risk of liquefaction, the lateral soil resistance of the liquefied layer will be taken as zero.

c. Pile cap shall be designed based on IRS –CBC 1997. No support from soil below pile cap shall be considered.

d. The thickness of the pile cap shall be kept minimum 1.5 times diameter of the piles for multiple-pile group as per IRC 78.

e. The structural design of the pile cap shall be carried out as IRS CBC. Crack width shall be checked for load combination 1 IRS CBC.

f. Minimum reinforcement in pile caps at top shall be at least 0.12% in each direction in case of compression and in case of tension, it shall not be less than 0.2%.

4.7 Soil **Structure** Analysis

When designing element forces or estimating displacements the soil stiffness and other parameters shall be assessed based on the design ground water table.

4.8 Well Foundation **& Open foundation**

Well Foundation & Open foundation shall be designed as per IRS Bridge Substructure & Foundation Code/ IRC: 78, IRS-CBC.

4.9 CODAL PREFERENCE

The IRS Codes shall be followed in principle. Although main clauses have been mentioned in the ODS, the other relevant clauses as available in the IRS codes shall also be followed, whenever applicable. If provisions are not available in IRS, the order of preference shall be as follows, unless specified otherwise:

For railway loading related issues:

I. UIC Codes

II. Euro Codes

III. Any other code, which covers railway loading.

For other Design/ detailing related issues:

I. IS Codes

II. IRC Codes

III. EURO Codes

IV. AASHTO Codes

V. Any international code with approval of HRIDC.

5. OUTLINE DESIGN SPECIFICATIONS: Station

5.1 General

Master Plan & Concept Plan of the station building shall be provided to the Contractor. The Contractor shall prepare the detailed architectural design and drawings of the station. The structural design of buildings and other works as mentioned in the Design Requirement Criteria shall be done by the Contractor as per the requirements briefed hereunder.

This Outline Design Specification (ODS) is applicable for station buildings and other Civil works at Stations of HORC project station which do not support IR/Road live loads.

5.2 Details of Structures to be designed

The details of the items to be designed in this group are described as follows:

a) Stations

The Contractor shall prepare and submit architectural drawings of various stations. Various architectural alternatives shall be prepared for the station building with better aesthetics, pleasing appearance, durability and environment friendliness.

The Contractor shall design two stations namely New Patli and Sultanpur.

The design of station shall include, but not limited to, the following -

i. Station Buildings
ii. Platforms face wall of RCC, Platforms, platform shelter, water booths & toilets and seating arrangement
iii. Water supply, drainage & sewerage system
iv. Rain-water harvesting system for PF water
v. RCC retaining walls for embankment of station platforms
vi. Yard drainage
vii. Subway for inter-platform transfer including stairs with covering and lift
viii. Bore well, pump house, pipe connections, underground & overhead water storage tanks
ix. Septic tank
x. Land scaping, circulating area, internal roads, Parking etc.

The design of station building shall include, but not limited to, the following: -

i. Architectural and structural design
ii. Plumbing arrangement
iii. Arrangement for ventilation
iv. All other building services as necessary for functioning of the station as per NBC 2016

5.3 Design Requirements

a) Layout Criteria

i. The layouts of the stations, as prepared & provided by the Employer are indicative. The Contractor shall develop the layout so as to comply with the Employer's Requirements.

ii. Architecture and profile of all buildings shall conform to local aesthetics, cultural ethos, local architecture and environment and shall be subject to consent and approval of the Engineer.

iii. The functional and structural design of all the station buildings shall be carried out as per provisions of National Building Code 2016 and the by-laws of the local authorities to the extent of their applicability.

iv. Method of structural analysis shall be appropriate for the structure or component to be analysed and shall be carried out by the Contractor using well established software duly consented by the Engineer. However, critical designs shall be supported by manual checks.

v. Dynamic analysis shall be performed to obtain the design seismic force by Response Spectrum Method as per latest IS 1893. Analysis of framed structure shall be carried out considering fixed support at top of pile cap / Open foundation Structural design of building shall confirm to codal provision of IS 456, IS 4326 and IS 13920. Design of water retaining structure shall confirm to codal provision of IS 3370.

vi. Loading due to earthquake shall be assessed based on the provisions of IS: 1893 (Part I) and IRS seismic code, with latest revision.

vii. Loads and load combinations shall be for most unfavorable effects and shall comply with relevant Indian Standards including IS: 456 and IS:800.

viii. Overall stability and serviceability requirements shall be checked in accordance with the provisions of relevant Indian Standards.

ix. All the buildings shall have provision for concealed ducts/pipes for wiring of telecom facilities in addition to the wiring for power supply and distribution. Concealed ducts/pipes for wiring of telecom & power supply facilities shall be provided in consultation with the Engineer.

x. False ceiling shall be proposed at a clear height of about 3m in the rooms with air-conditioning facilities with a view to help in energy conservation.

xi. Station signages shall be designed as per IR standards.

xii. Height gauge for road – under – bridge shall be as per RDSO drawing no. RDSO/M-0001.

xiii. Benches at platform shall be four-seater bench with backrest, with seat partition as per RDSO drawing no. RDSO/WKS/2018/2.

b) VAC Requirements for Station Building

Ventilation of station building shall be provided as per provisions of ISHARE / National building Code except for Signalling/ Telecommunication / UPS/ IPS/ Battery Rooms.

c) Other requirements

The minimum requirement of the facilities for Operation and Maintenance shall be as specified below: -

i. All buildings within the Station area shall be provided with suitable rain-water harvesting system as per Rain Water Harvesting and Conservation Manual (CPWD).

ii. Amenities for passengers as per Railway Board letter for "Comprehensive instructions for provision of Passenger Amenities and user facilities at Stations" shall be provided at stations considering category of station as NSG-6. Amenities for passengers as per norms for 'Recommended Level' shall be provided at stations considering category of station as 'NSG-6' as per extant guidelines issued by Railway Board. Maximum Number of passenger "Nmax" shall be considered as 250.

iii. Main Platforms Shelters of length 20 m (two nos.) and covering entire platform width shall be provided on each platform as per detailed design.

iv. On island platform urinals shall be provided at the end of platform with wash basins nearby separately for ladies and gents.

v. Amenities for persons with disability (PwD) shall be provided as per as per extant Railway Board instructions/guidelines. All platforms shall be accessible for disabled passenger on wheelchair.

vi. In stairs, riser shall be kept maximum as 125mm and tread minimum as 250 mm in the station area and inter-platform connectivity.

vii. External Development of the station area shall include, but not limited to, the following:

(a) Providing RCC Land Boundary Pillars of size 200mm x 200mm x 1500mm all around the stations (except along KMP side in case of parallel section) and to be fixed @ 50m center to center and at every change in direction.

(b) Entrance to each station

(c) Internal roads and footpaths as per applicable standards and statutory requirements

(d) Street lighting including high mast lighting per applicable standards and statutory requirements. Illumination of all service roads shall be as per IS: 1944-1981

(e) Potable water supply system with borewells, overhead and underground water tanks and pumping system

(f) Storm water collection, carriage and disposal systems as per applicable standards and statutory requirements.

(g) Septic tanks shall be provided for disposal of sewage from stations.

(h) Landscaping as required.

viii. Connecting road from entrance of each station to the existing public road for providing road access to the station. All the internal roads within the station area and connecting road to nearest existing public road shall be at least single double lane bituminous road with 1.5m wide footpath and side drain.

ix. Lift capacity at stations shall be adequate for minimum 15 persons.

x. Covered underground water storage tank having minimum capacity of 50,000 liter. Depth of tank shall be kept about 1.5 m to 2.0 m. RCC Overhead tank of minimum capacity of 20,000 liter over station building on staging. Pipe connections and Pump with sensor-based auto pumping facility for filling of overhead tank.

xi. Requirements from Signalling, Telecommunication & Electrical shall be as per General Specifications and Particular Specifications S&T and Electrical.

xii. Platform-

- All platforms shall be high level.
- Platform surface shall be smooth and provided with Vacuum de watered concrete (VCD) flooring.
- End platforms shall be provided a slope of about 1:60 away from the track.
- Platform coping shall be of approximate size of 1125mmx530mmx100mm prefabricated from M-30 or higher grade concrete by vibrocompaction in a factory under controlled environment.
- Effluent from drinking water taps etc. shall be collected and disposed of safely through underground drainage system.
- Two underground ducts of suitable size (100 to150 mm) with manholes at about 30 m interval along the length of platform shall be provided for electrical and S&T wiring etc.

5.4 OUTLINE DESIGN CRITERIA

a) Objective

The objective is to lay down the structural analysis & design of proposed station building. It also incorporates the design process to establish the overall design philosophy to be adopted in the Analysis and design.

b) Statutory Requirements

The design of the Civil Structure will comply with the requirements of the following:

i. National Building Code.

ii. Local Building Regulations.

iii. Bureau of Indian standard codes.

iv. Indian Railway Standard

v. International codes as applicable.

vi. Any other regulation as per requirements.

c) Structural Design Requirement

The main considerations followed for the design of structure are:

i. Structure safety and stability.

ii. Functional suitability

iii. To meet the demands of aesthetics conceived by the architect.

iv. Availability of material, equipment and expertise.

v. Constructability and ease of maintenance.

vi. Durability.

vii. Economy

d) Structural Arrangement

The proposed building is considered to be of RCC frame structure with Isolated/ Strip /Raft/Pile foundations.

e) Loads

The structural members are loaded with various loads combinations during its services conditions. The loads on the structure are taken for analysis and design as per the relevant latest IS codes of practice.

i. Dead load as per IS: 875 (Part-1) -1987

ii. Imposed live load as per IS: 875(Part-2) -1987

iii. Wind loads as per IS: 875(Part 3) – 2015

iv. Seismic Loads as per IS: 1893-2016

Dead loads comprise of the self-weight of all permanent construction including walls, slabs, beams, columns, water proofing treatment, water tanks, staircase, floor finish etc. Other super imposed loads shall be considered. The structure would be designed for earthquake resistance as per IS 1893:2016, with due consideration for the structural detailing as per provisions of IS 13920-2016 and SP 34-1987.

(a) Dead Load (DL)

Dead load shall be based on the actual cross-sectional area and unit weights of materials and shall include the weight of structural members of the station building.

(b) Super Imposed Dead Load For NON-TRACK Area (SIDL)

For platform slabs, the following loads in SIDL shall be taken

i. Floor finishes load shall be assumed minimum 3.6kN/m2 uniform load as per architectural requirement.

ii. Suspension load shall be assumed minimum 2.0kN/m2 uniform load (Suspension load will be considered as the load of false ceiling and services etc. This load will be considered wherever is applicable.

iii. Light partition wall load shall be assumed minimum 1.0kN/m2 uniform load.

For concourse area, the following loads in SIDL will be considered.

i. Floor finishes load shall be assumed minimum 3.6kN/m2 uniform load as per architectural requirement.

ii. Load due to additional fill in the toilets (brick bat) shall be considered as per architectural drawing.

iii. Suspension load shall be assumed minimum 2.0kN/m2 uniform load (Suspension load will be considered as the load of false ceiling and services etc. This load will be considered wherever is applicable.

iv. Loads due to escalator / lift will be considered as per manufacturer's detail.

v. Light partition wall load shall be assumed minimum 1.0kN/m2 uniform load.

vi. Loads due to Platform screen door (PSD) shall be considered as per actual.

vii. Loads due to solar panel shall be considered as 30 kg/m2.

viii. SIDL for Technical Room shall be as follows:

(a) UPS Room* :25**kN/m2

(b) ASS room* :15**kN/m2

(c) Other Technical Room*: 10** kN/m2

(d) Minimum dead load of PEB roof shall be considered as 120Kg/m2. However actual to be taken as per architecture.

*This should be verified with actual load and its location.

** Values are minimum load to be considered in design. Actual loads will be calculated on the basis of equipment & machinery which have to be installed at detail design stage. The concentrated load of 40kN for ASS/UPS room and 20kN for other technical room shall also be considered in design.

Note:

The walls loading will be taken based on actual location shown in architectural drawings. External wall load/glazing load will be taken as per details provided in architectural drawings. It is proposed to take 230 mm thick brick wall with 20 mm thick plaster on either side. However, the same shall not be taken less than 2.4kN/m2.

Above loads intensities are minimum loads to be considered in design, Actual load may be higher as per detailed architectural drawings.

(c) Live loads (LL)

Location	**Distributed load (kN/m^2)**	**Concentrated load (kN)**
Any floor including Concourse, Platform, Staircase, store rooms, waiting room & others station building rooms	5	4.5

Live loads shall generally follow the requirements of National Building Code and IS 875:(Part 2), except where the loadings given below are more severe:

Platforms and Ticket Hall	5.0kN/m^2 or a concentrated load of 15kN on a square area of 300mm side, whichever is more onerous.
Staff Rooms, Toilets, Offices	2.5kN/m^2
Plant Room	According to self/weight of machines as provided

(d) Earthquake Loads (EQ)

Location of proposal site lies in Zone IV. The design parameters will be followed accordingly. However, the salient features are as under:

Seismic Zone	Zone IV
Seismic Importance Factor 'I'	1.5
Response Reduction Factor	The response reduction factor and fundamental period of vibration shall be taken as per IS 1893:2016, depending upon the structure and design requirements.
Fundamental Period of Vibration	
Percentage of Imposed Load to be considered in calculation of Seismic Building Weight	
Impose uniformity distributed floor load (KN/M2)	Percentage of Imposed loads
Upto and including 3.0	25
Above 3.0	50
Vb= Ah*W W= Seismic weight of the structure Ah= Horizontal seismic coefficient as per code	

Seismic Ductile detailing

a. For RCC structures as per IS: 13920
b. For other structures as per IS: 4326

(e) Wind Loads (WL)

Wind Loads (longitudinal & transverse) shall be calculated in accordance with IS 875: Part 3.

Design wind speed Vz(m/s) = 50m/s (As per NBC)

(f) Construction and Erection Loads (ER)

The weight of all temporary and permanent materials together with all other forces and effects which can operate on any part of structure during erection shall be taken into account. Allowances shall be made in the permanent design for any locked in stresses caused in any member during erection.

(g) Temperature Load (TL)

As per IS: 456. Temperature gradient shall be considered as per IRC-6, if applicable.

(h) Shrinkage & creep

Shrinkage & creep strain shall be evaluated as per IS: 456 for plain and RCC structures and IS: 1343 for prestressed concrete structures.

(i) Earth Pressure (EP) & Water pressure (WP)

In the design of structures or part of structures below ground level, such as retaining walls and underground pump room/ water tanks etc. the pressure exerted by soil or water or both shall be duly accounted for. When a portion or whole of the soil is below the free water surface, the lateral earth pressure shall be evaluated for weight of soil diminished by buoyancy and the full hydrostatic pressure. (As per IS: 875-part 5).

All foundation slabs / footings subjected to water pressure shall be designed to resist a uniformly distributed uplift equal to the full hydrostatic pressure. Checking of overturning of foundation under submerged condition shall be done considering buoyant weight of foundation.

If any of the structure supporting railway loading is subjected to earth pressure, the loads and effects shall be calculated in accordance with IRS substructure code.

(j) Surcharge Load (SL)

In the design of structures or the parts of the structures below ground level, such as retaining walls & underground pump room/ water tank etc. the pressure exerted by surcharge from stationary or moving load, shall be duly accounted for. For the area approachable by road traffic, the minimum live load surcharge shall be taken as 24 kN/m^2.

(k) Other Forces and Effects

As per IS: 456.

f) Deflection Criteria

The deflection limitations as per IS: 456 for Plain and RCC Structures.

g) Settlement (DS)

Maximum and differential settlement shall not exceed, as provided in Table 1 of IS: 1904. The allowable settlement for pile group is 25mm (as per IS 2911-part 4).

h) Lateral Sway

The lateral sway at the top of the building due to wind loads should not exceeds H/500, where 'H' is the height of the building.

i) Load combinations

For loadings, load combinations, analysis, and design of structures, all relevant IRS, IS, IRC and other relevant codes shall be followed as per Appendix- I.

i. For steel structures, the load combinations shall be as per IS: 800.

ii. For RCC structures / elements, shall be as per Table 18 of IS: 456.

j) MATERIALS

i. Cement

For plain and reinforced concrete structures cement shall be used according to IS: 456. For PSC structures IS: 1343 shall be used.

ii. Concrete

The minimum grade of concrete shall be as per IS: 456 for Plain and RCC structures and IS: 1343 for PSC structures.

Concrete & Short term modulus of elasticity (Ec) shall be as per IS: 456 in case of Plain and Reinforced Concrete structures and as per IS: 1343 for Pre-stressed concrete structures.

The modular ratio for concrete grades shall be taken as per Annex B of IS: 456.

iii. Density

(a) 25 kN/m3 for Reinforced concrete & Prestressed concrete

(b) 25 kN/m3 for Plain concrete

(c) 26 kN/m3 for wet concrete

For density of strands and all other materials, the densities shall be considered as per IS Codes.

iv. Structural Steel

Structural **steel used shall conform to following:**

(a) Hollow steel sections as per IS: 4923

(b) Steel for general Structural Purpose as per IS: 2062

(c) Steel tubes for structural purpose as per IS: 1161

(d) Design of steel structure will be governed by IS 800. In case of composite (steel-concrete) structure it will be governed by IS: 11384 & IS: 3935.

(e) Fabrication **shall be done in accordance with IS: 800.**

v. Reinforcement Steel (Rebars)

High strength deformed (HYSD) reinforcement bars of Fe-500D grade, conforming to IS 1786 and Clause 4.5 & 7.1.5 of IRS-CBC shall be used.

Young's Modulus	=	200,000 Mpa
Yield Stress(fy)	=	500 MPa.
Density	=	78.5 kN/m3

k) Reinforcement Detailing Reinforcement Detailing

All reinforcement shall be detailed in accordance with IS: 456 & SP: 34 for plain and reinforced concrete structures and IS: 1343 for PSC structures.

The ductile detailing of seismic resisting RC elements shall comply with ductile requirements of IS: 13920.

l) DURABILITY

Durability of concrete shall be as per IS: 456 for Plain & RCC, as per IS: 1343 for PSC elements and as per IS: 800 for steel structures.

m) Cover to Reinforcement

From durability consideration, exposure condition is assumed to be Moderate. The clear cover to main reinforcement shall be considered in the design, satisfying durability & 2 hrs. fire rating requirement, which shall be as follows (clause No. 26.4.2, Clauses 21.4-,26.4.3 and Fig 1 of IS 456-2000)

A	Footing	50MM
B	Columns	40MM
C	Floor/Roof Beams	30MM
D	Floor /Roof Slab	25MM
E	Lintel Beams, Chajja & Loft	15MM
F	Staircase Waist Slab & Landing	25MM
G	Plinth Beam	40MM
H	Walls	25MM

n) Fire **Resistance** Period

All the structural elements shall be designed for minimum period of fire resistant of 2 hour. The minimum element thickness for fire resistance shall be as per IS: 456 for concrete structures and as per IS: 800 for steel structures.

o) Crack width Check

All structural concrete elements shall be designed to prevent excessive cracking due to flexure, early age thermal and shrinkage. Flexural crack width shall be checked in accordance with IS: 456 for Plain and RCC structures and IS: 1343 for PSC structures. Crack width should not exceed 0.25 mm unless otherwise specified. Crack width for water retaining structure 0.2 mm as IS 3370.

p) CLEARANCES

Wherever the station locations are proposed on road or off-road, clearances for road traffic shall be minimum 5.5m beyond the outer face of pier i.e. in all cases 5.5 m clearance shall be kept from road level to soffit level of any structures.

q) Computation Methods – Modelling, Analysis, Design & Detailing

i. Modelling

The structure is idealized as a 3-D space frame model using the software packages STAAD pro/ Etabs. The masonry wall is used as filler wall and not cast monolithically with structure. Hence this is not modelled in the analysis. In this packages slab loads are applied as a floor loads. Wall loads are applied as UDL on beams. Self – weight is added in the software to have member loads.

The analysis of the proposed structure would be carried to

(a) Analyse to ensure elastic behaviour and fulfilment of serviceability criteria for un-factored load combination.

(b) Analyse to ensure adequate structural integrity for factored load combinations

(c) Obtain static displacements and rotations at various nodes.

(d) Obtain resultant member forces like bending moments, shear forces and axial forces.

(e) Support reactions (axial force and moment) coming on foundations.

ii. Control of Deflection (Vertical)

The deflections of a structure or part thereof shall not adversely affect the appearance or efficiency of the structure or finishes or partitions. The deflections shall generally be limited to the following (clause 23.2 of IS 456-2000):

(a) The final deflections due to all loads including heat effects of temperature, creep and shrinkage and measured from the as-cast level of the supports of floors, and all other horizontal members, should not normally exceed span/250.

(b) The deflection including the effects of temperature, creep and shrinkage occurring after erection of partitions and applications of finishes should not normally exceed span/350 or 20 mm whichever is less .When deflections are required to be calculated, the method given in Appendix – B of IS: 456-2000 will be used.

r) Design Philosophy

To meet the design life and durability requirements, codal provisions specified in clause 8.0 and table 5 of IS: 456- 2000 will be followed for reinforced Concrete Elements. All structural elements would be designed according to the Limit State Method as specified in IS: 456: 2000. M 25 grade concrete for beams, slabs footings, staircase, lift walls and M30 grade concrete for columns with Fe 500 Grade steel are considered for design. Along with specified analysis package, design sheets in MS Excel format shall be submitted as per Employer's requirement.

i. DESIGN OF FLOOR / ROOF SLAB

All floor/roof slabs be designed in accordance with Annex- D of IS: 456-2000 with corners held down. Cranking of reinforcement at the support will be provided. Torsion reinforcement will be provided at corners of the slab as per clause D-1.8 of Annex-D of IS: 456-2000.

The beams shall be designed for the envelopes of maximum bending moment and shear force for the load combination that gives the maximum stresses using the STAAD Pro2006 software as per the requirements of IS 456-2000. The critical members would be check manually also. Main reinforcement will not be bent-up and hence shear reinforcement shall be in the form vertical stirrups only.

ii. DESIGN OF COLUMNS:

The columns shall be designed for vertical load (reduced in accordance with clause 3.2 of IS: 875 (part-2-1987) and uniaxial or biaxial bending depending on its location. Effective length of the column will be in accordance with Annex- E of IS: 456:-2000, considering fixed end on both ends. Minimum diameter of longitudinal steel is 12mm and that for ties is 8mm. The columns shall be designed for the envelopes of maximum value as per STAAD Pro/Etab. The critical members would be check manually also.

iii. DESIGN OF FOOTINGS

Assume 10% of the vertical load from the column as the self-weight of the footing a preliminary step for the design. The same shall be checked after designing the footing dimensions. The plan size of the footing will be determined on the basis of the SBC of the soil. The design pressure at the base of the footing shall be determined by algebraic addition of the pressure due to vertical load and that the due to moment at the base of the column. The design pressure shall be less than SBC of soil except when seismic load are considered, Where SBC can be increased as per Table-1 of IS: 1893-2016.

Base pressure = (P/A)+/-(Mx/Zx) +/- (My/Zy)

Where P = Vertical load on the footing

A = Plan area of the footing

Mx and My = Bending moment at the base of the column along the X and Y directions

Zx and Zy = Sectional modules of the footing along the X and Y directions = $ab^2/6$ or $ba^2/6$

a & b are the dimensions of the footing

The footing shall be designed in accordance with clause 34 of IS:456-2000. The footing will be checked for the following:

(a) Bending moment at a section on the face of the column /pedestal

(b) Shear force at a section at a distance equal to effective depth of the footing from the face of the column or pedestal.

(c) Bearing stress on the footing due vertical load of the column.

(d) Punching shear on the footing due to vertical load of the column.

The reinforcement will be determined as a rectangular section in accordance with Annex-G of IS:456-2000 and SP-16.

iv. DESIGN OF LINTEL BEAMS, CHAJJA & LOFT

The lintel beams will be designed for:

(a) Weight of brick masonry above the lintel level

(b) Load from RCC Chajja attached to the lintel.

(c) Torsion moment due to eccentricity of the Chajja/loft.

Lintel beam shall have a minimum bearing equal to the thickness of the wall on which it is supported or the depth of the lintel beam, whichever is greater. It shall be designed as a simply supported rectangular section. Chajja/loft will be designed as a cantilever slab.

v. DESIGN OF STAIRCASE

The Internal staircase shall be designed in accordance with clause 33 of IS: 456-2000. The Staircase is slab type without stringer beam. The waist slab shall be designed as a simply supported rectangular section. The size of main reinforcement steel shall not be less than 12mm. The staircase would be analysed, designed & detailed as per the provisions of SP-34.

vi. UNDERGROUND SUMP COMBINED WITH WTP/OVERHEAD WATERTANK

Underground water tank would be designed to sustain the following two cases-

(a) Tank full and No earth fill

(b) Tank empty and active earth pressure acting from outside.

The walls and base slab would be designed as per the provisions of IS: 3370 (Part1-Part4)-1965 using the working stress method.

Overhead water tank would be designed to sustain the water load at full tank condition as per the provisions of IS: 3370 (Part 1- Part4) -1965 using the working stress method.

vii. Expansion &Construction Joints:

Seismic Expansion joints are recommended when structure exceeds 45m length. The width of the joints is being calculated as per IS-1893-2016, clause7.11.3.

viii. Detailing

The reinforcement layout should take into account the strength requirements as well as the economy of construction.

Following are the requirements of good detailing.

(a) Reinforcement detailing should be simple for fabrication and placing.

(b) Cracking of concrete should be within the permissible limits

(c) There should not be any free paths for propagation of cracks without being traversed by reinforcement

(d) Joints and discontinuities should be capable of withstanding the same forces as the adjoining sections

(e) Reinforcement should not deviate excessively from the direction of tensile stresses

(f) Reinforcement steel of same type and grade shall be used as main reinforcement in a structural member.

(g) Provisions of IS: 456-2000, IS 13920-1993 and IS: SP 34 will be followed for the purpose of detailing of reinforcement.

s) Design of water retaining structures

The underground tank in a station shall be designed as a water retaining structure based on IS: 3370. Various types of loadings shall be considered in the design of the underground tank. The side walls shall be subjected to earth pressure. Wherever encountered, horizontal pressure due to water table shall also be considered. Stability of water tank shall be checked against buoyancy and foundation raft shall be designed for the worst of buoyant force and soil pressure. The tank shall also be designed for surcharge loading if any. Water proofing treatment shall be done on the external surface as well as in the internal surface.

t) MASONRY WALLS

All Masonry walls shall be treated as non-structural infill panels and shall be treated as one way / two way slab panels spanning between adjoining beams and columns to check structural safety. Masonry walls shall be designed as un-reinforced masonry as per IS: 1905 and IS: 4326. Shear connector reinforcement between walls & beams and walls & columns shall be provided for external wall while the internal partition walls shall be connected with roof slabs/beams using dry packing mortar between top of walls and soffit of slab / beam.

5.5 CODAL PREFERENCE

The design shall be carried out as per provision of these design specifications. Reference shall be made to the following codes for any additional information:

Order of preferences of codes shall be as follows:

(a) Bureau of Indian Standard codes

(b) Indian Railway standard

(c) National Building Code

(d) IRC

(e) BS or Euro Codes

(f) AASHTO

(g) Any international code with approval of HRIDC.

6. OUTLINE DESIGN SPECIFICATIONS: Retaining Walls

6.1 General

This part lays down criteria for design of Retaining Wall.

6.2 Details of Structures to be designed

The Contractor shall design the retaining walls of various heights that are required in C2 Package.

Retaining wall is required to be provided at some of the locations along the alignment due to limited availability of ROW. On LHS (i.e. on KMP side) of main line, no retaining wall shall be provided. Further, some additional land is proposed to be acquired along the alignment. In case additional land is made available before undertaking the construction, provision of retaining wall shall be deleted and earthen slope shall be provided at that location. Cost of additional earthwork due to provision of slope shall be paid under the Schedule B.

Precast retaining walls shall be used up to 6m height (height above the ground level). Beyond 6m height, cast in situ retaining wall may be used.

Reinforced Earth wall (RE wall) shall not be permitted.

6.3 Design Criteria

a) Wherever sufficient land is not available to provide a stable slope for the formation along the alignment without infringing ROW, suitable earth retaining structure as per the IRS-Bridge Substructure & Foundation Code shall be provided.

b) Earth retaining structure if required at any other critical location, shall be proposed by the Contractor and shall be subject to approval of the Engineer.

c) The earth retaining structures, if required, shall be designed as per the following criteria:

   i. In case the location of the earth retaining structure is within Axle Load Impact Line, it shall be designed for earth pressure as well as surcharge due to DFC loading (32.5T axle load).

   ii. In case the location of the earth retaining structure is beyond the Axle-Load Impact Line, it shall be designed for retaining the earth.

d) Design and reinforcement detailing shall suit the lifting and handling requirements of the segments of precast retaining wall.

e) Joints between the segments shall be properly designed for required lap length also.

f) Expansion joints at 30m

7. LIST OF CODES

7.1 Introduction

The Contractor shall carry out the design on the basis of the codes and specifications given below. The list of codes mentioned herein is only for guidance. The Contractor may supplement these codes and standards with the consent of the Engineer if in his opinion it is essential to do so to comply with the Employer's Requirements.

The Contractor shall be responsible for detailing in his design report and specifications of the standards on which his materials and workmanship will be based and these will be of similar or higher standard than those listed below.

The Contractor shall also be responsible for getting the approval from the Engineer for the standards which he intends to apply for the detailing of his design and specifications additionally.

7.2 Relevant Standards

Apart from the basic data and specific requirements listed in the Employer's Requirement, all items of the Works shall be governed by the latest versions of the following codes and specifications as revised/corrected/amended (with latest correction slip) till the date of approval of design/drawings by the Engineer. In case of contradiction in various codal provisions, the order of precedence shall be as follows:-

i. Specific provisions in the Employer's Requirements.
ii. IRS Codes and specifications
iii. IS Codes
iv. IRC Codes and specifications
v. International Codes

However, in case of ROBs and other highway loading related structures, IRC Codal provisions shall prevail over IRS Codal provisions. Notwithstanding the precedence specified above, the Contractor shall always seek advice from the Engineer in the event of any conflict for a final decision.

a) Loading Standards shall be as given in Design Requirements Criteria

b) Indian Railway Standard Codes and Specifications (IRS)

i. Bridge Rules
ii. Indian Railways Schedule of Dimensions (BG)
iii. Concrete Bridge Code
iv. Steel Bridge Code
v. Fabrication Specification (B1)
vi. Welded Bridge Code
vii. Indian Railways Bridge Manual
viii. Indian Railways Permanent Way Manual

ix. Indian Railways Works Manual

x. Bridge Substructure & Foundation Code

xi. Well and Pile Foundation Code

xii. Seismic Code for Earthquake Resistant Design of Railway Bridges

c) RDSO Guidelines

i. BS-113 Guidelines for providing Arrangements for Bridge Inspection

ii. Comprehensive Guidelines and Specifications for Railway Formation: RDSO/2020/GE: IRS 0004

iii. BS-114 RDSO guidelines for carrying out rail-structure interaction studies on Indian Railways

iv. BS-126 Guidelines for continuation of LWR/CWR over ballasted deck bridges on Indian Railways

v. Report No. GE: R-50: Transitional System on approaches of bridges issued by RDSO.

vi. Report No. BS-111: Guidelines for use of High Strength Friction Grip (HSFG) bolts on bridges on Indian Railways.

vii. Guidelines for design of Spherical and Cylindrical bearings (in case of Steel Bridges).- Letter No.: RDSO/CBS/Bearing dated 22-06-2011

viii. RDSO drawing for H beam sleepers

d) Indian Road Congress (IRC) Codes and Specifications

i. IRC: 5 Standard Specifications and Codes of Practice for Road Bridges Section – I – General features of design.

ii. IRC: 6 Standard Specifications and Codes of Practice for Road Bridges –Section – II – Loads and Stresses – Seismic provisions of this standard are to be adopted for the bridge design.

iii. IRC:112 Code of Practice for Concrete Road Bridges

iv. IRC: 22 Standard Specifications and Codes of Practice for Road Bridges Section – VI – Composite Construction.

v. IRC: 24 Standard Specifications and Codes of Practice for Road Bridges – Section V, Steel Road Bridges.

vi. IRC: 54 – Lateral and Vertical Clearances for Vehicular Traffic.

vii. IRC: 83 (Part – III) – Standard Specifications and Codes of Practice for Road Bridges – Section – IX – Bearings Part – III, Pot, POT cum PTFE Pin and Metallic Guide Bearings.

viii. IRC: 83 (Part – IV) – Standard Specifications and Codes of Practice for Road Bridges – Section – IX- Bearings Part – IV, Spherical and Cylindrical

ix. IRC-78: Sub-structure for Road Bridges.

x. IRS-87: Design and erection of false work for road bridges.

xi. Specifications for Road and Bridge Works issued by Ministry of Road Transport & Highways (MORTH).

e) Indian Standards Codes and Specifications (IS)

i. IS: 456 Plain and reinforced concrete - code of practice

ii. IS: 800 Code of practice for General Construction Steel

iii. IS: 875 Code of Practice for Design Loads Part 1, 2 3, 4& 5 (Other than Earthquake)

iv. IS: 1080 Design and construction of shallow foundations in soils (other than raft ring and shell)

v. IS: 1364 Hexagon Head Bolts, Screws & nuts of product grades A & B Part 1 (part 1 Hexagon, Head Bolts (size range M 1:6 to M64)

vi. IS 1367 Threaded Steel Fasteners

vii. IS: 13920 Ductile detailing of reinforced concrete structures subjected to seismic forces code of practice

viii. IS: 1489 Specification for Portland pozzolana cement (Fly ash based)

ix. IS: 1786 High strength deformed steel bars and wires for concrete reinforcement

x. IS: 1893 Criteria for Earthquake Resistant Design of structures

xi. IS: 1904 Design and construction of Foundations in soils: general requirements.

xii. IS: 2062 Specifications for weldable Structural steel

xiii. IS: 2502 Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

xiv. IS: 2911 Design and Construction of Pile Foundation- Code of practice Part 1Concrete Pile- Section 2 Board Cast-in-situ-piles

xv. IS 2911 Design and Construction of Pile Foundation- Code of practice Part 4 Load test on piles

xvi. IS: 2950 Design and construction of raft foundations

xvii. IS: 3935 Code of Practice for Composite Construction

xviii. IS: 4326 Code of practice for Earthquake resistant design and construction of Buildings

xix. IS: 4923 Hollow steel sections for structural use -specification

xx. IS: 8009 Calculation of settlements of shallow foundations

xxi. IS: 269 Specifications of OPC cement

xxii. IS: 9103 Specifications of Concrete admixtures

xxiii. IS: 11384 Code of practice for Composite Construction in Structural Steel and Concrete

xxiv. IS: 12070 Code of practice for Design and construction of shallow foundation on Rocks

xxv. IS: 14593 Design and Construction of Bored Cast-in-Situ Piles Founded on Rocks.

xxvi. IS 455Specifications for Portland Slag cement

f) International Standards

i. UIC Code 774-3 (R) Track and Bridge Interaction

ii. UIC Code 772-2 (R) Code for the use of rubber bearings for rail bridges

The list of standards given above is only indicative. The Contractor shall follow provisions of appropriate codes and standards in force for items which are not covered in the codes mentioned in foregoing paras.

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Chapter 1. GENERAL-CIVIL

1.1 GENERAL:

1.1.1 These Specifications contained herein shall be read in conjunction with other tender documents.

1.1.2 All Materials, works and construction operations for civil works shall conform to the following manuals:

a) Indian Railways Permanent Way Manual

b) Indian Railway Bridge Manual

c) Indian Railway Works Manual

d) Indian Railway Schedule of Dimensions

e) Indian Railways Unified Standard Specification (Formation Works, Bridge Works and P.Way Works)

f) The relevant IRS Specifications referred to in the above documents listed at (a), (b), (c), (d) & (e)

g) CPWD Specifications, Vol 1&2 – 2019 for building works

h) In case of any contradiction in the various codal provisions, the order of precedence shall be as follows:-

i. IRS Codal provisions

ii. IRC Codal provisions

iii. IS (BIS) Codal provisions

1.1.3 The Work shall be carried out in accordance with the "Good for Construction" drawings and designs as would be issued to the Contractor by the Engineer duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Engineer's signature and stamp. Similarly, the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer in writing.

1.1.4 The work shall be executed and measured as per metric units given in the Schedule of Quantities, drawings etc. (FPS units where indicated are for guidance only).

1.1.5 Absence of terms such as providing, supplying, laying, installing, fixing etc in the descriptions does not even remotely suggest that the Contractor is absolved of such providing, supplying etc. unless an explicit stipulation is made in this contract. The Employer shall bear no costs of materials, labour, equipment, duties, taxes, royalties etc.

1.1.6 The specifications may have been divided into different sections / sub-heads for convenience only. They do not restrict any cross-references. The Contractor shall take into account inter-relations between various parts of works/trades. No claim

shall be entertained on the basis of compartmental interpretations.

1.1.7 Reference to the Standard Codes of Practice:

a) The contractor shall make available at site all relevant Codes of practice as applicable.

Legends	Definition
IRS	Indian Railway Standards
IR specifications	Indian Railways Unified Standard Specification (Formation Works, Bridge Works and P.Way Works)
IS	Indian Standards
IRC	Indian Road Congress
CPWD	Central Public Works Department
RDSO	Research Designs and Standards Organisation
UIC	International Union of Railways (UIC, French: Union international des chemins de fer)
MORTH	Ministry of Road Transport and Highways
EN	European Standard
ISO	International Organization for Standardization
ASTM	American Section of the International Association for Testing and Materials
BS	British Standard

1.1.8 Alternative or additional codes and standards proposed by the contractor shall be internationally recognized codes and shall be equivalent to or better than, Indian Standards issued by the Bureau of Indian Standards or any other Indian professional body or organization, subject to being, in the opinion of the Employer's Representative, suitable for incorporation or reference into the specifications.

1.1.9 Contractor to Provide:

The Contractor shall provide and maintain at site throughout the period of works the following at his own cost and without extra charge, except for the items specified in the Bill of Quantities the cost being held to be included in the Contract Rates:

a) General works such as setting out, site clearance before setting out and on completion of works. All weather approach roads to the site office should also be constructed and maintained in good condition.

b) All labour, materials, plant, equipment and temporary works, Overhead charges as well as general liabilities, obligations, insurance and risks arising out of GCC, required to complete and maintain the works to the satisfaction of the Engineer.

c) Adequate lighting for night work, and also whenever and wherever required by the Engineer.

d) Temporary fences, barricades, guards, lights and protective work necessary for protection of workmen, supervisors, engineers, General public and any other persons permitted access to the site. Contractor shall provide proper signages as directed.

All fences, barricade shall be painted with colour shades as specified by the Engineer. The barricading should be of adequate height to ensure visual obstruction of work from public view.

e) All equipment, instruments, labour and materials required by the Engineer for checking alignment, levels, slopes and evenness of surfaces measurements and quality etc.

f) Design mixes and testing them as per relevant clauses of specifications giving proportion of ingredients, sources of aggregates and binder along with accompanying trial mixes. Test results to be submitted to the Engineer for his approval before adoption on works.

g) Cost of Preparation and compliance with provision of a quality assurance control program.

h) Cost of safeguarding the environment.

i) A testing laboratory as specified by the Engineer equipped with the following minimum apparatus, materials and competent trained staff required for carrying out tests, as specified in the relevant sections of the specifications: -

   i. 1 Set of standard sieves for testing grading of sand with mechanical sieve shaker.

   ii. Sieves with openings respectively of 4.75mm, 10mm, 20mm, 25mm, 30mm for testing and grading of aggregates.

iii. Weighing Balance of capacity up to 10 Kg. reading up to 5 gm.

iv. Electric Thermostat controlled oven and pans for drying of sand and aggregates.

v. Glass measuring flasks of 1/2, 1 liter & 2 liter capacity.

vi. Flask for determining moisture content of sand.

vii. Slump cone with rod and V B Apparatus, flow table to measure slump or DIN Specifications.

viii. Apparatus to measure permeability of concrete as per Appendix 1700/II of MOST Specifications.

ix. Minimum 24 Nos. steel moulds for 150mm x 150mm x 150mm concrete test cubes. It may be necessary to provide more steel cube moulds depending upon concreting program.

x. 25mm dia vibrator for compaction of concrete in test cubes and also vibrating table.

xi. Concrete cube testing machine of 200 tonnes capacity with 3 dial gauges electrically operated.

xii. Work benches, shelves, desks, sinks and any other furniture and lighting as required by the Engineer.

xiii. Abrasion Flakiness & Impact testing Equipment for testing coarse aggregate.

xiv. Silt Testing Equipment.

xv. Equipments for field lab as per list given in Annexure-VIII of RDSO guidelines No. RDSO/2020/GE: IRS-0004, Sept-2020

xvi. Any other equipment specified by Engineer.

1.1.10 Quality Assurance & Quality Control:

a) The work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. The Contractor shall conform to the Quality standards prescribed, which shall form the backbone for the Quality Assurance and Quality Control system.

b) At the site, the Contractor shall arrange the materials, their stacking/storage in appropriate manner to ensure the quality. The Contractor shall provide all the necessary equipment and qualified manpower to test the quality of materials, assemblies etc., as directed by the Engineer. The tests shall be conducted at specified intervals and the results of tests properly documented. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes, and evenness of the surfaces.

c) The Engineer shall be free to carry out such tests as may be decided by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor may provide the samples and labour for collecting the

samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

i. The test shall be conducted at the Site laboratory that may be established by the Contractor or at any other Standard Laboratory selected by the Engineer.

ii. The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of the Contractor failing to arrange transportation of the samples in proper time the Engineer shall have them transported and recover two times the actual cost from the Contractor's bills.

iii. All testing shall be performed in the presence of Engineer. Testing may be witnessed by the Contractor or his authorised representative if permitted by the Test House. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

d) The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, all equipment including the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged, and the Engineer's approval obtained prior to starting of the particular item of work. This shall, however, not relieve the Contractor of his responsibilities. All materials which do not conform to these specifications shall be rejected and shall be removed from the site immediately. The Engineer shall have the powers to cause the Contractors to purchase and use materials from any particular source, as May in the Engineer's opinion be necessary for the proper execution of work.

1.1.11 Training

The Contractor shall arrange the following trainings for all his concerned persons and 15 persons of the Engineer and the Employer together:

a) 4 days training for fabrication of welded steel girders for railway including one day for practical demonstration at site.

b) 4 days training for concrete, testing, scaffolding and formwork including one day for practical demonstration at site

c) 2 days training on embankment construction and testing

The Contractor shall bear all the expenditure for training including boarding, lodging, airfare, transport, and remuneration of trainers. Training place shall be provided by the Employer free of cost. However, the Contractor shall bear the expenditure for refreshments and meals for all the participants during the training period. The syllabus of training and the names of the trainers shall be submitted to the Engineer for approval. Training shall be imparted only by those trainers who are approved by the Engineer.

1.1.12 Dimensions**:**

a) Figured dimensions on drawings shall only be followed and drawings to a large scale shall take precedence over those to a smaller scale. Special dimensions or directions in the specifications shall supersede all others. All dimensions shall be checked on site prior to execution.

b) The dimensions where stated do not allow for waste, laps, joints, etc. but the Contractor shall provide at his own cost sufficient labour and materials to cover such waste, laps, joints, etc.

c) The levels, measurements and other information concerning the existing site as shown on the drawings are believed to be correct, but the Contractor should verify them for himself and also examine the nature of the ground as no claim or allowance whatsoever will be entertained on account of any errors or omissions in the levels or the description of the ground levels or strata turning out different from what was expected or shown on the drawings.

1.1.13 Setting out of Works:

The Contractor shall set out the Works indicated in the Contract. The Contractor shall provide suitable stones with flat tops and build the same in concrete for temporary benchmarks. All the pegs for setting out the Works and fixing the levels required for the execution thereof shall, if desired by the Engineer, likewise be built in masonry at such places and in such a manner as the Engineer may direct. The Contractor shall carefully protect and preserve all benchmarks and other marks used in setting out the works. The contractor will make overall layout of complete work and get it checked from engineer. The cost of all operations of setting out including construction of benchmarks is deemed to be included in the quoted rates.

a) All the survey work except leveling work shall be carried out using total stations with one second accuracy. The leveling work shall be carried out using Auto level.

b) The triangulations point given by concerned organization before start of work shall be maintained during execution and handed over back to concerned organization after completion of work.

1.1.14 Materials:

a) Source of Materials:

It shall be the responsibility of the contractor to procure all the materials required for construction and completion of the contract. The contractor shall indicate in writing the source of materials well in advance to the Engineer, after the award of the work and before commencing the work. If the material from any source is found to be unacceptable at any time, it shall be rejected by the Engineer and the contractor shall forthwith remove the material immediately from the site as directed by the Engineer.

b) Quality:

All materials used in the works shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the Engineer and shall comply strictly with the tests prescribed hereafter, or where tests are not laid down in the specifications, with the requirements of the latest issues of the relevant Indian Standards.

c) Sampling and Testing:

All materials used in the works shall be subjected to inspection and test in addition to test certificates. Samples of all materials proposed to be employed in the permanent works shall be submitted to the Engineer at least 45 days in advance for approval before they are brought to the site.

Samples provided to the Engineer for their retention are to be labeled in boxes suitable for storage. Materials or workmanship not corresponding in character and quality with approved samples will be rejected by the Engineer.

Samples required for approval and testing must be supplied sufficiently in advance if required quality and number to allow for testing and approval, due allowance being made for the fact that if the first samples are rejected further samples may be required. Delay to the works arising from the late submission of samples will not be acceptable as a reason for delay in completion of the works.

Materials shall be tested before leaving the manufacturer's premises, quarry or resource, wherever possible. Materials shall also be tested on the site and they may be rejected if not found suitable or in accordance with the specification, notwithstanding the results of the tests at the manufacturer's works or elsewhere or test certificates or any approval given earlier.

The contractor will bear all expenses for sampling and testing, whether at the manufacturer's premises at source, at site or at any testing laboratory or institution as directed by the Engineer. No extra payment shall be made on this account.

d) Dispatch of materials:

Materials shall not be dispatched from the manufacturer's works to the site without written authority from the Engineer.

e) Test certificates:

All manufacturer's certificates of test, proof sheets, etc. showing that the materials have been tested in accordance with the requirement of this specification and of the appropriate Indian Standard, are to be supplied free of charge on request to the Engineer.

f) Rejection:

Any materials that have not been found to conform to the specifications will be rejected forthwith and shall be removed from the site by the Contractor at

his own cost within two weeks or as instructed by the Engineer.

g) The Engineer shall have power to cause the Contractors to purchase and use such materials from any particular source, as may in his opinion be necessary for the proper execution of the work.

1.1.15 Storing of Materials at site:

All materials used in the works shall be stored on racks, supports, in bins, under cover etc. as appropriate to prevent deterioration or damage from any cause whatsoever to the entire satisfaction of the Engineer.

The storage of materials shall be in accordance with IS 4082 "Recommendation on stacking and storage or construction materials on site" and as per IS 7969 "Safety code for handling and storage of building materials".

The materials shall be stored in a proper manner at places at site approved by the Engineer. Should the place where material is stored by the Contractor be required by the Employer for any other purpose, the Contractor shall forthwith remove the material from that place at his own cost and clear the place for the use of the Employer.

1.1.16 Water:

a) Water from approved source:

Potable water only shall be used for the works. Contractor shall have his own source of water duly approved by Engineer. The water shall be free from any deleterious matter in solution or in suspension and be obtained from an approved source. The quality of water shall conform to IS 456:.

b) Storage:

The Contractor shall make his own arrangements for storing water, if necessary, in drums or tanks or cisterns, to the approval of the Engineer. Care shall be exercised to see that water is not contaminated in any way.

c) Testing:

Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use in concrete for approval of the Engineer. No water shall be used until tested and found satisfactory. Cost of all such Tests shall be borne by the contractor.

1.1.17 Workmanship:

a) All works shall be true to level, plumb and square and the corners, edges and arises in all cases shall be unbroken and neat.

Any work not to the satisfaction of the Engineer or his representative will be rejected and the same shall be rectified, or removed and replaced with work of the required standard of workmanship at no extra cost.

1.1.18 Load Testing on Completed Structures

a) Load Testing of superstructure, in case of major bridges with OWG/ composite girders/ PSC girders and minor bridges with skew shall be done by the Contractor as per the directions of the Engineer. Cost of span load test is included in Schedule-C.

b) During the period of construction or within the defect liability period the Engineer may at his discretion order the load testing of any completed structure or any part thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons:

i. Results of compressive strength on concrete test cubes falling below the specified strength.

ii. Premature removal of formwork.

iii. Inadequate curing of concrete.

iv. Over loading during the construction of the structure or part thereof.

v. Carrying out concreting of any portion without prior approval of the Engineer.

vi. Honey combed or damaged concrete which in the opinion of the Engineer

vii. is particularly weak and will affect the stability of the structure to carry the design load, more so in important or critical areas of the structure.

viii. Loss of camber in OWG beyond permissible range as specified by Railway Board/RDSO.

ix. Any other circumstances attributable to alleged negligence of the contractor which in the opinion of the Engineer may result in the structure or any part thereof being of less than the expected strength.

c) All the loading tests shall be carried out by the contractor strictly in accordance with the instructions of the Engineer, as per IRS:CBC and IRC:SP-51. Such tests shall be carried out only after expiry of minimum 28 days or such longer period as directed by the Engineer.

d) The structure shall be subjected to the load as approved for SLS condition in the design. This load shall be maintained for a period of 24 hours before removal. Incremental loading shall be done in accordance with IRC:SP-51, unless otherwise directed by the Engineer.

In case the recovery of the structure is not as per codal provisions, the structure shall be considered to have failed to pass the test and shall be deemed to be unacceptable.

e) In such cases the portion of the work concerned shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the Engineer. However, such remedial measures shall be carried out to the

complete satisfaction of the Engineer. Again Load test shall be conducted as per codal provisions.

f) All costs involved in carrying out the tests (except integrity test for piles) and other incidental expense thereto shall be borne by the contractor regardless of the result of the tests. The contractor shall take down or cut out and reconstruct the defective work or shall make the remedial measures instructed at his own cost.

If the load testing is instructed on any ground other than mentioned in (i) to (viii) of Cl. 1.1.17.2, the cost of the same shall be reimbursed to the Contractor, if the result of the test are found to be satisfactory.

g) In addition to the load tests mentioned in Sub-Clause 1.1.17.2, non-destructive test methods such as core test and ultrasonic pulse velocity test shall be carried out by the contractor at his own expense if so desired by the Engineer. Such tests shall be carried out by an agency approved by the Engineer and shall be done using only recommended testing equipment. The acceptance criteria for these tests shall be as per provisions in the relevant Indian/International standards and as approved by the Engineer.

1.2 STRUCTURAL WORK:

1.2.1 Unless specified, only controlled concrete with design mix and weigh batching is to be used for the work.

1.2.2 Minimum cement content specified in the codal specifications is purely from durability point of view. Larger content of cement shall have to be provided if demanded by mix design.

1.2.3 Provision of cement slurry to create bond between plain / reinforced concrete surface and subsequent applied finishes shall not be paid extra.

1.2.4 Mix design using smaller aggregates of 10mm down shall also be done in advance for the use in the junction having congested reinforcement.

1.2.5 Procedure of mixing the admixtures shall be strictly as per the manufacturer's recommendations if not otherwise directed by the Engineer.

1.2.6 All the water tanks and other liquid retaining concrete structures shall undergo hydro-testing.

1.2.7 Special benches shall be provided at site for stacking reinforcement bars of different sizes.

1.2.8 Formwork for beams of RCC areas shall be designed in such a way that the formwork of the adjacent slabs can be removed without disturbing the props / supports of the beams.

1.2.9 Wherever there are tension / suspended concrete members which are suspended from upper-level structural members, the shuttering / scaffolding of such members at lower level shall have to be kept in place till the time the upper level supporting

members gain minimum required strength. Cost of such larger duration of keeping in place the shuttering/scaffolding shall be deemed to be included in the price quoted for respective structural members.

1.2.10 Formwork is required for full height at all locations. Special precaution for such tall formwork shall be taken to ensure its safety. Extra costs for such formwork shall be deemed to have been included in the price quoted against relevant items.

1.2.11 In the mobilization period, the contractor shall carry out expeditiously and without delay the following works:

i. Material testing and mix designs of concrete as contemplated in the specifications.

ii. Setting up of full-fledged site laboratory as per the requirements of these specifications.

iii. Any other pre-requisite items required for final execution.

iv. Site office for the use of the Engineer staff.

v. Casting yard with full facilities.

1.2.12 Casting yard to have following minimum facilities:

i. Casting beds as required.

ii. All handling facilities for precast elements.

iii. Curing arrangements as required.

iv. Stacking arrangements for precast elements.

v. Storing of materials.

vi. Proper drainage and approach roads.

1.2.13 Fabrication yard to have following minimum facilities:

i. Fabrication beds as required.

ii. All handling facilities.

iii. Stacking arrangements for precast elements.

iv. Storing of materials.

v. Proper drainage and approach roads.

1.3 SUPPLY OF PROGRES PHOTOGRAPHS AND ALBUMS (DIGITAL):

The work covers the supply of digital photographs to serve as a permanent record of various stages/facets of work needed for an authentic documentation as approved by the Engineer.

The photographs shall be of acceptable quality and they shall be taken by a professionally competent photographer with camera having the facility to record the date of the photographs taken in the soft copy. Each photograph in

the album shall be suitably captioned and dated.

The photographs and materials shall form a part of the records of concerned organization and same cannot be supplied to anybody else or published without the written permission of concerned organization.

1.4 SUPPLY OF VIDEO CDs:

The work consists of taking video films of important activities of the works as directed by the Engineer during the currency of the Project and editing them to a video film of playing time not less than 60 minutes. It shall contain narration of the activities in English by a competent narrator. The edition of the film and script of the narration shall be approved by the Engineer.

Drone videography of the whole package for inspection and monitoring of structures, shall be done by the Contractor once in a month.

The record of progress (photographs and videos) shall be submitted to the engineer on monthly basis or as directed by engineer.

1.5 SURVEY WORK:

The said work involves at the very start of work taking-over of reference point from the Engineer, establishment of control points, triangulation points, bench marks, grid layout for all the piers and other structures maintaining horizontal and vertical control within the permissible limits, incorporating changes (if any), submission of full data in the tabulation form and survey drawings including setting and layout of various works during the progress of work and matching of the station area track alignment with the alignment of the approaches at station ends and incorporating the changes (if any).

1.6 BARRICADING

The work covers barricading for the work done along the median and areas affecting road traffic and other areas like casting yard, batching plant, storage and other working area. All barricading shall be done at own cost by the Contractor. The detailed scope of work is as follows:

i. Providing and installing the barricade of the design and type as shown in the Tender Drawings furnished as per the approved plan firmly to the ground and maintaining it during the progress of work.

ii. Dismantling of barricading and other temporary installations from the site and cleaning the site as per direction of Engineer upon completion and acceptance of work.

iii. Providing earthing of Barricades.

iv. Providing Lighting on the periphery of Barricades for Direction illumination.

1.7 FINISHING WORK:

1.7.1 The Contractor shall incorporate seismic considerations of anchoring and isolation in the design and detailing of the finishes as directed by the Engineer. The element

to be anchored shall have its motion suitably restrained whilst at the same time it shall be suitably isolated so as not to be affected by the deformations/ vibrations of the building during Construction.

1.7.2 Sub-Contractor:

Works as listed below and those dealing with proprietary materials/ products may be carried out by the Contractor through the Sub-Contractors as may be approved by the Engineer in writing. The Sub-Contractors must be firms of repute and long standing, having adequate experience and complete facilities to carry out all items of work required for completion as per Specifications and expected quality to the satisfaction of the Engineer. The Sub-Contractor must also have personnel experienced in preparing shop drawings. All such works, not limited to the following, shall be carried out under the direct supervision of the manufacturers of the proprietary materials/ products or their trained and accredited licensee.

i. Bearings

ii. Fabrication, assembly and launching of steel OWG

1.7.3 Responsibility for Shop drawings, Samples and Mock-ups:

Approval of shop drawings, samples and mock-ups for the various components shall not absolve the Contractor of his responsibility of completing the work to the specifications, standards, tests for performance and guarantees given in these documents and to a quality of finish as desired by the Engineer.

1.7.4 Cleaning:

Surfaces on which finishes are to be provided shall be cleaned with water jets or oil free compressed air or power tools with wire brushes and detergents all as approved by the Engineer.

1.8 Applicable Codes, Standards & Publications for Structural & Architectural Work:

The more important Codes, Standards and Publications to Contract are listed here under:

Any other code/publication, if found necessary by the engineer, may be referred to for such works. The latest revision along with all corrections slip & amendments shall only be followed

Sr. No.	Code No.	Code Name
General		
1.	IS: 875	Code of Practice for design loads (other than earthquake) for buildings and structures
2.	IS: 122 (part 4)	Methods of measurement of buildings and Civil engineering works-Stone masonry

3.	IS:1237	Specification for cement concrete flooring tiles
4.	IS: 1322	Bitumen felts for water proofing and damp-proofing
5.	IS: 1893	Criteria for earthquake resistant design of structures
6.	IS: 2185 (Part 1)	Concrete masonry units: Hollow and solid concrete
7.	IS: 2185 (Part 2)	Concrete masonry units: Hollow and solid light weight
8.	IS: 2185 (Part 3)	Concrete masonry units: Autoclaved cellular aerated concrete blocks
9.	IS: 2572	Code of Practice for construction of hollow concrete block Masonry
10.	IS: 3414	Code of practice for design and installation of joints in Buildings
11.	IS: 3462	Specification for unbacked flexible PVC flooring
12.	IS: 5318	Code of practice for laying of flexible PVC sheet and tile Flooring
13.	IS: 6408 (Parts 1,2)	Recommendations for modular co-ordination in building Industry-tolerances
14.	IS: 8183	Bonded mineral wool
15.	IS:10958	General check list of functions of joints in building
16.	IS:11817	Classification of joints in buildings for accommodation of dimensional deviations during construction
17.	IS:11818	Method of test for laboratory determination of air permeability of joints in buildings
18.	IS:12440	Precast concrete stone masonry blocks
19.	CPWD	Specifications with up-to-date correction slips
20.	BS:476 (Part 7)	Method for classification of the surface spread of flame of Products
21.	BS:476 (Part 20)	Method of determination of the fire resistance of elements of construction (general principles)
22.	BS:476 (Part 22)	Methods for determination of the fire resistance of non-load bearing elements of construction
23.	BS: 1245	Specification for metal door frames (steel)
24.	BS: 3261	Specification for unbacked flexible PVC flooring
25.	BS:3261: Part 1	Homogeneous flooring
26.	BS:5215	Specification for one-part gun grade polysulphide-based Sealants
27.	BS:5606	Guide to accuracy in building
28.	BS:5725 (Part 1)	Specification for panic bolts and panic latches mechanically operated by a horizontal push-bar
29.	BS:6093	Code of practice for the design of joints and jointing in building construction
30.	BS:8200	Code of practice for the design of non-load bearing external vertical enclosure of building
31.	ASTM C 332	Specification for light weight aggregate for insulating Concrete

32.	ASTM C 635	Specification for the manufacture, performance and testing of metal suspension systems for acoustical tile and lay-in panel ceilings
33.	SP 7	National Building Code of India
34.	SP 23 (S&T)	Hand Book on Concrete Mixes
Bitumen		
35.	IS:702	Industrial Bitumen
36.	IS:3384	Specification for bitumen primer for use in waterproofing and damp-proofing
Building Construction Practices		
37.	IS: 1838 Parts I and II.	Specifications for preformed fillers for expansion joint in concrete pavements and structures
38.	IS: 1946	Code of Practice for use of fixing devices in walls, ceilings, and floors of solid construction.
39.	IS: 3414	Code of Practice for design and installation of joints in buildings.
40.	IS: 6509	Code of Practice for installation of joints in concrete pavements.
41.	IS: 11134	Code of Practice for setting out of buildings.
42.	IS: 11433	Parts I and II. Specifications for one part Gun grade polysulphide based joint sealant
43.	IS: 12200	Code of Practice for provision of water stops at transverse construction joints in masonry and concrete dams
Cement		
44.	IS:269	33 grade ordinary Portland cement
45.	IS: 455	Portland Slag Cement
46.	IS: 650	Specification for standard sand for testing cement
47.	IS: 1489 (Part 1)	Portland pozzolana cement: Fly ash based
48.	IS: 1489 (Part 2)	Portland pozzolana cement: Calcined clay based
49.	IS: 3535	Method of Sampling Hydraulic Cements
50.	IS: 4031	(Parts 1 to 13) Methods of physical tests for hydraulic cement
51.	IS:4032	Methods of chemical analysis of hydraulic cement
52.	IS: 6925	Methods of test for determination of water-soluble chlorides in concrete admixtures
53.	IS:8042	White Portland Cement
54.	IS: 8112	Specification for 43 grade ordinary Portland cement
55.	IS:12269	Specification for 53 grade ordinary Portland cement
56.	IS: 12330	Specification for sulphate resistant Portland cement
57.	IRS: T40	Indian Railways standard specification for special grade cement for use in concrete sleepers
Concrete		
58.	IS:456	Code of practice for plain and reinforced concrete
59.	IS: 457	Code of practice for general construction of plain and

		reinforced concrete for dams and other massive structures
60.	IS: 460 (Part I TO III)	Specification for Test Sieves
61.	IS: 516	Methods of tests for strength of concrete
62.	IS: 1199	Methods of sampling & analysis of concrete
63.	IS: 1200	Methods of measurement of building and civil engineering
64.	IS: 1343	Code of practice for prestressed concrete
65.	IS: 1607	Methods of Test Sieving
66.	IS:2386	Parts I-VIII. Methods of tests for aggregates for concrete.
67.	IS:2430	Methods of Sampling of Aggregates of Concrete
68.	IS:2438	Specification for roller pan mixer
69.	IS:2514	Specification for concrete vibrating tables
70.	IS:2571	Code of practice for laying in-situ cement concrete Flooring
71.	IS:2645	Specifications for integral cement water proofing Compounds
72.	IS:2722	Specifications for portable swing batchers for concrete (double bucket type)
73.	IS:2770	Methods of testing bond in reinforced concrete part I pull out test
74.	IS:3025	Methods of sampling and test (physical and chemical) for water & waste water
75.	IS:3370	Code of practice for concrete structures for storage of Liquids
76.	IS:3935.	Code of practice for composite construction
77.	IS:4326	Code of practice for earthquake resistant construction of Building
78.	IS:6925.	Methods of test for determination of water soluble chlorides in concrete Admixtures
79.	IS:7242	Specifications for concrete spreaders
80.	IS:7251	Specifications for concrete finishers
81.	IS:7861	Parts I & II. Code of practice for extreme weather concreting
82.	IS:7969	Safety code for handling and storage of building materials
83.	IS:8989	Safety code for erection of concrete framed structures
84.	IS:8142	Methods of test for determining setting time of concrete by penetration resistance
85.	IS: 9103	Specification for admixtures for concrete
86.	IS: 9013	Method of making, curing and determining compressive strengths of accelerated cured concrete test specimens

87.	IS: 9284	Method of test for abrasion resistance of concrete
88.	IS:10262	Recommended guidelines for concrete mix design
89.	IS: 4926	Code of Practice ready mixed concrete needs to be included in list
90.	MORTH	Specifications for Road and Bridge Works, Ministry of Road Transport and Highways (Roads Wing)
91.	SP 34	Handbook on Concrete Reinforcement and Detailing
92.	IRS	Concrete Bridge Code
93.	IRC 112	Code of Practice for Concrete Road Bridge
94.	IRC 83 (Part 4)	Statndard Sepcifications and code of practice for road bridges Section IX Bearings (Spherical & Cylindrical)
95.	ASTM-C-94	Ready Mix Concrete
Construction Plant and Machinery		
96.	IS: 1791	Specification for batch type concrete mixers
97.	IS: 2505	General requirements for concrete vibrators: Immersion type.
98.	IS: 2506	General requirements for screed board concrete vibrators.
99.	IS: 3366	Specification for pan vibrators
100.	IS: 3558	Code of Practice for use of immersion vibrators for consolidating concrete
101.	IS: 4656	Specifications for form vibrators for concrete.
102.	IS: 4925	Specification for concrete batching and mixing plant.
103.	IS: 11993	Code of Practice for use of screed board concrete vibrators.
Formwork		
104.	IS: 4990	Specifications for plywood for concrete

		shuttering work
105.	IRC: 87	Guidelines for the design and erection of false work for road bridges.
106.	IS: 806	Code of practice for use of steel tubes in general building construction.
107.	IS: 1161	Specification of steel tubes for structural purposes.
108.	IS: 1239	Specification for mild steel tubes, tubular and other wrought steel fittings
Gypsum and Gypsum Board		
109.	IS: 2095	Gypsum plaster boards
110.	IS: 2542 (Part 1/Sec to 12)	Methods of test for gypsum plaster, concrete and products: plaster and concrete
111.	IS: 2542 (Part 2/Sec 1to 8)	Methods of test for gypsum plaster, concrete and products: Gypsum products
112.	IS: 2542 (Part1)	Gypsum building plaster: Excluding premixed lightweight plaster
113.	IS: 2547 (Part 2)	Gypsum building plaster: Premixed lightweight plaster
Handling and Storage		
114.	IS:4082	Recommendation of Stacking and Storage of construction materials
115.	IS:8348	Code of practice for stacking and packing of stone slabs for transportation
116.	IS:8759	Code of practice for maintenance and preservation of stones in building
Instruments for Testing Cement and Concrete		
117.	IS:5513	Specification for vicat apparatus.
118.	IS:5514	Specification for apparatus used in Le-Chaterlier test.
119.	IS:5515	Specification for compaction factor apparatus.
120.	IS:7320	Specification for concrete slump test apparatus.
121.	IS:7325	Specification for apparatus to determine constituents of fresh concrete.

122.	IS:10080	Specification for vibration machine.
123.	IS:10086	Specification for moulds for use in tests of cement and concrete.
124.	IS:10510	Specification for vee-bee consistometer.
	Joint Fillers	
125.	IS:1838 (Part 1)	Preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type): Bitumen impregnated fibre
Paints and Coatings		
126.	IS:102	Ready mixed paint, brushing, red lead, non-setting, priming
127.	IS:109	Ready mixed paint, brushing, priming, plaster, to Indian Standard Colour No. 361 and 631 white and off white.
128.	IS:218	Creosote and anthracene oil for use as wood preservatives
129.	IS:347	Varnish, shellac, for general purpose
130.	IS:348	French Polish
131.	IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming
132.	IS: 4833	Methods of field testing of preservatives in wood
133.	IS:10013 (Parts 1 to 3)	(Part -1) Water soluble type wood preservatives
134.	IS:10013 (Parts 1 to 3)	(Part-2) Acid-copper-chrome preservative
135.	IS: 10013 (Part 1 to 3)	(Part-3) Copper-chrome-boron wood preservative
136.	BS:6496	Specification for powder organic coatings for application and stoving to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with powder organic coatings
137.	BS:EN:10152	Specification for electrolytically zinc coated cold rolled

		steel flat products. Technical delivery conditions
138.	ASTM A 164-71	Specification for electrodeposited coatings of zinc on steel
Pigment for cement		
139.	BS:1014	Specification for pigments for Portland cement and Portland cement products
Reinforcement & Structural Steel		
140.	IS:206	Code of Practice for use of Steel Tubes in General Building Construction
141.	IS:210	Grey Iron Castings
142.	IS:280	Mild steel wire for general engineering purposes
143.	IS:432	Part I. Mild steel and medium tensile steel bars. Part II Hard drawn steel wire.
144.	IS:451	Technical Supply conditions for Wood Screws
145.	IS:806	Code of practice for use of steel tubes in general building construction
146.	IS:815	Classification coding of covered electrodes for metal arc welding of structural steels
147.	IS:1239	Specification for mild steel tubes, tubulars and other wrought steel fittings
148.	IS 1343	Code of Practice for Prestressed Concrete
149.	IS:1363	Black hexagon bolts, nuts and lock nuts and black hexagon screws.
150.	IS:1365	Slotted countersunk screws.
151.	IS:1566	(Part I) Specifications for hard-drawn steel wire fabric for Concrete reinforcement
152.	IS:1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
153.	IS:2502	Code of Practice for bending and fixing of bars for concrete reinforcement.
154.	IS:2629	Recommended practice for hot-dip galvanising of iron and steel.

155.	IS:2751	Code of Practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
156.	IS 4000	Code of practice for high strength bolts in steel structures
157.	IS:4759	Hot-dip zinc coating on structural steel and other allied products.
158.	IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works
159.	IS:9417	Recommendations for welding cold-worked steel bars for reinforced concrete construction.
160.	IS:14268	Uncoated stress relieved low relaxation steel class 2 for Prestressed concrete
161.	IS:226	Structural steel (Standard Quality)
162.	IS:800	Code of practice for use of structural steel in general building construction.
163.	IS:813	Scheme of symbols for welding
164.	IS:814	Covered electrodes for metal arc welding of structural steel. (Part I & Part II)
165.	IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
166.	IS:822	Code of practice for inspection of welds.
167.	IS:961	Structural steel (High Tensile)
168.	IS:1024	Code of practice for use of welding in bridges and structures subject to dynamic loading.
169.	IS:1030	Carbon steel casting for General Engineering Purposes
170.	IS:1120	Coach Screws
171.	IS:1367	Technical Supply Conditions for Threaded Fasteners
172.	IS:1161	Steel tubes for structural purposes.
173.	IS:1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates.
174.	IS:1915	Code of Practice for Steel Bridges
175.	IS:2016	Plain Washers

176.	IS:2062	Structural steel (Fusion welding quality)
177.	IS:3063	Single Coil Rectangular Section Sprint Washers for Nuts, Bolts and Screws
178.	IS:3443	Crane Rail Sections
179.	IS:3757	Specification for high tensile friction grip bolts
180.	IS:5624	Specification for foundation bolts
181.	IS:3600	Code of practice for testing of fusion welded (Part I) joints and weld metal in steel
182.	IS:4923	Hollow steel sections for structural use.
183.	IS:6227	Code of practice for use of metal arc welding in tubular structure.
184.	IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.
185.	IS:811	Specifications for cold formed light gauge structural steel sections.
186.	IS:8500	Structural steel Micro alloyed (Medium and high strength qualities)
187.	IS:8910	General requirements of supply of weldable structural steel
188.	IS:9595	Recommendations for metal arc welding of carbon & carbon- manganese steels.
189.	IS 16172	Reinforced Couplers for Mechanical Splices of Bars in Concrete
Sand		
190.	IS:383	Coarse and fine aggregates from natural sources for concrete.
Scaffolding		
191.	IS:2750	Specification for steel scaffoldings
192.	IS:3696 (Part 1)	Safety Code of scaffolds andladders: Scaffolds
193.	IS:3696 (Part 2)	Safety Code of scaffolds andladders: Ladders
194.	IS:4014 (Part 1)	Code of practice for steel tubular scaffolding: Definition and Materials

195.	IS:4014 (Part 2)	Code of practice for steel tubular scaffolding: Safety regulations for scaffolding
196.	IRC:87	Guidelines for the design and erection of falsework for Road bridge
Sealants		
197.	IS: 10959	Glossary of terms for sealants for building purposes
198.	IS: 11433 (Part 1)	One part grade polysulphide base joint sealant: General requirements
199.	IS: 11433 (Part 2)	One part grade polysulphide base joint sealant: Methods of test
200.	IS: 13055	Methods of sampling and test for anaerobic adhesives and sealants
201.	BS: 5889	Specification for one part gun grade silicone based sealants.
Wood		
202.	IS: 303	Plywood for General Purposes
203.	IS: 848	Synthetic resin adhesives for plywood (phenolic and aminoplastic)
204.	IS: 1141	Seasoning of Timber – Code of Practice
205.	IS:1328	Veneered decorative plywood
206.	IS: 1659	Blocks Boards
207.	IS: 2046	Decorative thermosetting synthetic resin bonded laminated sheets
208.	IS: 2202 (Part 1)	Wooden flush door shutters (solid core type): Plywood face panels
209.	IS: 2202 (Part 2)	Wooden flush door shutters (solid core (type): Particle face panels and hardboard face panels
Bearing		
210.	IRC: 83 Part-II	Standard specifications and code of practice for road bridges Elastomeric Bearings

211.	IRC: 83 Part-III EN 1337gh	Standard specifications and code of practice for road bridges Pot Bearings
212.	IRC: 83 Part-IV	Standard Specifications and Code of Practice for Road Bridges (Section – IX) Bearings (Spherical and Cylindrical)
Piling		
213.	IS: 2911 (All Parts)	Bored Cast in-situ Concrete Piles
214.	IRC: 78	Standard specifications and code of practice for road bridges Foundation And Substructure
All Indian Railway & RDSO Standards, any other code or publication as approved by engineer in-charge		
Metal		
215.	IS: 276	Austenitic manganese steel castings
216.	IS: 733	Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purpose.
217.	IS: 737	Specifications for wrought aluminium and aluminium alloy sheet and strip for general engineering purpose.
218.	IS: 3614 (Part 1)	Specification for fire check doors: Plate metal covered and rolling type
219.	IS: 3614 (Part 2)	Specification for metallic and non-metallic fire check doors: Resistance test and performance criteria
220.	IS: 7196	Specification for Hold Fasts
221.	ASME set 2 Part A	Ferrous Material Specification
222.	ASTM B 221	Specification for aluminum-alloy extruded bars, rods, wires, shapes, and tubes
223.	BS: 4873	Specification for Aluminum alloy windows
224.	BS: 7352	Specification for strength and durability performance of metal hinges for side hanging applications and dimensional requirements for template drilled hinges
225.	BS EN: 10143	Specification for continuously hot-dip metal coated steel sheet and strip. Tolerances on dimensions and shape

Stone and Facings/Linings		
226.	IS:1121-(Parts 1 to 4)	Methods of test for determination of strength properties of natural building stones
227.	IS:1121-(Parts 1 to 4)	(Part-1 Compressive strength)
228.	IS:1121-(Parts 1 to 4)	(Part-2 Transverse strength)
229.	IS:1121-(Parts 1 to 4)	(Part-3 Tensile strength)
230.	IS:1121-(Parts 1 to 4)	(Part-4 Shear strength)
231.	IS:1122	Method of test for determination of true specific gravity of natural building stones.
232.	IS:1123	Method of identification of natural building stones.
233.	IS:1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
234.	IS:1125	Method of test for determination of weathering of natural building stones
235.	IS:1126	Method of test for determination of durability of natural building stones.
236.	IS:1127	Recommendations for dimensions and workmanship of natural building stones for masonry work.
237.	IS:1128	Specification for Limestone (Slabs and Tiles)
238.	IS:1129	Recommendation for dressing of natural building stones.
239.	IS:1130	Specification for marble (blocks, slabs and tiles)
240.	IS:1597 (Part 2)	Code of practice for construction of stone masonry Ashlar masonry
241.	IS:1706	Method for determination of resistance to wear by abrasion of natural building stones
242.	IS:1805	Glossary of terms relating to stones, quarrying and Dressing

243.	IS:3620	Specification for laterite stone block for masonry
244.	IS:3622	Specification for Sandstone (slab & tiles)
245.	IS:4101 (Part 1)	Code of practice for external facing and veneers: stone Facing
246.	IS:4101 (Part 2)	Code of practice for external facing and veneers: Cement concrete facing
247.	IS:4101 (Part 3)	Code of practice for external facing and veneers: Wall tiling and mosaics
248.	IS:4121	Method of test for determination of water transmission rate by capillary action through natural building stones
249.	IS:4122	Method of test for surface softening of natural building stones by exposure to acidic atmospheres
250.	IS:4348	Method of test for determination of permeability of natural building stones
251.	IS:5218	Method of test for toughness of natural building stones
252.	IS:8381	Recommended practice for quarrying stones for construction purposes
253.	IS:14223 (Part 1)	Polished building stones: Granite
254.	BS: 8298	Code of practice for design and installation of natural stone cladding and lining

Chapter 2. Earthwork in Formation

2.1 FORMATION IN EMBANKMENT

Earthwork in formation and blanketing shall be carried out as per RDSO specification No. RDSO/2020/GE: IRS-004 September 2020 "Comprehensive Guidelines and Specifications for Railway Formation" and in accordance with the approved drawings.

The contractor shall arrange suitable borrow areas at his own cost and get them approved from the Engineer before using soil from such borrow areas.

Soils mentioned in Clause 3.7 (a) of the RDSO Guidelines shall not be used.

SQ-1 type of soils shall not be used in prepared subgrade and top layer of subgrade.

MDD in laboratory shall be determined by using Heavy Proctor test as per IS 2720 Part- 16.

MDD achieved in the field compaction trial shall not be less than 98% of the MDD achieved in laboratory.

Degree of compaction of soil in prepared subgrade/top layer of subgrade shall not be less than 98% of MDD achieved in field as a result of Field Compaction Trial.

Degree of compaction of soil in lower layer of subgrade shall not be less than 97% of MDD achieved in field as a result of Field Compaction Trial

Slope shall also be compacted with vibratory rollers of approved capacity and make as per RDSO guidelines. This would be done after dressing of the bank for final profile.

Blanketing material shall be as per RDSO Guidelines.

The type of test, frequency and acceptance criteria for quality check of earthwork and blanketing shall be as given in Chapter 7 of RDSO Guidelines.

NP-4 pipe of 450mm diameter conforming to IS 458 shall be provided under the embankment, at an approximate interval of 500m. Installation conditions for the pipe shall be adopted as per the design requirement of IS-783 for various height of fill.

Precast retaining wall shall be manufactured from high strength reinforced concrete in factory under controlled environment and shall be steam cured. Dimensional tolerance shall be 0+/- 2 mm.

Chapter 3. BRIDGES

3.1 General

3.1.1 Scope of Specifications

This specification shall be applicable for carrying out bridge works.

3.1.2 Applicable Standards

The applicable standards shall be as follows:

a) Indian Railway Standard Codes and Specifications (IRS)

i. Bridge Rules
ii. Concrete Bridge Code
iii. Steel Bridge Code
iv. Well and Pile Foundation Code
v. Fabrication Specification No. B1-2001
vi. Specification No. B-2 for Steel Structures (other than Girder Bridges)- Part 3.
vii. Welded Bridge Code
viii. Bridge Sub-structure & Foundation Code
ix. Specification No.M-28, Classification, testing and approval of metal arc welding electrodes for use-Indian Railway
x. Specification No.M-29, Classification, testing and approval of submerged arc welding with flame combination
xi. Indian Railways Unified Standard Schedule of Rates - 2019
xii. Indian Railways Unified Standard Specification (Formation Works, Bridge Works & P.Way Works) - 2019
xiii. Indian Railways Permanent Way Manual (IRPWM)
xiv. Indian Railways Works Manual (IRWM)
xv. Indian Railways Bridge Manual (IRBM)
xvi. Indian Railways Engineering Code
xvii. Manual on the design and construction of Well and Pile foundations
xviii. Indian Railways Schedule of Dimensions (BG)
xix. IRS Seismic code for Earthquake Resistant Design of Railway bridges.

b) RDSO Guidelines

i. BS-113 Guidelines for providing Arrangements for Bridge Inspection

ii. Comprehensive Guidelines and Specifications for Railway Formation: RDSO/2020/GE: IRS 0004.

iii. Report No. GE: R-50: Transitional System on approaches of bridges

iv. Report No. BS-111: Guidelines for use of High Strength Friction Grip (HSFG) bolts on bridges on Indian Railways

v. Guidelines for design of Spherical and Cylindrical bearings (in case of Steel Bridges).- RDSO/CBS/Bearing dated 22-06-2011

vi. RDSO drawings for H-beam sleepers

vii. Report No. BS 115 : Guidelines for Composite Construction Including Stud Shear Connectors

c) Indian Standards Codes and Specifications (IS)

i. IS: 456 Plain and reinforced concrete - code of practice

ii. IS: 800 Code of practice for General Construction Steel

iii. IS: 875 Code of Practice for Design Loads Part 1, 2 3, 4& 5 (Other than Earthquake)

iv. IS: 1080 Design and construction of shallow foundations in soils (other than raft ring and shell)

v. IS: 1367 Technical Supply Conditions for Threaded Steel Fasteners

vi. IS: 13920 Ductile detailing of reinforced concrete structures subjected to seismic forces code of practice

vii. IS: 1489 Specification for Portland pozzolana cement (Fly ash based)

viii. IS: 1786 High strength deformed steel bars and wires for concrete reinforcement

ix. IS: 1904 Design and construction of Foundations in soils: general requirements.

x. IS: 2062 Specifications for weldable Structural steel

xi. IS: 2502 Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

xii. IS: 2911 Design and Construction of Pile Foundation - Code of practice Part1 Concrete Pile- Section 2 Bored Cast-in-situ-piles

xiii. IS: 2911 Design and Construction of Pile Foundation- Code of practice Part1 Concrete Pile- Section 4 Precast Concrete Piles in Prebored Holes

xiv. IS 2911 Design and Construction of Pile Foundation- Code of practice Part 4 Load test on piles

xv. IS: 2950 Design and construction of raft foundations

xvi. IS: 3935 Code of Practice for Composite Construction

xvii. IS: 4923 Hollow steel sections for structural use -specification

xviii. IS: 1161 Steel Tubes for Structural Purposes- specifications

xix. IS: 8009 Calculation of settlements of shallow foundations

xx. IS: 269 Specifications of OPC cement

xxi. IS: 9103 Specifications of Concrete admixtures

xxii. IS: 12070 Code of practice for Design and construction of shallow foundation on Rocks

xxiii. IS: 14593 Design and Construction of Bored Cast-in-Situ Piles Founded on Rocks.

xxiv. IS 455 Specifications for portland slag cement

d) Other Standards

i. CPWD specifications, (Vol 1 & 2) -2019

ii. Delhi Schedule of Rates, (Vol 1 & 2) - 2021

iii. UIC Code 772-2 (R) Code for the use of rubber bearings for rail bridges

iv. IRC:83-2018 (Pt. II) - Standard Specifications and Code of Practice for Road Bridges (Section – IX) Bearings (Elastomeric Bearings)

v. IRC:83-2014 (Pt. IV) - Standard Specifications and Code of Practice for Road Bridges (Section – IX) Bearings (Spherical and Cylindrical)

vi. ISO 6892 – Tensile Testing of Metallic Materials

vii. ISO 13918-2008 – Welding- Studs and Ceramic Ferrules for Arc Stud Welding

3.2 Bridge Works: Substructure

3.2.1 GENERAL

a) Coverage

The Specifications given in this chapter deal with items pertaining to all types of foundations for bridges and bridge superstructure viz., Piers, abutments, wing walls, bed blocks and ballast walls / dirt walls.

3.2.2 Setting out for foundations

a) Setting out for Minor Bridges and Culverts

Shall be carried out by a competent / qualified engineer, employed by the Contractor and checked by the Engineer's representative for all bridges and culverts. Contractor shall provide necessary instruments, linear tapes, pegs etc.

The setting out for foundations and sub-structure shall be carried out with a theodolite and steel tapes / Invar tapes in case of works not involving deep foundations or standing water. All levels will be measured using a precise levelling instrument. Errors in location of piers / abutments and fixing levels shall be within following limits.

Linear Measurements	±5 mm
Levels	±3 mm

b) Setting out for Major Bridges

i. Locations of piers and abutments along with the centre line of the bridge should be accurately laid out by establishing one or more base lines as directed and a system of pegs and posts. Also sufficient reference pegs and pillars should be established for checking the positions with ease during progress of work. Reference Bench Marks for levelling should be established nearby on a permanent structure or on a pillar to be built up in vicinity.

ii. The principal reference lines and level pegs should be established at easily accessible locations. They include-

1) Longitudinal Centre line

2) Transverse Centre lines of abutments and piers

3) Tangent points of the curve at either end, if alignment is on a curve.

iii. For Bridge Works involving deep excavations, pile driving or well sinking and / or where there is standing water, use of base line is obligatory. They should be preferably at right angle to centre line of bridge, with one on either end on high bank in case of long bridges or on one side bank of bridge for shorter ones.

iv. In case of bridges of length exceeding 1000 Metres, base lines and reference towers will have to be established. Provision of all assistance in form of measuring instruments, linear tapes as may be required by the surveyor, technical and skilled staff and labour required to assist them, fixing pegs, pillars and towers including all building materials and maintaining and guarding them including supply of all materials, tools and plant shall be done by the Contractor at his cost. Nothing extra will be payable to them on this account. Important points to be observed in this activity are:

1) Linear Measurement shall be carried out with invar tape or electronic distance measuring instruments

2) Spring balances shall be used for giving specified tension to the tape. Tape readings shall be corrected for tension, temperature and slope.

3) Concrete pillars with steel plates fixed over them shall be located at intermediate points (at tape lengths) and ends.

4) Reference pillars at pier and abutment position along centre lines and reference pillars on base lines shall be to standards to be prescribed by the Engineer. During construction, since centre line pillars at abutment / pier locations will be disturbed, reference pillars and lines shall be fixed around each structure by the Contractor under Site Engineer's supervision. Reference diagrams at Annexures 4/1 and 4/2 and Clause 401 of IRBM shall be referred to for more details.

3.3 Soil Exploration

Soil exploration and test shall be carried out conforming to Indian Railways Codes and Specifications according to soil type, foundation type and site requirement.

3.4 Earthwork in excavation

Excavation shall be made only to the exact depth as shown on the drawings. In the event of excavation having been made deeper than that shown on the drawing or as ordered by the Engineer, the extra depth shall be made up with M10 concrete in case of foundation resting on soil and with concrete of the same grade as that of the foundation, in case of foundation resting on rock.

3.4.1 Method Statement

The Contractor shall submit Method Statement for carrying out the work of excavation in foundations and flooring etc. suiting to local ground conditions and safety measures conforming to IS: 3764 (Excavation Work- Code of Safety) to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement and drawings.

3.4.2 Site Clearance

Site clearance shall be done as per the Contract.

3.4.3 Setting Out

After the site has been cleared, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. The Contractor shall be responsible for the setting out of works and the establishment and maintenance of benchmarks, other marks & stakes as long as in the opinion of the Engineer, they are required for the work.

a) Excavation shall be carried out in all types of soil encountered at site and to the lines, levels and profiles shown on the drawings that have NONO from the Engineer. The Work shall be carried out by the Contractor in such a way as to avoid soil erosion and groundwater pollution, accidents in habitational or frequented places, disturbance to the surrounding ground or structures, accident to workmen and any other untoward incident. Fencing, caution signages with red lights and other safety measures shall be employed to avoid accidents. Where necessary, signal men shall be employed to guide the movement of people, vehicles and equipment.

b) The work shall be carried out in a careful manner to ensure that the exposed surfaces are as sound as the nature of the material permits and that no point shall protrude inside the lines shown on the Drawings.

c) The Contractor shall be responsible for the safety and stability of all excavations performed by him or under his control. In case of any slips or blows in the excavation, the same shall be cleared by the Contractor at his own cost.

d) The Contractor shall notify the Engineer without delay of any permeable strata, joints, faults, fissures or unusual ground conditions encountered during excavation and any excavation instability and/or collapse.

e) The Contractor shall ensure that no air pollution takes place during excavation, storage and transportation of earth/spoil by providing suitable measures such as appropriate cover and the like.

f) The Contractor shall carry out ground stabilization measures without delay before and/or after excavation, if required.

g) The Contractor shall make provision for all shoring, de-watering, dredging, bailing out or draining water whether subsoil or rain or other water and the excavation shall be kept free of water while concrete work is in progress until the Engineer considers the work well set. The sides of trenches shall be kept vertical and the bottom level throughout or properly stepped as directed by the Engineer. No extra payment shall be made on this account.

h) De-watering shall be carried out by suitable means with adequate stand-by arrangements as may be approved by the Engineer. The Contractor shall be deemed to have satisfied himself with regard to feasibility of all aspects of de-watering including site constraints due to existing structures. Though the method of de-watering is left to the Contractor, he shall be required to submit method statement of de-watering scheme including requisite justifications to obtain approval from the Engineer.

i) Approval of the Engineer, however, shall not relieve the Contractor of the responsibility of adequacy and appropriateness of de-watering and protection arrangements for the quality and safety of the work.

j) The Contractor shall erect and maintain during progress of works temporary fences/ barricading around the work area with all safety measures as shown in Reference Information/Reports. The excavations near habitations, public movement areas and all works along the roads shall be provided with proper caution signs and marked with red lights, reflectors at night to avoid accidents. The Contractor shall take all adequate protective measures to see that excavation operations do not affect or damage adjoining structures.

k) Disposal of muck: The surplus excavated material (that cannot be used in the Works), shall be treated as contractor's property. The contractor shall be free to take away and make use of this surplus excavated material in the manner he wishes to, including disposal in spoil dumps or elsewhere as approved by the

Engineer/concerned parties and regulating authorities. The employer takes no responsibility for the arrangement of dumping areas and these will have to be arranged by the Contractor at his own cost. The Contractor is required to carry out detailed survey to identify dumping areas, clearances required, leads involved etc. The quoted rates shall be deemed to have taken all these factors into account. The excavated material that can be used in the Works, shall be temporarily stockpiled, if required, in a dump site as proposed by the contractor and agreed by the Engineer and the concerned regulating authorities. Any royalty, if to be paid to local authorities on the excavated material, is to be borne by the Contractor at his own cost irrespective of whether the excavated material is used for the Works or being used for any other purpose or being disposed off as surplus. Truck drivers shall be trained and educated by the Contractor to follow the traffic rules.

l) The Contractor shall ensure that traffic management on roads and railways is carried out in accordance with Sub-Division 6070 of the General Specifications.

3.4.4 Excavation beyond True Lines and Levels

If due to any cause whatsoever excavations are carried out beyond their true line and level, the Contractor shall make good excavation at his own cost to the required line and level with the appropriate grade of filling or with concrete subject to the NONO from the Engineer.

3.4.5 Backfill to Structures

a) Prior to commencement of backfill, the Contractor shall submit Method Statement for carrying out work such that the optimum use may be made of excavated material and obtain approval from the Engineer. The proposals shall include details of the compaction plant and methods for adjusting the moisture content of the material.

b) No filling shall commence until approval has been received from the Engineer.

c) The Contractor shall not backfill around structures until the structural elements have attained adequate strength.

d) The backfill material shall be selected excavated material, thoroughly compacted mechanically in layers not exceeding 300mm loose thickness to achieve a density of at least 90% of the maximum dry density.

3.4.6 Tolerance

Permissible Tolerance for excavation

Item	**Standard value (mm)**
Finished depth of excavation	±25

length/width	0 to +50

3.5 Bored cast in-situ Piling

Piling shall be carried out by hydraulic piling rig.

3.5.1 Method Statement

The Contractor shall submit Method Statement for carrying out the work of piling. The work shall be carried out strictly in accordance with the approved Method Statement, Manual on the design and construction of Well and Pile foundations, the Specification and the Drawings.

3.5.2 Materials

a) **Concrete**

Piles shall be constructed in accordance with the details shown in the drawings using the grade of concrete indicated, produced and placed in accordance with provisions of Annexure OCS-1 of these specifications.

b) **Reinforcement Steel**

Reinforcement steel shall comply with the provisions of Annexure OCS-2 of these specifications.

c) **Temporary Casings**

Temporary casings, as approved by the Engineer, shall be used to maintain the stability of pile bore hole. Temporary casings shall be free of distortion and shall be of uniform cross-section throughout each continuous length. During concreting, they shall be free of internal projections and encrusted concrete which may prevent proper formation of the pile.

d) **Stabilizing Material**

The stabilizing material to maintain the sides of pile bores shall preferably be natural drilling mud. If natural mud is not available, then stabilizing fluid having bentonite, controlled with a polymer like CMC (Carboxyl Methyl Cellulose), shall be used. The stabilizing material shall be approved by the Engineer. Bentonite, when used, shall conform to IS 2911 (Part 1/ Section 4).

3.5.3 Pile Installation

a) General

i. Bored cast-in-situ concrete piles shall conform to IS 2911 (Part 1/ Section 2), where not contravening to the following provisions. Based on borehole reports and drawings, installation of piles shall be carried out as per pile layout drawings, installation criteria, approved Method Statement and instructions of

the Engineer. Any changes to the pile design, based on test-piles results, bore-hole data or soil conditions encountered during boring, shall be as instructed by the Engineer.

ii. The equipment and accessories for installation of piles shall be selected giving the due consideration to the sub-soil conditions, ground water conditions and type of founding material. These shall be of standard type and shall have been approved by the Engineer.

iii. Before installing the initial test pile, the Contractor shall finalise the pile testing arrangement and obtain approval of the Engineer.

iv. It is envisaged that the working piles shall be installed after the successful completion of the initial pile load test.

v. In case the Contractor desires to install the working pile, pending successful completion of initial pile load test, he may be permitted to do so, provided he gives undertaking to the Engineer to bear all associated risks and costs involved to make up for the short falls in the pile capacity, in the event of the failure of the initial pile load tests to establish specified 'Design Ultimate Load' carrying capacity of initial test pile.

vi. The Engineer reserves the right to reject any pile which in his opinion is defective on account of less carrying capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles, as per the directions of the Engineer, at no additional cost to the Employer. Further, the cost of additional piles and increase in the pile cap size, if any, on account of additional piles, shall be borne by the Contractor.

vii. Each pile shall be identified with a reference number and shall be as shown in the Drawings. The convenience of installation may be considered while scheduling the sequence of piling in a group.

viii. In a pile group, the sequence of installation of piles shall normally be from the center to the periphery of the group or from one side to the other.

ix. Level marks shall be accurately painted on each pile immediately after its installation. Subsequently, if any pile displays any tendency to heave up due to installation of other piles or due to any other reasons, the same shall be reinstalled firmly as per the directions of the Engineer without any additional cost.

x. The Contractor shall record all the information during installation of piles, including pile-bore observations before concreting each pile. The data sheet for recording pile data shall be as approved by the Engineer. On completion of each pile installation, pile record shall be submitted to the Engineer within two days of completion of concreting of the pile.

b) Control of Position and Alignment

Piles shall be installed as accurately vertical as possible. The permissible tolerances with respect to position and inclination/alignment are as shown below:

Tolerances

No	Item	Permissible tolerance	Figure
1	Level of top i.e. Cut-off-Level (m)	-25mm to 25mm	
2	Position of the head in plan at Cut-off-Level (d)	75mm or less	
3	Embedded depth in bearing stratum (l)	Design value or more	
4	Diameter of the pile (D)	Design value or more	
5	Variation from vertical at Cut-off-Level (v)	1.5% or less	

c) Pile Boring

i. Boring Operation:

- Boring operations shall be done by rotary hydraulic feed drilling rigs with reverse mud circulation or other suitable boring methods that have been approved by the Engineer. The boring or drilling equipment shall have suitable and adequate accessories for boring or drilling through all types of strata expected at site.
- The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm. However, the pile bore shall be of the specified size.
- The boring centre shall be aligned with the pile centre and the boring machine shall be installed so as not to move or incline. The sides of the bore-hole shall be stable throughout.
- Working level shall be above the Cut-off-Level. After the initial boring of about 1.0 m, temporary guide casing of suitable length shall be lowered in the pile bore for vertical pile. The diameter of guide casing shall be such as to give the necessary finished diameter of the concrete pile. The centre line of the guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0 m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.

- The temporary guide casing (if provided) shall be withdrawn cautiously, after concreting is done up to the required level. While withdrawing the casing, concrete shall not be disturbed.
- For providing permanent MS liner, Clause 709.1.4 of IRC:78 shall be complied with. Whenever stricter provision has been given in the drawings, the same shall be followed.
- If boring operation becomes difficult before reaching the predetermined depth, further plan of action shall be submitted by the Contractor and approval shall be obtained from the Engineer for the same. The piles shall be founded on rock or other suitable strata as approved by the Engineer.

ii. Maintaining the bore **hole:**

- For maintaining bore hole wall while boring, a stabilizing material, according to the soil shall be used and the level of the stabilizing fluid shall be maintained at not less than 2.0 m above the ground water level or at such other level as will ensure that the fluid pressure is at all times in excess of pressures exerted by the soils and external groundwater. The stabilizing fluid shall be under constant circulation till start of concreting. The level of stabilizing fluid for all piles shall be recorded by the Contractor and reported to the Engineer, including the confirmation of the bore-hole wall shape after boring. Where temporary casings or an alternative method for maintaining stability of a boring are used, these shall be subject to the Engineer's approval.
- Consistency of the stabilizing material suspension shall be controlled throughout concreting operations in order to keep the bore stabilized, as well as to prevent concrete getting mixed up with the thicker suspension of the mud.
- When the boring is done by rotary drilling rigs, the verticality of Kelly bar shall always be maintained. In the soil layer such as sandy soil layer where the bore hole tends to collapse, care shall be taken to ensure the drilling bucket does not hit the hole wall. While boring in the founding soil layer, the drilling bucket shall be raised at appropriate speed to prevent loosening of the soil by suction.

iii. Stabilizing material management:

In addition to the requirements that are already stated, the following shall be considered:

- The stabilizing material shall be controlled so as to prevent pile-bore wall collapse and ensure the quality and shape of the concrete.

- While boring, the Contractor shall periodically check the properties of the stabilizing material and control the management items (specific gravity, marsh funnel viscosity, pH, etc.) to be within the values set in the Method Statement that has been approved by the Engineer.
- Stabilizing fluid shall comprise of bentonite, complying with the specifications of IS 2720, IS 2911 (Part 1/ Sec2; ANNEX D) or otherwise approved by the Engineer, thoroughly mixed with clean fresh water along with the required Polymer like CMC, to form a suspension meeting the specification requirements as submitted to and consented by the Engineer.
- The Contractor shall obtain manufacturers' certificates of the bentonite powder consigned to the Site giving properties of each consignment and shall submit them to the Engineer prior to commencing the work and whenever required.
- The frequency of testing stabilizing material and the method and procedure of sampling shall be proposed by the Contractor and approved by the Engineer prior to the commencement of piling work. Such control tests on the bentonite suspension as required or as approved by the Engineer shall be carried out during the piling work.
- Prior to concreting a pile, the Contractor shall take measures to remove any heavily contaminated stabilizing material which could impair the free flow of concrete from the tremie pipe. Placing of concrete shall proceed only with due modification as per consent of the Engineer.
- All reasonable steps shall be taken to prevent the spillage of bentonite suspension in the Site in areas outside the immediate vicinity of boring.

iv. Confirmation of bearing stratum for termination level:

- Confirmation of the support layer shall be carried out by boring depth and comparing excavated soil and soil survey material. Also, the pile designated as per approved Method Statement or by the Engineer shall receive necessary confirmation.
- The boring depth shall be measured at two or more places to the bottom of the hole immediately after completion of boring operations. The results shall be reported promptly.
- A protocol shall be maintained regarding the strata at the founding level, Standard Penetration Test (SPT) value, percent core recovery, Unconfined Compressive Strength (UCS) from the nearest borehole, socketing horizon, flushing of pile bore, time interval between end of boring and start of concreting, bentonite density prior to the commencement of concreting.

v. Cleaning of pile bore just after boring:

- After completion of the pile bore up to the required depth, the pile bore shall be cleaned of loose, disturbed or re-moulded soil from the base of the pile.
- The cleaning shall preferably be achieved by three stages flushing of slurry using airlift technique, as per approved Method Statement. The bottom of the pile bore shall be thoroughly cleaned by airlift technique. Cleaning shall ensure that the pile bore is completely free of sludge or bored material, debris of rock or boulder etc. Necessary checks shall be made to ensure the thorough cleaning of the pile bore.
- Concreting operations shall not proceed if the contaminated stabilizing material at the bottom of the pile bore possesses a density of more than 1.12 g/ml. The stabilizing material sample shall be collected from the bottom of pile bore. For this a solid cone shall be lowered by a string to the bottom of pile bore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimise the leakage, while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.
- When the boring is done by rotary drilling rigs, cleaning-bucket attached to the Kelly shall be used for cleaning the bore. Wherever stabilizing material is used, after using the cleaning-bucket, the bore shall be flushed with fresh slurry.
- The Contractor shall measure the final depth after this cleaning and confirm its effect by comparing with the depth at the end of boring.

vi. Cleaning of pile bore just before concreting:

- Pile bore shall be cleaned by fresh stabilizing material through tremie pipe or as specified in the Method Statement, before (in case delay in concreting after the completion of bore) and after placing the reinforcement cage and just before the start of concreting. Pile boring shall be inspected and approved by the Engineer, in accordance with approved Method Statement, before concreting.
- The Contractor shall measure the final depth after this cleaning, when there is a delay in concreting after completion of the bore, for knowing the casting pile length, and confirm its effect by comparing with the depth at the end of boring.

vii. Other relevant considerations for pile boring:

- Care shall be taken not to harm a recently concreted pile due to driving the casing nearby before the concrete has sufficiently set in that pile. The danger of doing harm is greater in compact soils than in loose soils.

- For bored holes, the finishing and cleaning of the bore, lowering of reinforcement cage and concreting of the pile for full height must be accomplished in one continuous operation without any stoppage.
- Pumping from a boring shall not be permitted unless approval has been issued by the Engineer.
- A pile excavation shall be backfilled without delay where a rapid loss of drilling fluid occurs and no further excavation at the location of that pile shall be carried out until the Engineer's approval is obtained.
- After each pile has been cast, any empty bore which may remain shall be protected and carefully backfilled as soon as possible to the satisfaction of the Engineer.
- Carriage and Disposal: The bored spoil material and contaminated mud and bentonite slurry shall be disposed at the designated areas identified by the Contractor and as per the procedure approved by the Engineer and as mandated by other relevant Contract provisions.

d) Concreting

i. Cast-in-Situ pile concreting shall conform to provisions of Annexure OCS-1 of these Specifications and the relevant provisions of IS 2911 (Part 1/ Sec 2), where not in contravention to the following provisions.

ii. Concreting shall not be done until the Engineer is satisfied that the termination level of pile, is as per the installation criteria and the Method Statement that has been approved by the Engineer.

iii. Concrete in the pile shall be coherent, rich in cement with high slump and restricted water cement ratio. The slump of concrete shall vary between 150 mm to 180 mm for bored piles. For long or large diameter piles, use of retarding plasticiser in concrete is desirable.

iv. The time interval between the completion of boring and placement of concrete in pile bore shall not exceed 6 hours. In case the time interval exceeds 6 hours, the pile bore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the termination level and clean the pile bore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

v. The concrete shall be properly graded, self-compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silty clays and other soils which have the tendency to squeeze into the newly deposited concrete and cause necking. Adequate head of green concrete shall be maintained to prevent inflow of soil or water into the concrete.

vi. Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS 2911 (Part 1/ Sec 2). Stabilizing material

shall be maintained sufficiently above the ground water level, as specified elsewhere in this Specifications.

vii. Concreting by tremie shall continue to allow the initial pours of concrete, mixed with stabilizing fluid, sludge and cut spoils from the bore to overflow and the consistency and quality of the overflowing concrete is comparable to that of design mix. The length of overflow shall be decided by the Engineer.

viii. It shall be ensured that the volume of concrete poured is at least equal to the theoretically computed volume of the pile shaft being cast.

ix. The tremie shall have uniform and smooth cross-section inside. The tremie shall be water-tight throughout its length and have a hopper attached at its head by a water-tight connection. All tremie tubes shall be scrupulously cleaned before and after use.

x. While concreting the tremie shall be withdrawn slowly ensuring adequate height of concrete outside the tremie pipe at all stages of withdrawal.

xi. An adequate quantity of concrete within the pipe shall be maintained at all times to ensure that the pressure from it exceeds that from the water or drilling fluid.

xii. The tremie pipe shall be lowered to the bottom of the bore-hole, allowing water or stabilizing material to rise inside it before pouring concrete. The tip of the tremie pipe shall not be separated from the bottom of the hole more than necessary (when plunger is used, it is about 0.2 m or less from the hole bottom)

xiii. The tremie pipe shall always be kept full of concrete and shall penetrate well into the concrete in the borehole, at least 2 m or more, with adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

xiv. During concreting, the cycle time of concreting, concreting volume, concrete placement height and the height of the tremie pipe tip in concrete shall be checked for all the piles and reported in a format that has been approved by the Engineer.

xv. To prevent the reinforcement cage from floating during placement of concrete, appropriate countermeasures shall be made in advance, as per the Method Statement that has been approved by the Engineer. The same shall be monitored for all piles and reported.

xvi. Temporary casings, when used, shall be extracted carefully to the satisfaction of the Engineer, whilst the concrete is sufficiently workable to ensure it is not disturbed or lifted, and the reinforcement cage does not get disturbed. During extraction, sufficient quantity of concrete shall be maintained inside the casing to overcome the pressure from external water, soil or stabilizing material and to ensure that no reduction in section by way

of necking or shearing of concrete and contamination of the pile takes place.

xvii. Segregation of the ingredients shall be prevented. The displacement or distortion of reinforcement during concreting shall be avoided. If the concrete is placed inside precast concrete tubes or consists of precast sections, subject to the approval of the Engineer, these shall be free of cracks or other damage before being installed.

xviii. While concreting uncased piles, voids in concrete shall be avoided and adequate head of concrete shall be maintained to prevent inflow of soil or water into the concrete. It is also necessary to take precautions during concreting to minimise the softening of the soil by excess water. Uncased cast- in-situ piles shall not be allowed where mudflow conditions exist.

xix. Where concrete is placed in dry borings, measures, subject to approval of the Engineer, shall be taken to avoid segregation and bleeding and to ensure that the concrete at the bottom of the pile is not deficient in grout.

xx. Where enlarged bases are required, as per site conditions and as approved by the Engineer, these shall be mechanically formed and shall be concentric with the pile shaft within a tolerance of 10% of the shaft diameter and shall not be smaller than the required dimension. The sloping surface of the frustum forming the enlargement shall make an angle of not less than 55° to the horizontal.

xxi. Grouting at base of pile shall be done wherever the results of proof coring (in case of rock), sonic logging and/or loading test etc. confirm that there is a void/ sludge at the pile base. The grouting shall be done with cement slurry under suitable pressure after concrete in the pile attains the desired strength, if required by the Engineer. For this purpose, conduit pipes with easily removable plugs at the bottom end shall be placed in the bore along with reinforcement cage before concreting

3.5.4 Top of Concrete in Pile, Cut-off-Level (COL):

a) Cut-off-Level of piles shall be as indicated in the drawings.

b) The top of concrete in pile cast shall be above the Cut-off-Level by 1.0 m (minimum) and as per the Method Statement, to remove all laitance and weak concrete and to ensure good concrete at Cut-off-Level, for the proper embedment into the pile cap. Any exceptions, due to contingent situation, will be subject to the approval of the Engineer.

c) Preparation of pile head: The area surrounding the piles shall be excavated up to the bottom of the pile caps. After seven days of concreting of pile, the exposed part of concrete above the COL shall be removed or chipped off and made rough at COL. In case a part of extra-pile concrete before curing is handled, the Contractor shall obtain prior approval from the Engineer. The projected reinforcement above COL shall be properly cleaned and bent carefully, only where required, to the required shape and level to be anchored into the pile cap as per the

drawing. While finishing the pile head, care shall be taken to ensure no harmful damage, such as cracks, occurs in the concrete. The pile top shall be embedded into the pile cap by 150 mm as per the Drawings and as agreed by the Engineer. All loose material on the top of pile head after chipping to the desired level shall be removed and disposed as per contractual procedure and as directed by the Engineer.

3.5.5 Reinforcement Steel

a) Reinforcement steel, along with its inspection and testing shall conform to Annexure – OCS-2 of these Specifications, along with IS 2911 (Part 1/ Sec 2) and used as per the drawings.

b) The reinforcement shall be assembled before placing in the moulds and all hoops and links shall be of uniform length firmly wired into position. Ends of helical reinforcement, if used, shall be firmly secured. Diagonal fork spacers shall be of a pattern that has been approved by the Engineer.

c) Lap joints in main longitudinal bars will be permitted only when, in the opinion of the Engineer, each bar cannot be supplied in one complete length. Where permitted, joints shall be provided at agreed centres, designed to develop the full strength of the bar across the joint, provided with adequate links or stirrups and staggered in position from those of adjacent longitudinal bars or as indicated in the drawings, subject to the approval of the Engineer.

d) The 'L' bends in the reinforcements at the bottom of the piles shall not be provided to avoid the formation of soft toe.

e) Jointing of Reinforcement Steel for Piles: Only lap joints shall be provided as shown in the drawings.

f) Lowering of the reinforcement cage:

i. The reinforcement cage shall be properly aligned with the pile core and kept vertical without collapsing the hole wall. In lowering of the reinforcement cage, it shall avoid deformations, damages, etc. by using reinforcing material as necessary. In the lap joint part of the reinforcement cage, the upper and lower cages shall be in a straight line, with the joints tightly bound.

ii. Proper cover to reinforcement and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers cast specifically for the purpose, as directed by the Engineer. The longitudinal reinforcement shall project above Cut-off-Level as indicated in the drawings.

iii. After lowering of the reinforcement cage, the height of the top end of the reinforcement shall be measured and reported. The axes of the reinforcement cage and the pile core shall be matched, checked and reported.

3.5.6 Breaking off of Piles

If any pile already cast requires breaking due to subsequent change of Cut-off-Level, then the same shall be carried out, not before seven days of casting without affecting

the quality of existing pile, such as loosening, cracking etc., and to the satisfaction of the Engineer.

3.5.7 Pile Caps

The ground shall be excavated, levelled, prepared and then layers of coarse aggregate and blinding concrete shall be constructed below pile cap. The pile cap shall then be cast as per the Drawings and conforming to Annexure OCS-1 and Annexure OCS-2 of these Specifications, subject to tolerances mentioned therein.

3.5.8 Tests on Piles

a) General

When preparing for conducting a pile test, the Contractor shall follow the requirements of the various acts, orders, regulations and other statutory instruments that are applicable to the work for the provision and maintenance of safe working conditions, and shall in addition make such other provision as may be necessary to safeguard against any hazards that are involved in the testing or preparations for testing.

b) Load **Test on Piles**

i. Sub-Clause 2.5.8(g) to Sub-Clause 2.5.8(h) of these Specifications covers the requirements for initial vertical load and routine vertical load tests on reinforced concrete single vertical piles of specified diameter to assess their vertical load carrying capacities. All pile load testing shall conform IS 2911 (Part 1/ Sec 4)

ii. Full details of the equipment proposed to be used, the test setup and pile testing scheme along with detailed design, drawings shall be submitted to the Engineer, before making arrangements to carry out the tests, for obtaining his approval. Approval of the Engineer shall also be obtained after the test setup is complete, prior to commencement of loading.

iii. The work shall include mobilization of all necessary equipment, kentledge, anchor piles and rock anchors, or combination of kentledge and anchor piles and rock anchors, providing necessary engineering supervision and technical personnel, skilled and unskilled labour as required, to carry out the complete pile testing and submission of test reports.

iv. In all cases, the Contractor shall ensure that when the hydraulic jack and load measuring device are mounted on the pile head the whole system will be stable up to the maximum load to be applied.

v. Necessary means shall be provided to enable dial gauges to be read from a position clear of the kentledge stack or test frame in conditions where failure in any part of the system due to overloading, buckling, loss of hydraulic pressure and so on might constitute a hazard to personnel.

vi. The hydraulic jack, pump, hoses, pipes, couplings and other apparatus to be operated under hydraulic pressure shall be capable of withstanding a test

pressure of one and a half times the maximum working pressure without leaking.

vii. The maximum test load or test pressure expressed as a reading on the gauge in use shall be displayed and all operators shall be made aware of this limit.

viii. Where kentledge is used, the Contractor shall construct the foundations for the kentledge and any cribwork, beams or other supporting structures in such a manner that there will not be differential settlement, bending or deflection of an amount that constitutes a hazard to safety or impairs the efficiency of the operation. The kentledge shall be adequately bonded, tied or otherwise held together to prevent it falling apart, or becoming unstable because of deflection of the supports. The weight of kentledge shall be greater than the maximum test load and if the weight is estimated from the density and volume of the constituent materials, an adequate factor of safety against error shall be allowed.

ix. It is essential that all the equipment and instruments are properly calibrated both at the commencement and immediately after the completion of tests, so that they represent true values. If the Engineer desires, the Contractor at his own cost shall arrange for calibration of the instruments in presence of the Engineer, at a laboratory having Engineer's approval, and the test report and calibration certificate shall be submitted to the Engineer.

x. The complete jacking system including the hydraulic jack, hydraulic pump and pressure gauge shall be calibrated as single unit. The complete unit shall be calibrated over its complete range of travel for increasing and decreasing loads same as that of test loads. The calibration certificate shall be submitted to the Engineer.

xi. The reaction load to be made available for the test shall be at least 25% greater than the maximum jacking force. The reaction system as relevant shall be designed for the total reaction load. All reaction loads shall be stable and balanced during all operations of testing. During testing, stability of reaction system shall be ensured.

xii. The vertical displacement of pile shall be measured using dial gauges having a least count of 0.01 mm.

xiii. Load test shall be conducted at pile Cut-off-Level (COL). If the water table is above the COL, the test pit shall be kept dry throughout the test period by suitable dewatering methods.

xiv. In case of initial vertical load test, where the water table level is higher than the COL, the Contractor may use anchor piles and rock anchors for testing purposes. The Engineer, at his discretion, may decide to raise the COL above water table.

xv. All operations in connection with pile load test shall be carried out in a safe manner to prevent exposure of the people to hazard and also to ensure the

safety of manpower and material.

xvi. Test record and report for pile load tests shall be as per IS 2911 (Part 1/ Sec 2) and as approved by the Engineer. The reports shall be submitted to the Engineer immediately on completion of each test.

xvii. Two fixed independent benchmarks shall be established as reference points at least 15 m from the test pile to monitor the settlements.

xviii. If any initial pile load test gets abandoned and is not successfully completed, then the Contractor shall install another test pile and repeat the initial test after correcting the fault, at his own cost.

xix. On completion of a test all equipment and measuring devices shall be dismantled, checked and either stored so that they are available for use in further tests or removed from the Site.

c) Test Pile Installation

i. Piles shall be installed as per Sub-Clause 4.14.3 herein above.

ii. Pile installation data as applicable shall be furnished along with the load test results to the Engineer.

d) Types of Tests

i. Initial vertical (compression) load test and lateral load test shall be carried out on test piles, which are not to be incorporated in the work, to assess the 'Ultimate Load Capacity of Pile' before the commencement of the installation of working piles.

ii. The test piles shall have the same design details as of the working piles typically adopted in the predominant soil profile in that area.

iii. Routine vertical (compression) load test and lateral load test shall be conducted to verify the load carrying capacity of working pile.

iv. Pile integrity test shall be carried out on each pile by The Low Strain Method as per IS 14893 to verify the structural integrity, shape and continuity of pile as detailed in Sub-Clause 2.5.8(i).

e) Number of Tests:

i. **Initial pile-load tests:** The number of load tests shall be as per IS 2911 (Part 4) depending upon the total number of piles but not less than two (2). Wherever the soil strata are erratic or there is change in structure type (such as river bridge, rigid frame), additional tests shall be required as directed by the Engineer.

ii. **Routine pile-load tests:** The number of tests may generally be 0.5 percent of the total number of piles required, but not less than one (1). The number may be increased up to 2% depending upon the nature, type of structure and sub-strata condition.

iii. Initial and routine tests may be suitably increased for important structures or cases with large variation in the subsurface strata as directed by the Engineer.

iv. Pile load tests shall be carried as per IS 2911 (Part 4).

f) Testing-Piles

i. The testing-piles for routine load test shall be identified by the Engineer. For initial load test, testing-pile shall be installed as a test-pile, separate from working piles, as directed by the Engineer.

ii. A minimum time period of four weeks shall be allowed between the time of pile casting and testing. Testing-pile head shall be prepared for testing purposes only, one week after casting the pile.

iii. Testing-piles shall be cut off at the proper level and provided with a proper cap, to provide a plane bearing surface for the test plate and for proper arrangements for seating of the jack and dial gauges.

g) Static Vertical Load Test

i. The tests shall conform to IS 2911 (Part 4).

ii. Equipment and Test Setup

- A steel plate of adequate thickness and not less than 50 mm shall be centered on the pile cap to prevent it from getting crushed under applied load. The size of the circular test plate shall not be less than the pile size nor less than the area covered by the base of the hydraulic jack(s).
- The datum bars shall be supported on immovable supports, preferably of concrete pedestals or steel sections, placed sufficiently far away from the test pile. The distance shall not be less than 3 times the diameter of testing-pile and in no case less than 2 metres from the edge of testing-pile. These supports shall be placed at an adequate depth below ground to be unaffected by ground movements.

iii. Loading System

The test load on pile shall be applied by means of hydraulic jack(s) which obtain reaction in one of the ways mentioned in Cl.7.1.3 of IS 2911 (Part 4).

The measurement of strains for load monitoring may also be done by load cell connected to a digital read out unit.

iv. Test Procedure

- Application of Load:- The test should be carried out by applying a series of vertical downward incremental load each increment being of about 20 percent of safe load on the pile. For testing of raker piles it is essential that loading is along the axis.
- This is applicable for both initial and routine test. In this method application of increment of test load and taking of measurement or

displacement in each stage of loading is maintained till rate of movement of the pile top is not more than 0.2mm/h or until 2 h has elapsed, whichever is earlier subject to a minimum of 1 h. The test load shall be maintained for 24 h.

- Duration of vertical loading shall be as per Cl. 7.2 of IS 2911 (Part 4)
- Settlement:- Settlement shall be recorded as per Cl. 7.1.4 of IS 2911 (Part 4).
- The safe vertical load on single pile for the initial test shall be as per Cl. 7.1.5 of IS 2911 (Part 4).
- Items to be measured:

  The following items shall be measured:

  - Time;
  - Applied pressure;
  - Applied load;
  - Displacement at the pile head;
  - Movement of reaction devices;
  - Others, as decided by the Engineer.
- Commencement, interruption and completion of the test:
  - The test shall be commenced after ensuring the conditions surrounding the site, preparations of all equipment and the suitability of the weather condition.
  - If any abnormal conditions are noticed during the test, the test shall be interrupted promptly. The test can only be resumed when the cause of the abnormal condition has been detected and rectified.
  - The test shall be completed when the objectives of the test shall have been achieved, or when it is judged that abnormal conditions make it impossible to continue the test.
- Loading on the pile shall be continued till as given in IS 2911 (Part 4).

h) Lateral load tests – Lateral load tests shall be carried out on test pile as well as on working pile safe load capacity determined as per Clause 8 of IS 2911 (Part 4).

i) Pile Integrity Test on Working Piles (other than piles subjected to routine load test):

i. Pile integrity test shall be carried out on each pile by The Low Strain Method as per IS 14893:2001. In case of large diameter piles, the tests shall be conducted at 5-6 places to cover the entire section of the pile.

ii. The tests shall be conducted on piles whose length is correctly recorded or on test piles where available, to determine the value of stress wave velocity and characteristic or reference signal for comparing the signals for testing subsequent piles.

iii. The area surrounding the pile should be free from standing water and kept dewatered during the tests. The pile head should be accessible.

iv. Testing should be free of work likely to cause disturbance. The cast-in-situ piles should not be tested normally before 14 days of casting.

v. The test piles, if available at site, can be used to determine the pulse velocity and characteristic or reference signal generated. Where no test pile is available information can be obtained from cast piles whose length is accurately recorded.

vi. Methodology for Low Strain Integrity test:

- This is a system of assessing the integrity of piles by the use of low stress wave imparted to the pile shaft and is also known as Sonic Integrity or Sonic Echo Test. A small metal/hard rubber hammer is used to produce a light tap on top of the pile. The shock traveling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/accelerometre (also held on top of the pile close to the point of impact) in a computer disk or diskette for subsequent analysis. The primary shock wave which travels down the length of the shaft is reflected from the toe by the change in density between the concrete and sub-strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections which will be added to the return signal.
- The reflected stress wave can be monitored using either processing technique, the observed signals are amplified and converted into digital display as velocity versus length or frequency versus mobility records, providing information on structural integrity of piles. The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's modulus and mass density of pile concrete. This value generally lies between 3000-4000 metre per second depending on the grade of concrete used (M15-M25).

j) Sampling, Testing, Inspection, and Acceptance Criteria Including Construction Tolerances of Piles

i. Frequency of sampling, testing and quality assurance including the method of conducting the tests, acceptance criteria and construction tolerances shall be as mentioned herein above and included in the Method Statement that has been approved by the Engineer. The tests shall be performed and reported as per the Method Statement that has been approved by the Engineer.

ii. Forcible corrections for any deviations shall not be made to concrete piles.

iii. Data Reporting and processing

- The assessment of structural integrity is based on two equally important aspects:
  - Quality of signals, and
  - Accurate analysis and interpretation of signal.
- Piles requiring remedial measures should be so marked immediately on completion of the field integrity testing and rectification measures selected.
- The final report should include signals of each integrity test and structural condition of piles.

iv. Submission of Results: Immediately after testing, a signed copy of all the raw data of a pile shall be given to the Engineer. A test report shall be submitted to the Engineer within 3 days after testing.

3.5.9 Safety

The Contractor shall adopt appropriate method and practice conforming to IS 5121 (Piling and other deep foundation - Code of Safety) suiting to local ground characteristics.

3.6 Formwork

Form work for bridge foundations, sub structure and superstructures shall be as per IS-3696, IS-4014 and Annexure OCS-1. It includes all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as directed by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support.

3.7 Substructure

3.7.1 Piers and Abutments

a) Concrete and reinforcement for piers and abutments shall conform to relevant sections of these specifications and drawings. In case of concrete piers, minimum grade will be M 20 unless otherwise specified / approved. The number of horizontal construction joints shall be kept to minimum. Construction joints shall be avoided in splash zones unless specifically permitted by the Engineer and provided they are treated in accordance with special provisions. No vertical construction joint shall be provided. Shear connectors in the form of vertical plumbs, dowels, bond bars or rail cut pieces shall be provided at all horizontal joints as directed by Engineer. The work shall conform strictly to the drawings or as directed by the Engineer.

b) In case of tall piers and abutments, use of slipform shall be preferred. The design, erection and raising of slip form shall be subject to special specifications which will be furnished by the Contractor. The concrete shall also be of higher grade and subject to additional specifications as necessary. All specifications and arrangements shall be subject to the approval of the Engineer.

c) The surface of foundation / well cap / pile cap shall be scraped with wire brush and all loose materials removed. In case reinforcing bars projecting from foundations are coated with cement slurry, the same shall be removed by tapping, hammering or wire brushing. Care shall be taken to remove all loose materials around reinforcements. Just before commencing masonry or concrete work, the surface shall be thoroughly wetted.

d) In case of solid (non-spill through type) abutments, weep holes as shown on the drawings or as directed by the Engineer, shall be provided.

e) The surface finish shall be smooth, except the earth face of abutments which shall be rough finished or left as form finished.

f) In case of abutments likely to experience considerable movement on account of backfill of approaches and settlement of foundations, the construction of the abutment shall be followed by filling up of embankment in layers simultaneously with filter backing behind to the full height to allow for the anticipated movement during construction period before casting of superstructure.

3.7.2 Pier Cap and Abutment Cap (Bed Blocks)

a) Form work, Concrete and reinforcement shall conform to relevant paras of Concrete work & RCC of these specifications and the Drawings. Unless otherwise specified, minimum grade of concrete mix shall be M 35.

b) The locations and levels of pier cap / abutment cap / pedestals and bolts for fixing bearings shall be checked carefully to ensure alignment in accordance with the drawings of the bridge.

c) The surface of cap shall be finished smooth and shall have a slope for draining of water as shown on the drawings or as directed by the Engineer. For short span slab bridges with continuous support on pier caps, the surface shall be cast horizontal. The top surface of the pedestal on which bearings are to be placed shall also be cast horizontal.

d) The surface on which elastomeric bearings are to be placed shall be wood float finished to a level plane which shall not vary more than 1.5mm from straight edge placed in any direction across the area. The surface on which other bearings (steel bearings, pot bearings) are to be placed shall be cast about 25mm below the bottom level of bearings and as indicated on the drawings. Specified rich levelling mortar shall be provided over this at the time of placing of bearing.

3.7.3 Dirt / Ballast Wall, Return Wall and Wing wall

a) Dirt / ballast walls ,return wall & wing walls shall be in RCC. Minimum grade of concrete will be M35 unless otherwise specified. In case of cantilever return walls, no construction joint shall generally be permitted. Wherever feasible, the concreting in cantilever return walls shall be carried out in continuation of the ballast wall.

b) For concrete return and wing wall, the surface of foundation shall be prepared in the same manner as prescribed for construction of abutment. No horizontal construction joint shall be provided. If shown on drawing or directed by the Engineer, vertical construction joint may be provided. Vertical expansion gap of 20mm shall be provided in return wall / wing wall at every 10 metre intervals or as directed by the Engineer. Weep holes shall be provided as prescribed for abutments or as shown on the drawings.

c) Form work, reinforcement and concrete in dirt / ballast wall shall conform to relevant sections of these specifications.

d) The finish of the surface on the earth side shall be rough/form finish while the front face shall be smooth finished.

e) Architectural coping for wing wall / return wall in brick masonry shall conform to Drawings.

3.7.4 Tests and Standards of Acceptance

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

3.7.5 Tolerances in Concrete elements

a) Variation in cross-sectional dimensions: + 10mm, -5mm

b) Misplacement from specified position in plan: 10mm

c) Variation of levels at the top: + 10mm

d) Variations of reduced levels of bearing areas: + 5mm

e) Variations from plumb over full height: + 10mm

f) Surface irregularities measured with 3m straight edge

- All surfaces except bearing areas: 5mm
- Bearing areas: 3 mm

3.8 Bridge Work : Superstructure

3.8.1 GENERAL

a) Coverage

This chapter covers specifications for the following types of superstructures:

i. RCC Box

ii. Prestressed concrete girders and slabs

iii. Steel- Open Web Girders (OWG) and Composite Girders

3.8.2 RCC BOX

All concrete works for RCC box shall conform to Annexue OCS-1 & 2.

3.8.3 STEEL Open Web Girders (OWG) and Composite Girders

Fabrication and erection of steel girders shall conform to Annexure OCS-3.

Concrete and reinforcement for composite girders shall conform to Annexue OCS-1 & 2.

3.8.4 PRE-STRESSED CONCRETE GIRDERS AND SLABS

All prestressed works for bridges shall be carried out in accordance with Annexure OCS-1 to 4.

3.8.5 Linking of Track on Open Web Girder (OWG)

Galvanised H-beam bridge sleepers shall be as per RDSO Drawing No. B-1636/4/R, 5 & 9. Zero toe load fastening shall be as per RDSO Drawing No. T-8759 to T-8765 for 60kg running rail and 52 kg guard rail. Both H-beam bridge sleepers and track fittings/fastenings shall be procured from RDSO approved source. Inspection of material shall be done by the Engineer at factory premises before dispatch. The Contractor shall arrange for necessary inspection/testing of material at factory premises.

Linking of track on H-beam sleeper with 60 kg running rail and 52 kg guard rail shall include bending of guard rail, drilling of holes, cutting of rails, providing wooden wedge at the end of guard rail, provision of gang pathway of 6 mm thick MS chequered plate as per RDSO Drawing No. B-1636 /5 on H-beam sleeper and making track fit for normal sectional speed.

Chapter 4. Station- Civil

4.1 General

Specification for various activities involved in station shall generally be in accordance with CPWD specification-2019 for Civil Works Volume 1 & 2, as amended up to date unless stated otherwise in these specifications. In case of any contradictory instruction in the specification, Engineer's decision shall be final & binding.

4.1.1 Earthwork

Earthwork in excavation and filling/backfilling in station buildings shall be carried out as per CPWD specifications. Soil for filling shall be arranged by the Contractor from outside the ROW. No Earth is to be taken from the Railway premises except surplus earth from excavation for the building.

4.1.2 Concrete Work

All plain and reinforced concrete works shall be carried out as per IS 456:2000 and Annexure OCS-1 and 2. Design Mix concrete as approved by the Engineer shall only be used.

4.1.3 Anti-Termite Treatment

Pre-Construction Anti-Termite Treatment shall be done as per clause 2.28 of CPWD specification 2019 Vol.-1. The chemical shall be approved by the Engineer and used as per the manufacturer's instructions/specification.

4.1.4 Plinth Protection

Plinth protection shall be of 1000 mm wide all around the building, it comprises of 50mm thick M-25 concrete over 75 mm thick bed of dry brick aggregate of 40mm nominal size, grouted with fine sand. The outer edge or face edge shall be lined 2nd class bricks laid on the edge and joints laid in cement mortar 1:4. It shall be laid to the required width and slope in outward direction.

4.1.5 Damp Proof Course (DPC)

Unless otherwise mentioned in the drawings, DPC will consist of 40mm thick M25 CC with two coats of bitumen over it shall be provided as per clause 4.4 of CPWD Specification 2019 Volume-1.

4.1.6 Masonry Work

Masonry work has to be in well burnt clay bricks of class designation 7.5 in general and class 12.5 for external walls which are neither plastered nor rendered on the outer face, free standing walls, and parapets, as approved by the Engineer. All outer and load bearing walls shall be of minimum 230 mm thickness or more as per design, in cement mortar 1:6, all partition walls shall be 115 mm thick in cement mortar 1:4 as per Clause 6 of CPWD Specification Volume-I 2019. Fly ash bricks or cement concrete blocks (hollow/solid) confirming to the BIS or stone masonry can be used as per local availability in lieu of clay bricks, but nothing shall be paid extra on this account.

4.1.7 Plaster

Plaster of 15-19mm thick in cement mortar 1:4 on all outer and inner walls except in ceiling. Inner walls shall be finally finished with POP. Underside of the slabs shall be rendered smooth wherever required and finished with POP as per Clause 3 of CPWD Specification Volume-I 2019.

4.1.8 Painting

Two coats of synthetic enamel paint of 1st quality over a priming coat of Asian, Berger, Nerolac or equivalent brand and shade as approved by the Engineer, on all exposed steel and wooden surfaces.

4.2 Sanitary fittings/sewerage system:

4.2.1 Manholes

Manholes and junction chambers to be constructed by Contractor as per the design by the Contractor & approved by the Engineer and to be connected with RCC pipes of 150/200 mm dia. with each other and to septic tank or to existing sewerage arrangement (up to 15m from extreme outer wall of building in the direction of source to be connected), including obtaining necessary clearance from concerned authorities required from the same. In case sewage system is not be connected with trunk sewer, contractor will furnish appropriate design of septic tank for 50 No. of users to be approved by the Engineer and will construct the Septic Tank accordingly.

4.2.2 Rainwater pipes

Adequate number of rainwater pipes of min 125mm dia, PVC of approved quality and make as approved by the Engineer to be provided. Inlet of the rainwater pipe to be provided with shoe and CI gratings and at the outlets necessary protection to be done to prevent erosion of soil.

4.2.3 Soil and vent pipes

PVC pipes of min 100 mm dia to be provided for soil and vent pipes including all branches of required degree, access door and other accessories as necessary for laying the pipes of approved quality and make as approved by the Engineer to be provided. Before embedding the pipes under the floor/platform the same will have to be tested against any leakage. Necessary floor traps, gully traps as essential will be provided. Storm water drain of suitable size to be provided as approved by the engineer.

4.2.4 Wash Basins, Sink and Water closet

Wash basins (Ceramic) of approved size, colour and make as per IS: 2556 (Part 1) and IS: 2556 (Part 4) shall be provided in ladies and gents toilet with shelf, looking glass and towel rails (CP Brass). Urinal in gent's toilet shall be of Bowl type with flushing rim & partition slab and in ladies toilet Squatting plate type (ceramic) of approved size and make as per IS: 2556 (Part 6) with ceramic flushing cisterns as shown in tender drawings. Water closet shall be Indian (Orissa type) as per IS: 2556 (Part3) / European type as per IS: 2556 (Part1) and IS: 2556 (Part2) with ceramic flushing cisterns as shown in tender drawings. Stainless steel/Ceramic sinks as per IS: 771 (Part2) of

approved size and makes to be provided in battery rooms. All water services and sinks will be connected through bottle traps to concealed outlet pipe.

4.2.5 Water supply

a) Bore well shall be constructed as per IS 2800 Part 1 & Part 2. Chlorinator using common salt shall be provided at each tube well for chlorination of water.

b) Necessary layout for water supply distribution in the water booth, toilets and bathroom to be designed by the contractor and submitted for approval of the Engineer. All internal pipes shall be laid concealed in walls and tested for leakages for minimum 12m head of water. All GI pipes shall be of minimum class 'B.' All necessary taps, stop valve etc. of approved size and make to be provided by Contractor to make the toilets and kitchens functional including provision of RCC underground & overhead water tanks of designed capacity. This will include provision of float valve, copper/brass rod and plastic ball with inlet, outlet, overflow, washout connections etc. for the water tank complete in all respect. Taps in platform toilets & water booths shall be self-closing type.

4.2.6 Water proofing and heat insulation of roofs:

Water proofing of roof shall be carried out by the Contractor as approved by the Engineer.

Heat treatment as approved by the Engineer shall be provided for roof of buildings.

4.2.7 Drip courses

Drip course of approved design shall be provided all around the building, chajjas etc.

4.3 EI Building

4.3.1 Finishes

a) **Interior finish**

Two coats of 1st quality oil bound distemper of approved shade over POP coating to make the surface smooth. 3rd coat may be done before handing over of assets.

b) Exterior finish

Two coats of 1st quality cement paint of approved shade over POP coating to make the surface smooth. 3rd coat shall be done before handing over of assets.

4.3.2 Flooring

a) **Cable entry and Exchange Room**

Tele/OFC Room, Equip Room and Electrical panel room IPS, Data logger room, traffic store and other some rooms: 40mm thick, cement concreate flooring with M-25 CC laid in one layer finished with cement slurry to a true smooth surface with proper joints duly provided with glass strips of 4mm thick to form panels not exceeding 1200x1200mm, laid over 100mm thick CC M-10 over 100mm

thick sand filling over well rammed and consolidated earth filling as per Clause 11.2 of CPWD Specification Volume-I 2019.

b) **Battery Room**

Acid proof files conforming to IS 4457-1967 as approved by the Engineer over 20m thick cement sand mortar 1:4, over 100mm thick CC M-10 over 100mm thick sand filling over well rammed consolidated earth filing. Acid proof tiles also to be provided in dado as per requirement up to 1.5 m height as per Clause 11.14 of CPWD Specification Volume-I 2019.

c) **Staircase**

Kota Stone 25 mm thick to be provided in risers, treads and landings of steps laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement sand mortar 1:3 and 150 mm height skirting of same Kota Stone as per Clause 11.22 of CPWD Specification Volume-I 2019. Kota stone provided on riser & tread of steps shall be minimum 1.8 m long & shall cover full height/width of the step. Exposed end of kota stone on treads shall be rounded to provide nosing. Kota stone tile at other places shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

d) **Verandah Flooring & Ground Floor Passage**

Kota Stone 25 mm thick flooring and 150 mm height skirting laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement sand mortar 1:3 over 100mm thick CC M-10 over 100mm thick sand filling over well rammed consolidated earth filing and 150 mm height skirting of same Kota Stone as per Clause 11.22 of CPWD Specification Volume-I 2019. Kota stone tile shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

e) **Toilets**:

Finished floor to be kept 25mm below the normal floor of the building. 300x300mm ceramic antiskid floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria, Nitco or similar make and shade and approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shade of tiles between joints and over the base in floors laid over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling on ground floor. On subsequent floors the tiles will be laid directory on mortar bed. Glazed tiles of suitable size (300mmx300mm or 300mmx450mm) and minimum 06mm thickness confirming to IS 13630-1993 of Kajaria, Nitco or similar make, quality and shade as approved by the engineer to be provided on wall for full height up to ceilings over 13mm thick cement mortar 1:3. All the tiles to be laid with zero gaps between them.

f) **Relay Rooms**

Axle counter room, booking, Panel Room and other S&T structures etc. 1st quality

600x600mm vitrified floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria, Nitco or similar make and shade as approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shades of tiles between joints and over the base in floors over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling for ground floor. On subsequent floors tiles shall be laid directly on mortar bed. Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness confirming to IS 13630-1993 of Kajaria, Nitco or similar make, quality and shade as approved by the Engineer to be provided on walls in dado up to 90cm height from floor level or up to the window sill. All the tiles to be laid with zero gap between them as per Clause 11.15 & 11.16 of CPWD Specification Volume-I 2019.

Note:-

Color and make of all the flooring shall be as per the direction of the Engineer.

4.3.3 Door, Windows and Ventilation

a) **Door frames:**

Door frame shall be ofof manufactured from T iron. Sizes of T-section used for manufacture of door, window & ventilator frames shall be as per IS:1038. Requisite number of holes shall be made in the frame for fixing fittings.

b) **Door Shutter**:

35mm thick flush floor shutter, commercial type thermosetting synthetic resin bound core of block board construction with lipping of 1st class commercial quality timber, such as elm or its equivalent, battens on all edges and well-matched commercial ply veneering with vertical grains on both faces of shutters. Veneer and board shall as per BIS specifications with brass fittings of approved size and make as per requirement.

c) **Windows/Ventilators**

Steel windows shall be manufactured from rolled steel sections and shall conform to IS: 1038. Glass panes 4mm thick with glazing clips and special metal sash putty, of approved make with brass fittings of approved size and make as per requirement.

d) Windows in relay room shall be mix of double shutters/fix panes to provide insulation for effective air conditioning.

e) MS grill of approved design/drawing shall be provided in the windows and ventilators.

f) Necessary exhaust fan opening to be provided as required.

4.4 Station Building

4.4.1 Doors, Windows & Ventilators

a) **Exterior Doors**

Main entrance from circulating area to the station building shall be provided with fully glazed Aluminum Door. Remaining portion of entrance shall be provided with fixed glazing with aluminum frames as per approved drawing. The frames shall be manufactured from extruded aluminum ally sections of standard sizes and designs as per IS 1948 and IS 1949 or as manufactured by Indian Aluminum Co. Ltd or approved equivalent. The alloy used shall conform to the IS designation HE9-WP of IS:733. Glazing shall be of 10 mm thick clear glass, horizontally tempered (toughened) as per DIN:1249 Part-12 with no tong or suspension mark and edges machined with no burrs or sharp surfaces. All Toughened Glass shall be heat soak test certified as per BS EN-14179-1.

b) **Door frames** of office of Station Master/SS/Dy. SS/Waiting Rooms/Booking Office shall be of well-seasoned steam beech/2nd class of teak wood of minimum section 65mmx100mm.

c) **Door Shutter**

The door shutters shall be of 35mm thick flush door shutter, commercial type thermosetting, synthetic resin bound core of block board construction with lipping of 1st class commercial quality timber, such as elm or its equivalent, battens on all edges and well-matched commercial ply veneering with vertical grains on both faces of shutters. Veneer and board shall be of BIS specifications. These door shutters may be partially glazed as per requirement, as per drawing approved by the Engineer. Glazing shall be of glass pane of 6mm thickness. Doors shall be finished with duco painted of desired shade and colour of melamine polished complete with all fittings including door closures.

d) **Windows/Ventilators Shutters**

The frames of windows and ventilators in the station building shall be of powder coated aluminum with extruded built up standard tubular sections/ Z sections of approved make conforming to IS: 733 and IS:1285 fixed with dash fasteners of required dia and size with fully glazed shutters of 5 mm thick float glass provided with EPDM rubber/ neoprene gasket with complete fittings as per CPWD specifications Vol.-II.

e) **Door/Window fittings**:

These shall be chromium plated brass, of size and make as approved by the engineer.

4.4.2 Finishes

a) **Interior finish**

Two coats of 1st quality oil bound distemper of approved shade over POP coating to make the surface smooth. 3rd coat may be done before handing over of assets.

b) **Exterior finish**

Two coats of 1st quality cement paint of approved shade over POP coating to make the surface smooth. 3rd coat shall be done before handing over of assets.

4.4.3 Flooring and Dado

a) 1st quality 600x600mm vitrified floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria, Nitco or similar make and shade as approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shades of tiles between joints and over the base in floors over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling. On subsequent floors tiles shall be laid directly on mortar bed. Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness confirming to IS 13630-1993 of Kajaria, Nitco or similar make, quality and shade as approved by the Engineer to be provided on walls in dado up to 90cm height from floor level or up to the window sill. All the tiles to be laid with zero gap between them over 13mm thick cement mortar 1:3. as per Clause 11.15 & 11.16 of CPWD Specification Volume-I 2019.

b) Chequered terrazzo tile 22mm thick with graded marble chips size up to 6mm to be provided in risers, treads and landings of steps laid on with neat cement slurry mixed with pigment to match the shade of tile including rubbing polishing complete on 20mm thick cement sand mortar 1:4 as per Clause 11.12 & 11.13 of CPWD Specification Volume-I 2019.

c) Toilets

Finished floor to be kept 25mm below the normal floor of the building. 300x300mm ceramic antiskid floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria or similar make and shade as approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shade of tiles between joints and over the base in floors laid over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling. Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness conforming to IS 13630-1993 of Kajaria or similar make, quality and shade as approved by the Engineer to be provided on walls for full height up to ceilings over 13mm thick cement mortar 1:3.Tiles shall be laid with zero gaps between them as per Clause 11.15 & 11.16 of CPWD Specification Volume-I 2019.

4.4.4 Ticketing Room

a) Booking Counter & Facia

Counters & facia to be made with Granite Top of 20mm thick on with neat cement slurry mixed with pigment to match the shade of Granite slab including rubbing polishing complete on 20mm thick cement and sand mortar 1:3 on RCC Self as per approved design.

b) Flooring & Skirting

1st quality 600x600mm vitrified floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria, Nitco or similar make and shade as approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shades of tiles between joints and over the base in floors over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling. On subsequent floors tiles shall be laid directly on mortar bed. Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness confirming to IS 13630-1993 of Kajaria, Nitco or similar make, quality and shade as approved by the Engineer to be provided on walls in dado up to 90cm height from floor level or up to the window sill. All the tiles to be laid with zero gap between them over 13mm thick cement mortar 1:3. as per Clause 11.15 & 11.16 of CPWD Specification Volume-I 2019.

c) Booking Window

Booking window shall be of toughened sheet glass 10mm thick with a hole for intercommunications at suitable height above the countertop and a suitable gap between the partition and counter for collection of fare and issue of tickets, the partition being protected on the passenger side by a aluminum grill of approved design.

d) **Ramp for Handicapped**

Facilities for physically handicapped Ramps of designed width with stainless steel railing (SS 304) on both edges and a slope of 1:12 shall be provided as per the provisions of "The persons with disabilities" (Equal opportunities protection of rights and full participation): Act 1995. Flooring of ramp shall be of Chequered terrazzo tile 22mm thick with graded marble chips size up to 6mm fixed with neat cement slurry mixed with pigment to match the shade of tile including rubbing polishing complete on 20mm thick cement sand mortar 1:4 over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling as per Clause 11.12 & 11.13 of CPWD Specification Volume-I 2019.

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4.4.5 Subway & inter platform connectivity

a) **Flooring**

Kota stone 25 mm thick to be provided in flooring laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement and sand mortar 1:3 as per Clause 11.22 of CPWD Specification Volume-I 2019. Kota stone tile shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

b) **Dado**

Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness confirming to IS 13630- 1993 of Kajaria, Nitco or

similar make, quality and shade as approved by the Engineer to be provided on walls in dado up to 2.5 m height from floor level.

c) **Stairs & Ramps**

Kota Stone 25 mm thick to be provided in risers, treads and landings of steps laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement and sand mortar 1:3 and 150 mm height skirting of same Kota Stone as per Clause 11.22 of CPWD Specification Volume-I 2019. . Kota stone provided on riser & tread of steps shall be minimum 1.8 m long & shall cover full height/width of the step. Exposed end of kota stone on treads shall be rounded to provide nosing. Kota stone tile at other places shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

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d) **Railing**

Assembly and erection as per approved drawing on stairs of Stainless steel of material grade SS 304 as per CPWD specification Vol.-1 2019.

e) **Covering for Stairs & Ramp**

Roofing with Galvalume Sheets pre painted Al-Zn alloy coated sheeting CRCA (Cold Rolled Close Annealed) steel thickness shall be 0.60 mm and steel shall comply with requirement of Gr.60 as per ASTM A 792 M.

4.4.6 Platform Covering

a) **Main Platform Shelter**

Main Platforms Shelters of length 40 m and covering entire platform width shall be provided on each platform as per approved drawings. It shall be fabricated from rolled steel sections conforming to IS:2062/4923. Roof shelter shall have arrangement for collection and safe outlet of rain water. Shelter roofing shall consist of Galvalume Sheets pre painted Al-Zn alloy coated sheeting CRCA (Cold Rolled Close Annealed) steel thickness shall be 0.90 mm (+- 0.2 mm) and steel shall comply with requirement of Gr.60 as per ASTM A 792 M.

b) **Mini Shelter**

All mini shelter shall be with seating capacity of 6 passenger as shown in tender drawing. Roofing with 6MM thick multiwall translucent Polycarbonate sheet both side UV protected make in curved shape as shown in tender drawing .

c) **Shelter Flooring**

Kota Stone 25 mm thick to be provided in flooring laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement and sand mortar 1:3 as per Clause 11.22 of CPWD Specification Volume-I 2019.

4.4.7 Platform Surfacing-

a) **VDC Flooring**

100mm thick fiber reinforced Vacuum Dewatered Concrete (VDC) flooring of grade M25 of stone aggregate 20 mm and downsize laid as specified in CAMTECH/2021/C/VDF/1.0 2021 of RDSO publication over 100mm thick CC M-10 over 100mm thick fine sand filling over well rammed and consolidated earth filling.

The area to be paved with VDC should be divided into suitable panels by fixing screed strips. The depth of screed strips should be equal to the combined thickness of base concrete and topping. Generally, no dimension of panel shall exceed 4 m in case of floor finish laid monolithically with the base concrete and 2m in case finish laid separately on a hardened base. Length of panel shall not exceed 1.5 times its breadth. Reinforcement shall be provided as per design. Before placement of base concrete sub-base shall be properly wetted.

Tactile path shall be provided at 1.8 m from the coping edge along the entire length of platform and at entrance & exit points of platform to station as per direction of the Engineer. Tactile floor tile shall have a minimum thickness of 10 mm excluding the flat top blister like domes or flat topped bars and shall conform to IS 4457 and IS 15622 and "Handbook for barrier free accessibility"-CPWD.

Note: The position of trenches and pipes for services such as water, drainage, electric, S&T etc. must be fixed before floor concreting starts..

b) **Platform slope**

For End platform cross slope of 1 in 60 to be provided away from the track while on island platform cross slope 1 in 60 to be provided from center of track towards the end of coping/Track side.

c) **Joints**

At panel interfaces groove of about 5 mm wide shall be cut in top surface in both lateral & longitudinal direction for prevention of cracks as per instruction of the Engineer. These grooves shall be filled with suitable sealant.

4.4.8 Water Booth-

a) **Water Booth Platform**

Granite Stone cladding with Granite Top of 20mm thick on with neat cement slurry mixed with pigment to match the shade of Granite including rubbing polishing complete on 20mm thick cement and sand mortar 1:3.

b) **Drainage & its covering-**

On island platform an underground drain of 125 -150 mm dia with manhole at suitable interval shall be provided to safely carry the effluent from water booths, PF shelters, toilets etc and on end platform underground/open drain with removable MS grating cover shall be provided on the far end of the platform as shown in the tender drawings.

c) **Duct For Utilities-**

Two underground ducts of about 100mm size with manholes at about 30 m interval shall be provided along the entire length of platform to carry electrical and S&T cables.

d) **Taps**

Self-closing Taps with CP Brass/PTMT bib cock provided with quarter turn ceramic cartridges

Miscellaneous items shall be as given below-

Item No.	Description of items	Material Spec.
1.	Orissa WC Pan (Indian Style) with low level dual flushing PVC cistern	Ceramic
2-	European Type Wall Hung/Floor Mounted WC with seat, lid and low level dual flushing PVC Cistern	Ceramic
3-	Water Jet/Health Faucet with European WC	CP Brass
4-	Ceramic Wash Basin with CP brass Tap /PTMT Tap with Quarter Turns Ceramic Cartridges.	Ceramic
5-	Tap (Toilet, Bath & WC) CP Brass/PTMT bib cock provided with quarter turn ceramic cartridges	CP Brass
6-	Mirror (600 x 450mm) with each wash basin with PTMT glass shelf	PTMT
7-	Towel rail	CP Brass
8-	Soap Rack for each wash basin	CP Brass

Chapter 5. Station- Plumbing and Fire Fighting

5.1 Water Supply and Plumbing Works

5.1.1 Applicable Standards

The Contractor shall ensure the compliance to the following codes and standards:

IS 458: 2003	Specification for Precast Concrete Pipe
IS 783: 1985	Code of Practice for Laying of Concrete Pipes
IS 1172: 1993	Code of Basic Requirements for Water Supply, Drainage & Sanitation
IS 1239 (Part-1):2004	Steel Tubes, Tubulars and Other Wrought Steel– 2004 Fittings, Part 1: Steel Tubes
IS 1239 (Part-2):2011	Steel Tubes, Tubulars and Other Steel Fittings– 2011, Part 2: Steel Pipe Fittings
IS 1726: 1991	Specification for Cast Iron Manhole Covers & Frames
IS 3624: 1987	Specification for Pressure and Vacuum Gauges
IS 4984: 1995	Specification for Water Supply HDPE pipes
IS 7634 (Part 2): 2012	Specification of Installation for Water Supply HDPE Pipes
IS 8110:2000	Well screens and slotted Pipes.
IS 8329: 2000	Centrifugally Cast (spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage
IS: 9439:2002	Glossary of terms used in Water-well drilling technology.
IS 9523: 2000	Ductile Iron Fittings for Pressure Pipes for Water, Gas and Sewage
IS:11189: 1985	Method of Tubewell Development
IS 12288: 1987	Specification for Laying Ductile Iron Pipes
IS:12818: 2010	Unplasticized polyvinyl chloride (PVC-U) Screen and casing pipes for Borewell/tubewell specification
IS 16098 (Part-2) :2013	Structured-wall Plastics Piping Systems for Non-Pressure Drainage and Sewerage

BIS - SP (QAWSM) 56: 1994 Location, operation and Maintenance of tube/bore wells - Guidelines

5.1.2 Storage Tanks for Water Supply

Storage tanks for water supply shall be constructed in accordance with IS 3370 (Part 1 & Part 2) and as per drawings approved by the Engineer.

5.2 Plumbing and Firefighting

5.2.1 General

a) General Requirements

i. The workmanship shall be as per best industrial practices and shall conform to the specifications and Indian Standard Specifications in every respect and shall be as approved by the Engineer.

ii. All relevant certificates shall be submitted by the Contractor to show that the materials comply with the requirements and technical data specified in this document. The Engineer may require additional testing of materials to verify the compliance as per specifications for which the costs shall be borne by the Contractor.

b) Testing and Commissioning

i. Hydrostatic Pressure Testing of Pressure Pipes

ii. All pressurized pipelines shall be tested as specified in Sub-Clause 4.15, Part 9, Section 1 of NBC 2016.

iii. Testing of Non-Pressure Pipes

iv. All non-pressure pipelines shall be tested as specified in Sub-Clause 6.4.4.3 of 'Manual on Water Supply and Treatment", CPHEEO.

c) Flushing

The Contractor shall be responsible to check that the water pipework is flushed and chemically cleaned against unwanted substances. Contamination may occur during storage of materials, due to surface oxides and mill scale, or the application of protective grease and oils. During the installation period, the pipework can become further contaminated by construction material debris such as welding and jointing materials, swarf and dust. The Contractor responsible for installing the system shall ensure that care is taken to limit the amount of dirt entering the system during installation.

d) Site Acceptance Test, Commissioning and Inspection

i. The Contractor shall submit the schedule and Method Statements for testing and commissioning of all plumbing & fire-fighting equipment, materials, goods and systems to the Engineer, as soon as possible after the award of the Contract. Tests shall be conducted in the presence of the Engineer to his satisfaction. The Contractor shall submit these to obtain approval from the Engineer.

ii. The Contractor is responsible to ensure that all testing equipment, materials and personnel are available at the appropriate time for testing. The Contractor shall prepare forms to record all test procedures and results for the review of the Engineer. These forms shall constitute a record of testing and they are aimed for assisting the Engineer in giving his review of operations, performances and functions for equipment, materials, goods and systems.

iii. During the installation phase of the project, the Contractor shall carry out initial testing and pre-commissioning of all plumbing and fire-fighting services and systems, followed by final commissioning. This shall include the pressure testing, flushing and cleaning of pipework,

iv. Method Statements shall be submitted for review to the Engineer allowing enough time for review, comment and re-issue.

v. The Contractor shall be responsible to take date stamped photographic records of testing and commissioning; in case the Engineer is unavailable to attend a test demonstration. These shall be produced by the Contractor and submitted to the Engineer along with testing and commissioning records for review or request to re- demonstrate.

5.2.2 Plumbing

a) Qualification

The plumbing works shall be carried out by the plumbing sub-contractor / plumber who holds a valid plumbing license issued by the Municipal authority or other competent authority as per Clause 3.3 under Section-2 Part -IX of NBC-2016. The Contractor shall keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals related to water supply, sewerage and drainage system. He shall also be responsible for co-ordination with other Interfacing Contractors.

b) Materials

i. Piping Materials

All materials shall comply with the following specifications, unless otherwise specified. If after tests, any materials, work or portions or work are found defective, the Contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Engineer. To prove that the materials used are as specified, the Contractor shall furnish the Engineer with original invoice on demand.

1) Water supply pipes

Pipes for water supply shall be as follows –

(A) Ductile Iron (DI) shall conform to IS 8329 and fittings to IS: 9523. All pipe joints shall be with couplers or jointing fixtures as per respective IS codes and manufacturers recommendations

(B) HDPE pipes shall conform to IS 4984.

(C) GI pipes shall conform to IS 1239.

2) Sewage and drainage pipes

Sewage and drainage pipes shall be as follows –

(A) Non pressure HDPE pipes shall conform to IS 16098 Type B. Typical classification of pipes shall be double wall corrugated (DWC)SN8.

(B) RCC pipes shall be socket & spigot centrifugally spun conforming to IS 458 of NP-3 Class.

ii. Water supply pipeline

The Contractor shall install all piping and fittings in their final position in accordance with approved trial assemblies and as per drawings that have been approved by the Engineer. The installation shall be done as per CPHEEO/CPWD/IS specifications

1) DI pipes shall be laid as per IS 12288.

2) HDPE pipes shall be laid as per IS 7634 Part 2.

3) GI pipes

iii. Sewer and drainage pipeline

1) Structured wall plastic piping system shall be laid as per IS 16098.

2) Concrete pipes shall be laid as per IS 783.

3) Soil, waste water and drainage pipes from buildings shall be connected with sewerage and drainage systems through manholes to be constructed by the Contractor.

iv. Manholes

1) Manholes shall be constructed as specified in Sub-Clause 4.4.10 under Part-9, Section-2 of NBC-2016.

2) Manholes shall be provided with cast iron covers and frames embedded in RCC slab or SFRC precast concrete covers as per drawing approved by the Engineer.

v. Disinfection of Storage Tanks

The Contractor shall arrange to disinfect the water storage tanks before commissioning. The water storage tanks shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Adequate amount of chlorine shall be

used to give water a dose of 50 parts of chlorine to one million parts of water

5.2.3 Sourcing of water

i. Borewells

1) Location of bore-well shall be proposed by the Contractor for the Engineer's approval.

2) The Contractor shall provide borewells including borewell room, pumps, pipeline and electric wire rope hoist for lifting and lowering of pumps as per drawings approved by the Engineer. The Contractor shall provide pipe line with valves, fittings and accessories from borewell to storage tank as shown in the drawings. The well screen and slotted pipe shall conform to IS 8110 Type D. Material of wire of screens shall be stainless steel (SS) of designation XO4Cr18Ni10 of IS 6528. The housing and casing pipe shall conform to IS 4270 or IS 12818. Borewell shall be provided with sluice valve, pressure gauge, non-return valve and flow meter. Borewell shall be constructed and tested as per IS 2800 Part 1 and Part 2. The Contractor shall furnish information after completion of the borewell as per IS 2800 Part 2 to the Engineer for approval. Provisions of IS:SP(QAWSM) 56 shall be followed for ground water exploration, siting, construction and development of borewell.

5.2.4 Storage tanks for water supply

The Contractor shall construct underground and overhead water storage tanks as per the drawings approved by the Engineer.

5.2.5 Water **Supply** distribution system

The Contractor shall provide water supply distribution system including piping, pumping, valves and fittings to the required gradients and profiles as the drawings approved by the Engineer. The Contractor shall follow provisions of "Manual on Water Supply and Treatment" published by the Central Public Health and Environment Engineering Organization, Ministry of Urban Development, Govt. of India, (CPHEEO), CPWD Specifications (Vol. 2) and NBC 2016 for carrying out and testing the works of water supply distribution system.

5.2.6 Yard Drainage System

The Contractor shall provide yard drainage as per the drawings approved by the Engineer. The Contractor shall follow provisions of "Manual on Storm Water Drainage Systems" published by CPHEEO, CPWD Specifications (Vol. 2) and NBC 2016 for carrying out the works of yard drainage system.

5.2.7 Sewage Disposal System

The Contractor shall provide sewage disposal as per the drawings approved by the Engineer. The Contractor shall follow provisions of "Manual on Sewerage and Sewage Treatment Systems" published by CPHEEO, IS SP-35 "Handbook on Water Supply and Drainage" and NBC 2016 for carrying out and testing the works of sewage

disposal system.

5.2.8 Rainwater Harvesting System

The Contractor shall provide rainwater harvesting system as per the drawings approved by the Engineer. The Contractor shall follow provisions of "Manual for Rainwater Harvesting and Conservation" (CPWD), IS: 15792 (Guidelines for artificial recharge to ground water) and guidelines issued by CGWB and local authorities.

5.3 Firefighting System

5.3.1 Handheld Fire Extinguishers

The firefighting extinguishers works shall consist of the following:

i. Distribution or installation of fire extinguisher shall be in accordance with IS 2190 or IS 15683.

ii. Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wall by suitable anchor fasteners by skilled workmen.

iii. Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

iv. The extinguishers shall be treated for anti-corrosion internally and externally and painted with fire red paint. The paint shall be stove enamelled.

v. The description of extinguishers shall be marked with 2.5cm height in block letters within a triangle of 5cm each side.

vi. Fire extinguishers shall be counted in numbers and shall include installation of all necessary items required as given in the specifications.

a) Clean Agent Extinguisher

i. Clean agent type fire extinguishers i.e. stainless-steel body made shall be placed as per approved drawing.

ii. Clean agent fire extinguishers capacities as per city chief fire officer's recommendations & other suggestions shall be followed as per IS 15683.

iii. Clean agent extinguishers shall cover A, B & C type fire.

b) Dry Chemical Powder Extinguisher

i. The extinguisher shall be filled with grade 40 Mono Ammonium Phosphate (40%) from any approved manufacturer.

ii. The capacity of the extinguisher when filled with dry chemical powder as first filling as per IS 4308, Part II shall be 5 Kg ±2% or 10 Kg ±3%.

It shall be operated upright with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip fitted with a pin to prevent accidental discharge. It shall be pressurised with dry nitrogen as expellant and shall be

charged at a pressure of 15 Kg/cm^2.

c) Water Type Extinguisher (Gas Pressure Type)

i. The extinguishing medium shall be primarily water stored under normal pressure, and the discharge shall be by release of carbon dioxide gas from a cylinder.

ii. The capacity of extinguisher when filled up to the indicated level, shall be 9L±5%.

d) Mechanical Foam Type Fire Extinguisher

Mechanical foam fire extinguisher suitable for Class A and Class B fire shall be used for fire extinguishing. Foam being an effective smothering agent is used for liquid fires mainly. It shall react by flowing over the liquid fuel oil surface and isolating the fire from the air and shall also prevent re-ignition due to the foam stability.

Annexure OCS-1

PLAIN AND REINFORCED CEMENT CONCRETE

1 MATERIALS

a. Before bringing to the site, all materials for concrete shall be approved by the Engineer. All approved samples shall be deposited in the office of the Engineer before placing orders for the materials with suppliers. The materials brought on to the works shall conform in every respect to their approved samples.

b. Fresh samples shall be deposited with Engineer whenever type or source of any material changes. The contractor shall check fresh consignment of materials as it is brought on to the works to ensure that they conform to the specifications and/or approved samples.

c. The Engineer shall have the option to have any of the materials tested to find whether they are in accordance with specifications at the contractor's expense. All bills vouchers and test certificates which in the opinion of the Engineer are necessary to convince him as to the quality of materials or their suitability shall be produced for his inspection when required.

d. If fly ash is used in concrete, the contractor shall demonstrate the quality control procedure including source of fly ash, its properties, handling as per the relevant IS & international codes etc. and shall use in slabs and walls only after "no objection" to the same has been obtained from the Engineer.

e. Any materials which have not been found to conform to the specifications and not approved by the Engineer shall be rejected forthwith and shall be removed from the site by the contractor at his own cost within the time stipulated by the Engineer. The Engineer shall have the powers to cause the contractors to purchase and use materials from any particular source, as may in his opinion be necessary for the proper execution of work.

f. Contractor shall also ensure that all constituents of exposed concrete shall be taken from same sources to achieve a uniform colour and texture.

g. Approved list of Manufacturer's/Suppliers is given in Section VII- 11,Tender Drawings and Documents. In case the Contractor desired to procure the material from any other supplier, it shall be got approved by the Engineer.

2 Cement

2.1 Product and Materials for Cement

a. Cement to be used in the works shall conform to 53-grade OPC (IS 269:2015) or blended cement such as Portland Pozzolana Cement (IS 1489:2015) or Portland Slag Cement (IS 455:2015).

b. The Contractor shall submit to the Engineer the Manufacturer's Certificate to affirm that the cement complies with the relevant standards.

c. Samples of the proposed cement shall be taken and forwarded to an independent laboratory for analysis before the source is approved.

d. Prior to ordering cement, the Contractor shall submit details of the proposed supplier or manufacturer and information on the proposed methods of transport, storage and certification for the Engineer's approval and show that the quantity and quality required can be attained and maintained throughout the construction period. In exposed concrete elements, the cement used in the concrete for entire element shall preferably be from a single manufacturer to ensure uniform colour.

e. Subsequent to obtaining the Engineer's approval, the Contractor shall not change the agreed arrangements without the prior approval from the Engineer. Each delivery of cement shall be accompanied by a certificate which shall be submitted to the Engineer immediately after the delivery showing the place of manufacture and the results of standard tests carried out by the manufacturer.

2.2 Testing for Cement

a. Samples shall be tested from every batch of cement delivered on site or once for every 1000 bags whichever is more frequent. The sampling from bulker shall be increased as decided by the Engineer.

b. Samples shall be taken immediately on receipt of cement at site. The methods and procedures for sampling shall be in accordance with IS: 3535.

c. Tests shall be carried out as per IS4031 for physical analysis as fineness, initial and final setting time and compressive strength and results approved by the Engineer before use. The contractor shall provide complete facilities at site for carrying out the following tests:

   i. Setting time by vicat's apparatus as per IS:5513 and IS:4031.

   ii. Compressive strength of cement as per IS: 4031, IS:650, IS:10080.

d. The Engineer may require any other form of sampling and tests including chemical analysis. Total chloride content in cement and total sulphur content calculated shall in no case exceed the requirements of Table 2 of IS 269. In case the cement supplied is of doubtful quality, tests shall be done in accordance with IS 4032. The costs of such additional tests shall be borne by the Contractor.

3 Aggregates

3.1 General

Aggregates shall conform to the provisions specified in IS 383:2016. The contractor shall submit to the Engineer certificates of grading and compliance for all consignments of aggregate. In addition, at site from time to time, the contractor shall allow for carrying out tests and for supplying test records to the Engineer. Prior to commencing any concrete

work, the Contractor shall obtain the Engineer's approval of the proposed types and sources of aggregate.

For fair faced concrete, the contractor shall ensure that aggregates are free from iron pyrites and impurities, which may cause discoloration. Aggregates shall be stored on paved areas in different compartments according to their nominal size.

Sampling of aggregates shall be as per IS 2430.

3.2 Fine Aggregates (Sand)

a. The grading of the sand shall conform to IS:2386(Part1). The grading of fine aggregate shall be within the grading zones I, II, III. Sand, if found too coarse, shall be suitably blended with finer sand obtained from approved sources to obtain the desired grading. The provision of two types of sand, their separate stacking and their mixing in the specified proportions shall be at the Contractor's own cost.

b. The sand shall not contain silt, shale, clay and other weak particles for more than a total of 3% by weight. In case of sand containing excess silt, clay and chlorides, the sand shall be washed in screw type mechanical washers in potable water to remove the same. The screening and washing of sand shall be completed at least one day before using it in concrete. The washed sand shall be stored on a sloping platform while ensuring that contamination is avoided.

c. Water absorption shall be less than 3% by weight (ASTM C 117)

d. The sand shall be screened on a 4.75 mm size screen to eliminate oversized particles. The Contractor shall carry out the following tests at Site and ensure that the appropriate provisions of Indian or other standards, as may be applicable, are complied with:

   i. Proportion of clay, silt and fine dust by sedimentation method as per IS 383:2016 and IS 2386 (Part II)

   ii. Moisture content in fine aggregate as per IS 2386(Part III)

   iii. Water absorption shall be worked out as per IS 2386(Part III)

   iv. Bulk Density or bulkage as per IS 2386(Part III)

   v. Grading of fine aggregate asper IS 383:2016 and IS 2386(Part I)

3.3 Coarse Aggregates

a. All coarse aggregate shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, Parts I to VIII.

b. The maximum size of coarse aggregate shall be such that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of formwork. The grading of coarse aggregate shall be such that not more than 5% shall be larger than the maximum size and not more than 10% shall be smaller than the smallest size. Between these sizes the coarse aggregate shall be well graded. Unless otherwise permitted by the Engineer the nominal maximum size shall not exceed 20 mm.

c. Water absorption shall be less than 3% by weight (ASTM C 117)

d. Coarse aggregates used for the Works shall be crushed stone conforming to IS 383, obtained from approved sources by the Engineer. Only quarries having jaw crushers with choke feeding arrangements producing aggregates of nearly cubical shape shall be applied.

e. Coarse aggregate containing flat or flaky pieces or mica shall be rejected.

f. The Contractor shall carry out the following tests at site and ensure that the appropriate provisions of following Indian standards as may be applicable are complied with:

i. Moisture content in coarse aggregate asper IS 2386(Part III)

ii. Water absorption shall be worked out as per IS 2386(Part III)

iii. Bulk density and voids asper IS 2386(Part III)

iv. Grading of coarse aggregate as per IS 383:2016 and IS 2386(Part I)

4 Water

Water used in the works shall be potable water and free from deleterious materials. Water used for mixing and curing concrete as well as for cooling and/or washing aggregate shall be fresh and clean free from injurious amounts of oil, salts, acids, alkali, sugar other chemicals and organic matter. Mixing and curing with seawater shall not be permitted.

Water shall be from the source approved by the Engineer and shall be in accordance with IRS: CBC(Cl.4.3), IS: 456 (Cl. 5.4) and/or BS 3148.

Water samples from the intended source of supply shall be taken for analysis before any concrete work commences, and at regular intervals throughout the duration of the Works, as approved by the Engineer. Whenever the source of water changes, the water shall be tested for its chemical and other properties or impurities to ascertain its suitability for use in concrete, subject to the approval of the Engineer. No water shall be used until tested and found satisfactory. Cost of all such tests shall be borne by the Contractor.

5 Chloride Content

The chloride content of aggregates shall be within the recommended limits stated in IS: 383 or BS 882 and the chloride content of the concrete mix shall be within the recommended limit of IS: 456 or BS 8110. Chloride levels shall be determined daily in accordance with the methods described in BS 812.

6 Alkali-Silica Reactivity

If aggregates contain any materials which are reactive with alkalis in any of the constituents of the concrete, or in water which will be in contact with the finished work, then the Contractor shall take samples of these materials every week. The Contractor shall ensure that the concrete mix complies with the requirements of this Specification regarding "Minimising risk of alkali-silica reaction in concrete". The results of the Contractor's weekly monitoring tests shall be submitted in writing to the Engineer-in-charge.

7 Sulphate Content

The total acid soluble sulphate content of the concrete mix, expressed as SO3, shall not exceed the recommended limit in IS: 456 or BS 8110.

8 Reinforcement Steel

The Contractor shall refer to Annexure - C of these Technical Specifications.

9 Binding Wire

GI wires of 1.6mm diameter shall be used for binding of reinforcements. It shall conform to the provisions laid down in IS 280.

10 Concrete Admixtures

a. Admixtures shall conform to the provision laid down in IRS: CBC (Cl. 4.4).

b. Concrete admixtures are proprietary items of the manufacturer and shall be obtained only from established manufacturers with proven track record, quality assurance and full- fledged laboratory facilities for the manufacture and testing of concrete. Naphthalene or melamine-based admixtures that are approved by the Engineer only shall be used in the Works. The admixture shall be non-air entraining type. The Contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer:

   i. Normal dosage and detrimental effects, if any, of under dosage and over dosage.

   ii. The chemical names of the main ingredients in the admixtures.

   iii. The chloride content, if any, expressed as a percentage by weight of the admixture.

   iv. Values of dry material content, ash content and relative density of the admixture which can be used for uniformity tests.

   v. Whether or not the admixture leads to the entrainment of air when used as per the manufacturer's recommended dosage, and if so, to what extent.

   vi. Where two or more admixtures are proposed to be used in any one mix, confirmation of their compatibility.

   vii. Whether or not there would be an increase in risk of corrosion of the reinforcement or other embodiments as a result of using the admixture.

   viii. Retardation achieved in initial setting time.

c. Physical and chemical requirements of admixtures shall conform to IS 9103. In addition, the following conditions shall be satisfied:

   i. Plasticizers and superplasticizers shall meet the requirements indicated for "Water reducing Admixture".

ii. The air content of freshly mixed concrete, in accordance with the pressure method given in IS 1199, shall not be more than 1% higher than that of the corresponding control mix.

iii. There shall be no chloride content in admixture when tested in accordance with IS 6925.

iv. Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.

v. All tests relating to the concrete admixtures shall be conducted periodically at an independent laboratory and compared with the data given by the manufacturer.

vi. While qualifying the admixture, the infrared spectrograph plot shall be given. Each batch of the supply shall be tested for IR spectrograph and prove the consistency of supply.

11 Minimising the Risk of Alkali-Silica Reaction (ASR) in Concrete

a) Precautions against ASR in Concrete

Concrete mixes for use in the Permanent Works shall comply with one of the Subsections (b), (c) or (d). The Contractor shall notify the Engineer of his proposals for complying with this requirement.

b) The cementitious material shall have a reactive alkali content not exceeding a maximum value of 0.6% by mass when defined and tested in accordance with Subsections 3.3.1 ((e) to (k) inclusive).

To combat the ASR, Microsilica shall be used in minimum 5% cement and shall not exceed 10% by the wt of cement in order to bind free alkalis early in plastic concrete and to reduce the permeability of concrete to prevent the moisture and external alkalis penetration.

OR

c) The total mass of reactive alkali in the concrete mix shall not exceed 3.0 kg/m^3 of concrete when defined, tested and calculated in accordance with Subsections 3.3.1 ((e) to (k) inclusive) and 3.3.1 ((l) to (o) inclusive).

OR

d) The aggregate shall be classed as non-reactive in accordance with the definition in Subsection (n).

e) Cementitious Material (Hydraulic and Latent Hydraulic Binders):

f) The term alkali refers to the alkali metals sodium and potassium expressed as their oxides. The reactive alkali content of Portland cements shall be defined as the percentage by mass of equivalent sodium oxide (Na_2O) calculated from:- % equivalent Na_2O = % acid soluble Na_2O + 0.658 x (% acid soluble K_2O)

g) The method used in determining the acid soluble alkali content of the materials shall be in accordance with BS 4550: Part 2: Subsection 16.2.

h) The Contractor shall make available the certified average acid soluble alkali content of Portland cement on a weekly basis.

i) The Contractor shall give immediate notice of any change which may increase the certified average acid soluble alkali content above the level used in the mix design for the concrete. A revised mix design for any concrete which would be affected by the increased alkali content shall be submitted for consent with notification of the change.

j) Minimising the Risk by Using Cementitious material Containing less than 0.6% Reactive Alkali

The requirements of Subsection (b) will be met by Subsection (k) provided that the contribution of alkalis from other sources does not exceed 0.2 kg/m3 (see Subsections and (u)). Where alkalis exceed 0.2 kg/m3 the requirements of Subsections (l) to (o) shall apply.

k) The cementitious material shall be Portland cement complying with Indian Standard and shall have additionally a certified maximum acid soluble alkali content not exceeding 0.6%.

l) The Contractor shall provide on request weekly certificates which name the source of the cement and confirm compliance with the Specification.

Minimising the Risk by Limiting the ReactiveAlkali content of the concrete to 3.0 kg/m3. The requirements of Subsection (c) will be met provided that Subsections (m), (n) and are satisfied.

m) The reactive alkali content of the concrete contributed by the Portland cement to the concrete shall be calculated from:

Portland cement

$$A = \frac{C \times}{\frac{a}{100}},$$

Where,

A = reactive alkali content of the concrete to the nearest 0.1 (kg/m3) C = target mean Portland cement content of the concrete (kg/m3)

a = certified average acid soluble alkali content of the Portland cement (%).

n) Where reactive alkalis in excess of 0.2kg/m^3 are contributed to the concrete from sources other than the cementitious material the limit of 3.0 kg/m^3 from the cementitious material shall be reduced by the total amount so contributed.

The reactive alkali contributed by sodium chloride contamination of aggregates shall be calculated from:

$$H = 0.76x \frac{(NFxMF)+(NCxMC)}{100} \text{ (kg/m3)}$$

Where H = equivalent alkali contribution made to the concrete by the sodium chloride

NF = chloride ion content of the fine aggregate as a percentage by mass of dry aggregates and measured according to BS 812: Part 4

MF = fine aggregate content (kg/m3)

NC = chloride ion content of the coarse aggregate as a percentage by mass of dry aggregate and measured according to BS 812: Part 4: 1976 (now in draft as Part 117)

MC = coarse aggregate content (kg/m3).

The factor 0.76 is obtained from a consideration of the composition of sea water.

The chloride ion content of aggregate sources containing 0.01% of chloride ion by mass or more shall be determined weekly in accordance with BS 812 or another approved method. When the chloride ion level is less than 0.01% it shall be regarded as nil.

o) The Contractor shall provide certificates on request confirming compliance with the Specification and stating:

i. The target mean cementitious material content of the concrete.

ii. The names of the works manufacturing the cement.

iii. A weekly report of the cement alkali determinations in accordance with Subsection (f).

iv. The certified average acid soluble alkali content of the Portland cement.

p) Minimising the Risk by Using Selected Aggregates

Fine and coarse aggregate material shall comply with the requirements of IS:383 (and/or AASHTO Standard Specifications M6 and M80 respectively) to be taken out to conform to 512(2).

q) Water

r) Water for use in the manufacture of concrete shall be obtained from a public utility undertaking supply or from a source approved by Engineer and shall be of potable quality, and comply with the requirement of IS:456 and or BS 3148

s) Where a potable mains supply is not available the Contractor shall obtain confirmation of the quality and reliability of the proposed source from the appropriate water authority and shall thereafter seek consent from the Engineer to use the proposed source.

t) Water other than from a public utility undertaking supply shall be sampled at a frequency to be determined by the Engineer and tested in accordance with the relevant provisions of IS:3025 or BS 3148. The sodium oxide and potassium oxide content shall be declared and expressed as equivalent Na_2O and shall be taken into account when calculating the total reactive alkali content of the concrete mix.

u) Admixtures and Pigments

Admixtures and pigments shall comply with the requirements of IS 9103 and IS:6925 or BS 5075 and BS 1014. The manufacturer's declared equivalent acid soluble alkali content and the dosage rate of any admixture or pigment to be incorporated shall be included with details of all concrete mixes submitted for consent.

v) The alkali content of admixtures shall be taken into account when determining the total equivalent alkali content of the concrete mix.

w) Microsilica (silica fume) shall be used in 5% by the weight of cement and shall not exceed 15% by the weight of cement.

12 Storage of Materials

12.1 General

a. Handling and storage of all material shall be as per IS 4082.

b. All materials shall be stored at proper places to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work. The storage space shall also permit easy inspection, removal and restoring of the materials. All such materials even though stored in approved storage places, will be subjected to acceptance test prior to their immediate use.

c. The procedures to be adopted for transportation and storage of the materials shall obtain prior approval from the Engineer.

12.2 Cement

a. Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and watertight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used, it shall be ensured that their capacity is adequate to cater to the requirement at Site and they are cleaned at least once every 3 months. Cement older than 3 months from the date of manufacture shall not be used.

b. Each consignment shall be stored separately so that it may be readily identified and inspected, and cement shall be used in the sequence in which it is delivered at Site. Any consignment or part of a consignment of cement which had deteriorated of any sort during storage, shall not be used in the Works and shall be removed from the Site by the Contractor, without adding any costs to the Employer.

c. The Contractor shall prepare and maintain proper records on site regarding delivery, handling, storage and use of cement. These records shall be available for inspection by the Engineer at all times.

d. The Contractor shall make a monthly return to the Engineer on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

12.3 Aggregates

a. Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard and well drained. If necessary, the ground shall be covered with 50 mm plank. Each size of aggregate shall be stored separately. Aggregate shall be stored in such a way that segregation of sizes is prevented and contamination with fine sand other undesirable material is avoided.

b. In the case of fine aggregates, these shall be delivered at the mixing site in not less than 8 hours before use and shall be tested by the Contractor and approved by the Engineer.

c. Coarse aggregates, unless otherwise agreed by the Engineer in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more). Aggregates placed directly on the ground shall be used from the stockpile above 30 cm of the ground. Aggregates within 30 cm of the ground shall be cleaned, and then only the clean aggregates will be permitted to be used.

13 Design Mix Concrete

13.1 General

a. For all items of concrete, only design mix shall be used. Prior to the commencement of construction, the Contractor shall design the mix and submit the proportions of materials, including admixtures to be used to the Engineer for obtaining approval. Suitable water reducing admixtures or super-plasticizing admixtures shall be used for achieving desired workability and strength of the concrete only after obtaining prior approval from the Engineer. No extra payment shall be made for such admixtures.

b. Mix design shall conform to the provisions under IRS: CBC (Cl. 5.5 and 8.7) and IS 10262.

c. Drying shrinkage of concrete shall be 0.03% or less. Drying shrinkage of concrete shall be tested in accordance with IS 1199.

d. When non-bleeding high flow concrete is used, it shall be confirmed that no bleeding occurs under Concrete Bleeding Test specified in IS 9103. The Contractor shall submit the test results to the Engineer prior to the commencement of concrete works for obtaining approval.

e. Mix design, once approved, must not be altered without obtaining prior approval of the Engineer. However, if the Contractor anticipates any change in quality and/or change in source of future supply of materials than that used for earlier mix design, the

Contractor shall inform the Engineer well in advance and bring fresh samples sufficiently in advance, to carry out fresh trial mixes.

f. The total chloride content of all constituents of concrete in mix shall be limited to 0.43 kg/m3 for reinforced concrete works and prestressed concrete works as per IS:14959.

13.2 Workability of Concrete

a. The mix shall have the consistency which allows proper placement and consolidation in the required position. It shall be ensured that uniform consistency is maintained.

b. Workability of concrete shall conform to the provisions of IRS: CBC(Cl.5.3).

13.3 Durability of Concrete

a. Maximum water cement ratio for design mix shall conform to IRS: CBC(Clause5.4.3) as follows:

Plain Concrete	Reinforced Concrete
0.45	0.40

b. Minimum grade of concrete shall conform to IRS: CBC(Clause5.4.4) as follows:

Plain Concrete	Reinforced Concrete
M-20	M-35

c. Maximum and minimum permissible cementitious material shall conform to IRS: CBC (Clause5.4.5) as follows:

Minimum(kg/cum)		Max
Plain Concrete	Reinforced Concrete	
250	350	500

13.4 Trial Mixes

a. The Contractor is entirely responsible for the design of the concrete mixes. However, the design shall have approval from the Engineer. At least 8 weeks before commencing any concreting in the Works, the Contractor shall make trial mixes using samples of coarse aggregates, sand, water, super plasticiser and cement, typical of those to be used in the Works, and which have been tested in an approved laboratory. A clean dry mixer shall be used, and the first batch shall be discarded.

b. The mix shall be designed to produce the grade of concrete having the required workability, durability and a characteristic strength not less than appropriate value given in IRS: CBC (CL. 5.1, 5.3 & 5.4). Trial mixes shall be prepared under full-scale site conditions and tested in accordance with IS 10262.

c. Whenever there is a significant change in the quality of any of the ingredients for concrete, the Engineer, at his discretion, may order the carrying out of fresh trial mixes. All costs for trial mixes and tests shall be borne by the Contractor's and held to be included in the rates quoted in the priced Bill of Quantities.

d. Before commencing the Works, the Contractor shall submit full details of the preliminary trial mixes and tests to the Engineer for approval.

13.5 Size of Coarse Aggregate

The nominal size of coarse aggregates for concrete shall be as per the Drawings. The proportions of the various individual size of aggregates shall be so adjusted that the grading produces densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

13.6 Mixing Concrete

13.6.1 General

a. Production and control of concrete shall conform to IRS: CBC(Cl.5.6).

b. Concrete shall be mixed in an automatic batching and mixing plant as per this Technical Specifications. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location that shall be selected considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer. Unless permitted by the Engineer, all concrete shall be produced in computerised automatic weigh batching plant having printing facilities to printout records of each batch and installed at the Site.

c. Mixingshallbecontinuedtillmaterialsareuniformlydistributedandauniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement.

d. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed by the Engineer, the first batch of concrete from the mixer shall contain only two thirds of the normal quantity of coarse aggregate for cleaning purpose only, and the same shall not be used for concreting purpose. Mixing plant shall be thoroughly cleaned before changing from one type of mix to another.

13.6.2 Batching on site

a. Batching of concrete shall conform to the provision of IRS: CBC (Cl. 5.6.2) and IS 4925.

b. All weighing and measuring equipment shall be tested and calibrated as per IS 4926.The results of these tests and calibration shall be submitted to the Engineer.

c. Addition of water to compensate for slump loss shall not be resorted to nor shall the design maximum water content and maximum water-cement ratio be exceeded. If permitted by the Engineer, additional dose of retarder shall be used to compensate

the loss of slump at the Contractor's cost. Re-tempering water shall not be allowed to be added to mixed batches to obtain desired slump.

13.6.3 Ready Mixed Concrete

The Contractor can use RMC, if approved by the Engineer. The source batching plant of RMC shall not change during the course of work. If RMC is used, it shall conform to the provisions laid down in IRS: CBC (CL. 5.7).

a. Transporting, Placing and Compaction of Concrete

Transporting, placing, compacting and curing of concrete shall be in accordance with IRS: CBC(Cl.8), IS 456 and IS 5892.

i. Transporting

1 The method of transporting and placing concrete shall have approval from the Engineer. Transportation of concrete shall conform to IRS: CBC (Cl. 8.1, 5.7), if not in contravention to the following provisions.

- The mix shall be transported by agitating transit mixers, buckets, pumps etc. or asper approval by the Engineer, without causing segregation and loss of cement slurry and without altering its desired properties with respect to water content, water cement ratio, slump, air content, cohesion and homogeneity.
- $1m^3$ of each mix shall be supplied to Site before it is required in the Works to enable the Contractor to carry out workability tests. Under no circumstances shall extra water be added to the concrete after the original mixing is completed.

ii. Pumping

2 Pumping of concrete shall conform to IRS: CBC (Cl.8.9), if not in contravention to the following provisions.

- The type of concrete pump, the diameter of transporting pipe, the route of piping etc. shall be determined considering the pumpability of the concrete to obtain the required quality of concrete after pumping.
- The type and the number of concrete pumps shall be determined in consideration of the pumping pressure, the discharge amount, the pumping rate per hour, the environmental conditions of construction site etc.
- Prior to pumping design mix concrete, pumping of mortar with the same proportion as of design mix concrete shall be done to prevent loss of mortar in pump due to adherence.
- The mortar pumped prior to the concrete pumping shall not discharge into the formwork.

iii. Placing

a) Placing General

- Placing of concrete shall conform to the provisions laid down in IRS: CBC(Cl.8.2).
- Prior to concreting, detailed planning on the placing system, the arrangement and the number of pumping cars, the position of the inlet for concrete pump, lighting equipment and arrangements for power supply, the sequence and rate of placing, time interval between concrete lifts etc. shall be specified in the Method Statement and the same shall be submitted to the Engineer for approval. Due allowance shall be made to secure enough clear spacing of reinforcement bars which enables concrete to flow through the spaces between reinforcement bars.
- Concrete shall be transported by means which prevent contamination (by dust, rain etc.) segregation or loss of ingredients, and shall be transported and placed without delay.
- Concrete shall be placed directly in its final position without segregation or displacement of the reinforcement, embedded items and formwork. Concrete shall not be placed in water, except as specified. Concrete shall not be dropped through a height greater than 1.5 metres..
- All formwork shall be thoroughly cleaned to remove debris etc. before concreting. In addition, the Engineer shall inspect that there is no debris etc. in the formwork before concrete is cast. It shall be examined that there is no abnormality in the formwork and falsework before and during concreting.
- No concrete shall be placed in any part of the structure until approval of the Engineer has been obtained. If concreting did not commence within 24 hours of issuance of approval, then it shall be obtained again from the Engineer. Concreting then shall proceed continuously over the area between the construction joints.
- Except where otherwise agreed by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 300 mm.
- Concrete when delivered in the works shall be maintained at a temperature of not more than 35°C as far as possible.
- Clear spacing between reinforcements shall be secured adequately and lighting equipment shall be arranged adequately in order to visually check the position of inlet of the concrete pump and the filling situation of the concrete during concreting works. In addition, suitable measures

shall be taken so that the reinforcement bars do not move and clear cover to the reinforcement bars does not change.

- The clear cover shall be uniform and as per the Drawings. Concrete cover blocks used shall be of the same concrete mix as the member and shall contain the binding wire to secure it to the reinforcement. All ends of binding wire shall be carefully turned inside so that they do not project out of concrete cover. Reinforcement bars shall be adequately secured by chairs/ties/hangers so that it maintains its position during casting and vibrating concrete. Ends of the wires used to tie bars shall be bent into the member.
- In case of concreting the horizontal member immediately after the concreting of vertical member is finished, the horizontal member shall be cast after any settlement of concrete of the vertical member ceases in order to prevent settling cracks.
- If bleeding water is present on the surface of concrete during concreting, the bleeding water shall be removed before the following concrete is placed.
- The Contractor shall ensure that the place where concreting is to be done shall be free of water.

b) Extent of Pours

For piers and pier heads, portal columns the concreting is to be carried out in single stage i.e. in first stage concreting will be from kicker to just below pier head bottom and second stage of concreting will be pier head including shear key and cross girder (in station zone stages as given in drawings for all heights by using tremie/ pumps at the rate not more than 1.5m / hr or as approved by the Engineer.

Floors, roofs and ground slabs shall be placed in a sequence of pours to the approval of the Designer and the consent of the Engineer.

If the use of slip-forms or paving trains is permitted, these limits may be revised. The sequence of pours shall be arranged to minimise thermal and shrinkage strains.

c) Placing Equipment

Concrete shall generally be placed without segregation by pumping or bottom-opening skips. If chutes are used their slopes shall not cause segregation and spouts or baffles shall be provided.

d) Time for Placing

Concrete and mortar must be placed and compacted within 30 minutes of water being added to the mix or otherwise included via damp aggregates,

unless admixtures are in use. Partially-set concrete shall not be used in the Works.

e) Continuity of Placing

Placing in each section of work shall be continuous between construction joints. The Contractor shall make provision for standby equipment. If the placing of concrete is delayed due to breakdown then the Contractor shall erect vertical stop-ends and form a construction joint or remove the concrete already placed and restart after repair of the breakdown, as directed.

f) Placing in Inclement Weather

Placing shall not take place in the open during storms or heavy rains. If such conditions are likely to occur the Contractor shall provide protection for the materials, plant and formwork so that work may proceed. If strong winds are prevalent protection from driving rain and dust shall be provided.

g) Placing in High Temperature and Low Temperature

The temperature of concrete shall not exceed 32° nor below 5°C or the temperature stated in the table of Mixes whichever is the lower at the time of placing concrete. Also the maximum concrete temperature after placing shall not exceed temperature 50oC or 30oC above the concrete temperature at the time of placing whichever is the lower.

"Concrete in hot countries" published by FIP congress at New Delhi 1986 shall be complied with. The procedures the Contractor wishes to employ shall be subject to the Engineer consent

The Contractor shall supply suitable maximum/minimum thermometers and record the shade and sun temperatures at locations where concrete is being placed. Recommendations for cold weather concrete can be had from IS: 7861 (Part 2).

h) Placing at Night

If consent has been given for placing at night or in dark interiors, adequate lighting shall be provided where mixing, transportation and placing are in progress.

i) Placing Under Water

Underwater concrete shall be placed with minimum disturbance of the water. Running water and wave wash shall be controlled. The specified concrete grade shall be used and the mix design shall provide for good flowing ability.

Tremie pipes, bottom-dump skips or other approved placing equipment shall be used. Segregation shall be avoided.

Placing shall be commenced in approved sections and continued to completion.

The tremie pipe shall be buried in the concrete for at least 1.5m and the pipe must not be emptied until the pour is complete. If a bottom-dump skip is used, the contents shall be covered by canvas or similar before lowering into the water. The doors shall be opened when the skip is resting on the bottom with no tension in the support cable, and the skip shall be lifted gradually so that the concrete flows out steadily.

j) Preparation Before Placing

Before placing concrete for reinforced work on the ground, the formation shall be compacted as specified and a screed of blinding concrete shall be applied to form a surface for construction.

Before placing concrete on or against rock, masonry, brickwork or old concrete, loose material shall be removed and the surface washed down; water seepage shall be stopped or channelled away from the work.

iv. Compaction

3 Compaction of concrete shall conform to the provisions laid down in IRS: CBC (Cl.8.3).

- Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns. Concrete shall be compacted before setting commences and shall not be subsequently disturbed.

4 Internal (needle) and surface (screed board) vibrators of approved make shall be used for compaction of concrete. Internal vibrators shall be inserted in an orderly manner. The distance between insertions shall be 500 mm or less. The vibrator shall be made to operate at a regular pattern of spacing. The effective radii of action will overlap approximately half a radius to ensure complete compaction.

5 Internal vibrators shall be used for compaction of concrete in foundations, columns, buttresses arch section, slabs etc, and if required surface vibrators shall also be used. Depending on the thickness of layer to be compacted, 25 mm, 40 mm, 60 mm and 75 mm dia internal vibrators will be used. The concrete shall be compacted by use of appropriate diameter vibrator by holding the vibrator in position until:

a) Air bubbles cease to come to surface.

b) Resumption of steady frequency of vibrator after the initial short period of drop in the frequency, when the vibrator is first inserted.

- The vibration shall be done till the tone of the vibrated concrete becomes uniform. To achieve an even and dense surface free of aggregate pockets, vibration shall be

supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic.

c) Flattened, glistening surface, with coarse aggregates particles blended into it appears on the surface.

d) Use of curing compounds may be permitted with specific approval of Engineer.

6 After the compaction is completed, the vibrator should be withdrawn slowly from the concrete so that concrete can flow in to the space previously occupied by the vibrator. To avoid segregation during vibration the vibrator shall not be dragged through the concrete nor used to spread the concrete. The vibrator shall be made to penetrate, into the layer of fresh concrete below if any for a depth of about 150mm. The vibrator shall be made to operate at a regular pattern of spacing. The effective radii of action will overlap approximately half a radius to ensure complete compaction.

a) To secure even and dense surfaces free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic.

b) A sufficient number of spare vibrators shall be kept readily accessible to the place of deposition of concrete to assure adequate vibration in case of breakdown of those in use.

c) Form vibrators whenever used shall be clamped to the sides of formwork and shall not be fixed more than 450 mm above the base of the new formwork and concrete shall be filled not higher than 230mm above the vibrator. The formwork must be made specially strong and watertight where this type of vibrator is used.

Care must be taken to guard against over vibration especially where the workability of the concrete mix is high since this will encourage segregation of the concrete.

a) Plain concrete in foundations shall be placed in direct contact with the bottom of the excavation, the concrete being deposited in such a manner as not to be mixed with the earth. Plain concrete also shall be vibrated to achieve full compaction.

7 Construction Joints

a. Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown in the drawings, unless otherwise approved by the Engineer.

b. Where provision of construction joint is unavoidable, the location, direction and construction method of construction joint shall be determined in consideration of the structural strength, durability and appearance of the structure. Concreting shall be carried out continuously upto the construction joints. Construction joints shall conform to the provisions laid down in IRS: CBC (Cl. 8.5 and Annexure - B). The Contractor shall submit Method Statement on the construction joints which shall be subject to the consent of the Engineer prior to concreting works.

c. The location of the construction joints and their arrangement, procedure for surface preparation of construction joint and sequence of concreting shall be subject to the consent of the Engineer. Construction joints shall be located at locations where the shear force is minimum. The joints shall be provided in a direction perpendicular to the member axis. Sequencing of concrete placement shall be organized in such a way that cold joints are totally eliminated. Properly designed reinforcement shall be provided prior to casting of the next lift for transfer of full tensile stress across the joints.

8 Expansion, Contraction and Movement Joints

Expansion, contraction and other movement joints shall be incorporated in the works as shown on the Drawings.

Where shown on the Drawings approved, expansion joint fillers shall be supplied and installed. Filler material shall be stored flat on a dry surface adequately protected from rain or moisture in such a way that the material does not deteriorate. Filler material which has been damaged or has started to deteriorate shall not be incorporated in the works.

Movement joints shall be sealed with an approved sealant applied in strict accordance with the manufacturer's instructions to the dimensions shown on the Drawings. The surface of the concrete to which the sealant is to adhere shall be straight and cleaned of all filler material, dirt, oil, grease and other matter. The sealant shall be applied by methods recommended by the manufacturer so that the sealant is brought flush to the surface of structure and a smooth surface is achieved. Excess material and spillage shall be properly cleaned off and removed.

Dowel bars shall be installed and cast in across the movement joint where shown on the Drawings. The bars shall be straight with clean cut ends of the diameters and lengths as

shown on the Drawings or in the Schedules. Cutting and cleaning of the dowel bars shall comply with the requirements of this Specification.

The bars shall be firmly supported in the positions shown on the Drawings so that they remain accurately parallel and are not displaced during the casting of the concrete in the first part of the structure. After the concrete has hardened and the formwork removed, the projecting ends shall be cleaned of all concrete spillage and painted with two coats of an approved bituminous paint and caps shall be fitted to the free ends of the bars. Dowel bar end caps shall

be of cardboard or other material, of correct diameter for the dowel bar and of sufficient length to allow the specified movement of the two adjacent concrete structures. They shall be manufactured expressly for this purpose by an approved manufacturer.

The Contractor shall take care to protect the projecting ends of dowel bars from bending or other damage prior to concreting the succeeding bay. The bituminous paint shall be applied as soon as practicable, but end caps shall not be fitted until immediately prior to the succeeding concreting operations.

9 Bolts, Inserts and Openings

All fixing blocks, brackets, built in bolts, holes, chases, etc., shall be accurately set out and formed and carefully sealed prior to the concrete being placed. No cutting away of concrete for any of these items shall be done without the permission of the Engineer-in- Charge.

Bolts and other inserts to be cast into the concrete shall be securely fixed to the formwork in such a way that they are not displaced during the concreting operations, and that there is no loss of materials from the wet concrete through holes in the formwork.

Unless shown otherwise on the Drawings or the Engineer has given consent, reinforcement shall be locally moved so that the minimum specified cover is maintained at the locations of inserts, holes, chases, etc.

Temporary plugs shall be removed and the threads of cast in bolts shall be proved to be free and shall be greased before handing over any part of the Works. Construction joints in all concrete work shall be made as directed by the Engineer. Where vertical joints are required, these shall be shuttered as directed and not allowed to take the natural slope of the concrete.

10 Concreting under Special Conditions

Concreting under special conditions shall conform to the provisions laid down in IRS: CBC.

10.1 Concreting in Extreme Weather Conditions

Concreting in extreme weather conditions shall conform to the provisions laid down in IRS: CBC (Cl. 8.6.1).

10.2 Concreting under Water

a. Concreting underwater and seawater shall conform to the provisions laid down in IRS: CBC (Cl. 8.6.2 and Cl. 8.6.3), where not contravening to the following provisions.

b. When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used shall obtain approval of the Engineer, prior to the commencement of any work.

c. Concrete shall not be placed in water having a temperature below 5°C. The temperature of the concrete, when deposited, shall neither be less than 16 °C nor more than 35°C.

d. All underwater concreting shall be carried out by tremie method as described in IRS: CBC (CL.8.6.2) only, using tremie of appropriate diameter. The number and spacing of the tremie shall be worked out to ensure proper concreting. The tremie concreting when started shall continue without interruption for the full height of the member being concreted. The concrete production and placement equipment shall be adequate to enable the underwater concrete to be completed uninterrupted within the stipulated time. Necessary standby equipment shall be available for emergency situation.

e. In case of withdrawal of tremie out of the concrete either accidentally or to remove a choke in the tremie with the approval of the Engineer, the tremie shall be reintroduced in the following manner to prevent impregnation of laitance or scum lying on top of the concrete deposited in the bore. The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing the laitance or scum. The tremie shall be pushed further in steps making fresh concrete sweep away the laitance or scum in its way. When tremie is buried in for about 0.60m to1.0 m, concreting may be resumed.

f. In case of concreting through tremie or such pipes which are subsequently withdrawn, the concrete shall be placed in adequate quantity to ensure that during withdrawal of the tube, a sufficient head of concrete is maintained to prevent the inflow of soil and water or bentonite slurry.

g. No concrete shall be allowed to come in contact with seawater within 72 hours of casting.

10.3 Concreting under Aggressive Soils and Water

Concreting under aggressive soils and water shall conform to the provisions laid down in IRS: CBC (Cl. 8.6.4).

11 Curing of Concrete

11.1 General

a. Concreting operations shall not commence until adequate arrangements for curing of concrete have been made by the Contractor. Curing and protection of concrete shall commence after the concrete has set hard enough, to with stand stresses due to curing work and does not get damaged, in order to protect it from the following:

i. Premature drying out, particularly by solar radiation and wind.

ii. High internal thermal gradients.

iii. Leaching out by rain and flowing water.

iv. Rapid cooling during the first few days after placing.

v. Low temperature.

vi. Vibration and impact which may disrupt the concrete and interfere with its bond to there in forcement.

b. Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

11.2 Curing Procedure

a. In order to ensure the required quality of concrete in terms of parametres such as strength, durability and permeability, concrete shall be cured adequately, being kept at a temperature and humidity necessary to be hardened within a certain period of time after concreting, in order not to be affected by harmful effects such as low or high temperature, rapid temperature change, drying, loading and impact loading.

b. Curing of concrete shall conform to the provisions laid down in IRS: CBC (Cl.8.4). Approved curing compounds shall be used in lieu of moist curing, with the approval of the Engineer, particularly for all vertical faces and inaccessible areas, conforming to IRS: CBC (CL. 8.4.2).

11.3 Finishing

Finishing shall conform to the provisions laid down in IRS: CBC (Cl. 6.2.4), if not in contravention to the following provisions:

a. Immediately after removal of forms, exposed bars or bolt, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes shall be filled with cement mortar of dry pack consistency.

b. All construction and expansion joints in the completed work shall be left carefully tooled and free of any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

c. The finished surfaces of concrete after removal of form work shall be such that no touching up is required. All finsca used by form joints, if any, shall be ground using electric sur face grinder.

d. Immediate Lyon removal of forms, before any defects are rectified, the concrete work shall be examined by the Engineer.

i. Exposed concrete surfaces shall be smooth and even, originally as stripped, without any finishing or rendering. The Contractor shall exercise special care and supervision of formwork and concreting to ensure that the cast members are made true to their sizes, shapes and positions. The work that has sagged or contains honeycombing to an extent which is detrimental to structural safety or architectural appearance shall be rejected. Honeycombed parts of the concrete, including other surface defects in the concrete, shall be removed by the Contractor as per the methods which do not affect the strength of adjoining concrete and as per approval of the Engineer. In the final finish, no honeycombing is allowed.

ii. Part of defective concrete thus removed shall be recast using fresh concrete of same grade, as approved by the Engineer without any additional cost. For that purpose, the Contractor shall prepare a comprehensive work procedure and obtain approval of the Engineer. No additional payment shall be made for repair of the concrete. The Contractor shall ensure that no air bubbles are formed on the exposed surface. Concrete pouring sequence, vibration methodology etc. shall be planned to ensure that air bubbles are not formed. All materials, sizes and layouts of formwork including the locations for their joints shall have approval from the Engineer prior to the commencement of the works.

iii. After the finishing works, cracks which occurred in the surface of concrete until the concrete starts to set shall be removed by refinishing or tamping.

e. The top face of a slab intended to be surfaced with other material shall be left with a spaded finish.

f. Chemical surface retarders, if approved by the Engineer, shall be used to produce an exposed aggregate finish, provided the Contractor demonstrates that the durability of the concrete surface is not reduced.

12 Inspection, Tests and Standards of Acceptance

a. The Contractor shall submit test certificates from the manufacturer or supplier of materials along with each batch of material(s) delivered to site.

b. The Contractor shall set up a field laboratory with necessary equipment for testing of all materials & finished products to be used in the construction. The laboratory must have riffle divider of adequate capacity as approved by the Engineer for preparation of lab sample for sieve analysis of aggregates.

c. The test in go falls the materials shall be carried out by the Contractor at the field laboratory or from the laboratory approved by the Engineer and in the presence of the Engineer. The Contractor shall make all the necessary arrangements and bear the entire cost for the same.

d. Tests which cannot be carried out in the field laboratory shall be done at the Contractor's cost at any recognized laboratory or testing establishments having NABL certification and duly approved by the Engineer.

e. If materials are brought from abroad, the cost of sampling or testing, whether in India or abroad, shall be borne by the Contractor. The Contractor shall provide and maintain on site, until the works are completed, at all times the equipment and staff required for carrying out these tests.

13 Quality Control of Concrete

a. The Contractor shall carry out the following tests for concrete, at the site of placing, and ensure that they comply with appropriate provisions of Indian and/or other standards, as may be applicable:

i. Slump test for concrete: The frequency of slump test shall be as follows:

ii. Case 1: If the site of placing is at the same area as the concrete plant installed, then it shall be conducted once in every hour, as per IS1199(Cl. 5.0) and IS7320.

iii. Case2: Other than Case1, it shall be conducted once in each delivery of transit mixer, asper IS 1199 (CL. 5.0) and IS 7320.

iv. Tolerance for slump shall conform to IS4926(Cl.6.2.1).

v. Compressive and Flexural strength of concrete: Sampling, Strength tests and Acceptance criteria of concrete shall conform to IRS: CBC (Cl. 8.7) according to the type of concrete grade.

vi. Chloride ion content test: It shall be conducted as per IS:15949 once a week. Chloride ion content shall be0.43kg/m3 or less.

vii. Relative Density and pH value of plasticizer (if used): The test shall conform to IS9103(Cl.7.1, Cl.10.0, Annexure-E) and the tolerances shall be as specified in IS9103(Cl. 9.0, Table-2).

viii. Temperature of concrete shall be verified once in each slump test.

ix. The concrete shall be verified for permeability and the test procedure along with tolerances shall conform to IRS: CBC (Cl. 5.4.2, Appendix - G). The frequency of test shall depend up on the change in design mix or change in source of material used in the work. However, the Engineer shall select random batches of concrete for examination at his discretion, and any time during concreting. Sampling shall generally be done at the point of discharge from the mixer and at placing point. The concrete shall pass the permeability test if it is properly compacted and the water penetration depth in the broken core is less than 25mm.

b. It is the complete responsibility of the Contractor to redesign the concrete mixes as per the standard methods that have been approved and to produce there in forced concrete conforming to the specifications. The Contractor shall have competent staff to carry out this work.

c. After the completion of the quality control checks of concrete, the Contractor shall immediately report the test results to the Engineer by submitting quality control records of the concrete.

14 Inspection of Concrete

a. Inspection shall be carried out by the Contractor, after the removal of form work. Also, additional inspection shall be carried out if instructed by the Engineer.

b. Inspection shall be carried out as per approval of the Engineer for the Method Statement, incorporating the test procedures specified in Table below:

Table: Inspection of Concrete Surface Condition

Measurement Items	Inspection Method	Place to be Inspected

Presence or absence of honey combing, cold joint, discoloration, and cracking	Visual inspection at point-blank range	All parts
Presence or absence of cavity, float, and cracking	Hammering Inspection	As per approved Method Statement, and as directed by the Engineer
Clear cover to the outermost reinforcement	Non-destructive test using a probe	

c. Additional non-destructive tests (NDT) on the hardened concrete in the structure as a whole or any finished part of the structure where necessary, or directed by the Engineer, shall be carried out as laid down in IRS: CBC (CL. 18.3).

d. The Contractor shall report the inspection results along with the location to the Engineer immediately after the inspection. The forms generated from the probes during the inspection shall be attached to the records.

e. If defects such as deleterious cracking, spalling, deformation and finishing defects or damages caused by the Contractor are noticed from the results of the inspection, no repair work shall be commenced without prior permission taken from the Engineer.

f. Counter measures against the defects shall be subject to approval of the Engineer. In this case, "repair work" refers to all actions which make alterations to the surface of concrete after the removal of formwork (including plastering etc.). If repair work is required, the Contract or shall submit Method Statement on the repair work and shall obtain approval of the Engineer for the same, prior to the commencement of repair work. During the repair work, the Contractor shall record about the work, and shall report to the Engineer on the results of the work immediately after the repair work has finished.

g. If cracks develop in concrete construction, which in the opinion of the Engineer may be detrimental to the strength of the construction, the Contractor, at his own cost, shall dismantle the construction, carry away the debris, replace the construction and carry out all consequential work thereto.

h. If any cracks develop in the concrete construction, which in the opinion of the Engineer, are not detrimental to the stability of the construction, the Engineer shall decide whether such cracks are required to be grouted. The Contractor shall grout such cracks as decided by the Engineer with polymer cement grout of approved quality at his own risk and cost.

i. External crack width shall be restricted to 0.2mm or less on all concrete structures, unless otherwise specified in the Drawings/Design.

ADDITIONAL TESTS FOR CONCRETE:

As frequently as the Engineer may require, additional testing shall be carried out for

concreting in addition to mandatory test specified in CPWD specifications 1996/2002 / relevant IS Code / MOST/MORTH Specifications.

15 Non-Destructive tests for concrete

1. Ultrasonic pulse velocity test

2. Rebound hammer test

In order to determine the following properties of concrete, non-destructive tests for concrete (ultra-sonic pulse velocity test and rebound hammer test) in accordance with IS 13311(Part 1 and Part 2) shall be carried out.

i. the homogeneity of concrete
ii. the presence of cracks, voids and other imperfections
iii. changes in the structure of the concrete which may occur with time
iv. the quality of the concrete in relation to the standard requirements
v. the quality of one element of concrete in relation to the another, and
vi. the values of dynamic elastic modulus of the concrete

In view of the limitations of each method of the non destructive testing of the concrete, it is essential that the results of tests obtained by one method should be complemented by other tests and each method should be adopted very carefully.

16 Permeability test for Concrete:

The concrete will be verified for permeability by the following procedure and shall confirm to IS: 3085-1965 – „Permeability of Cement Mortar & Concrete", Section 1717.7..5 of MOST Specification and DIN 1048.

a) The Engineer shall select random batches of concrete for examination at his discretion and sampling will generally be done at the point of discharge from the mixer and at placing point.

b) From the batches thus selected two concrete cylinders shall be made in accordance DIN 1048.

c) All cylinders shall be made, cured, stored, transported and tested in accordance with clause 1717.7..5 of MOST Specifications. The tests shall be carried out in a laboratory approved by the Engineer.

d) At least two cylinders shall be made on each day"s concreting until 60 cylinders have been made for each grade of concrete. The cylinders will be tested as per the procedure, given in Clause (e) next.

e) Test Procedure:

The permeability of concrete will be verified by the following procedure:

i. Prepare a cylindrical test specimen 150 mm dia and 160mm high.

ii. After 28 days of curing, test specimen will be fitted in a machine such that the specimen can be placed in water under pressure up to 7 bars. The typical machine shall be similar to one shown in Appendix 1700/II of MOST.

iii. At first a pressure of one bar is applied for 48 hours, followed by 3 bars for 24 hours and 7 bars for next 24 hours.

iv. After the passage of the above period, the specimen is taken out and split in the middle by compression applied on two round bars on opposite sides above and below.

v. The water penetration in the broken core is measured with scale and the depth of penetration assessed in mm (max permissible limit 25 mm).

f) Acceptability Criteria:

The concrete shall pass the permeability test if it is properly compacted and is not considered permeable when tested as per DIN, and the water penetration in the broken core is less than 25mm.

No extra payment shall be made for this test and cost of the same will be included in his rate for concrete work.

17 Chlorides in Concrete

The levels of equivalent acid-soluble chlorides as NaCl (Cl x 1.65 = NaCl) in the constituents of concrete as stated elsewhere are indicative and are subject to the over- riding limits for the mixes.

The total estimated content as a percentage by weight of the cement in the mix shall not exceed the following limits: -

(a) For reinforced concrete

0.5% if made with Ordinary Portland Cement (OPC)

0.1% if made with Sulphate Resistant Portland Cement (SRPC)

(b) For mass concrete 1.0% if made with OPC

0.2% if made with SRPC

The Contractor shall test the constituents of the concrete to establish these contents as provided for elsewhere in this Specification.

In addition, regular tests to BS 1881: Part 6 for chloride content shall be made on the hardened concrete. The following values are acceptable: -

(i) For reinforced concrete made with OPC

95% of the test results less than 0.40% NaCl by weight of cement and no result greater than 0.50% NaCl by weight of cement.

(ii) For reinforced concrete made with SRPC

95% of the test results less than 0.1% NaCl by weight of cement and no result greater than 0.14% NaCl by weight of cement.

(iii) For mass concrete made with OPC

95% of the test results less than 1.0% NaCl by weight of cement, and no result greater than 1.30% NaCl by weight of cement.

(iv) For mass concrete made with SRPC

95% of the test results less than 0.2% NaCl by weight of cement and no result greater than 0.25% NaCl by weight of cement.

In the event that the SRPC used contains a proportion by weight of tri-calcium aluminate which approaches 4 - 8%, then consent may be sought for an appropriate adjustment of the relevant chloride content limits.

18 Sulphates in Concrete

The level of acid-soluble sulphates (SO_3) in the mix shall be no greater than: Coarse aggregate 0.4% by weight

Fine aggregate 0.4% by weight Water500 mg/l

The total estimated sulphate content (SO_3) of the mix including that present in the cement shall not exceed 3.7% by weight of cement in the mix.

In addition, regular tests to BS 1881: Part 6 shall be made on the hardened concrete to determine the total sulphate content, which shall not exceed 4% by weight of cement in the mix.

Permissible Level of Chloride and Sulphates

The permissible level of chlorides and sulphates quoted in the above Subsections shall not be considered as mean values for the whole of the Works, but shall apply to any concrete.

Concrete for water-retaining structures shall in addition be as per IS: 3370.

19 CRACKS:

If cracks, which in the opinion of the Engineer may be detrimental to the

strength of the construction, develop in concrete construction, the Contractor at his own expense shall test the structure as specified in "Loading Tests" of these Specifications.

If under such test loads the cracks develop further, the Contractor shall dismantle the construction, carry away the debris, replace the construction and carry out all consequential work thereto.

If any cracks develop in the concrete construction, which in the opinion of the Engineer- in-Charge, are not detrimental to the stability of the construction, the Contractor at his own expense shall grout the cracks with neat cement grout or with other composition as directed by Engineer-in-Charge and also at his own expense and risk shall make good to the satisfaction of the Engineer all other works such as plaster, moulding, surface finish, which in the opinion of the Engineer have suffered damage either in appearance or stability owing to such cracks. The Engineer's decision as to the extent of the liability of the Contractor in the above matter shall be final and binding.

External crack width shall be as per IRS: CBC with latest addendums.

20 DEFECTIVE CONCRETE:

Should any concrete be found honeycombed or in any way defective, such concrete shall be cut out partially or wholly by the Contractor and made good at his own expense. If Engineer feels that repaired structure will not be having same strength or shape or uniformity with other exposed surface as original desired structure / original structure, the same shall be rejected by Engineer and required to be dismantled and disposed by contractor at his own cost as instructed by Engineer-in-Charge. Decision of the Engineer shall be final and binding in this regard.

21 EXPOSED FACES, HOLES AND FIXTURES:

On no account shall concrete surfaces be patched or covered up or damaged concrete rectified or replaced until the Engineer or his representative has inspected the works and issued written instructions for rectification. Failure to observe this procedure will render that portion of the works liable to rejection.

Holes for foundation or other bolts or for any other purposes shall be moulded, and steel angles, holdfasts or other fixtures shall be embedded, according to the drawing or as instructed by the Engineer.

22 FINISHES:

Unless otherwise instructed the face of exposed concrete placed against formwork shall be rubbed down immediately on removal of the formwork to remove irregularities. The face of concrete for which formwork is not provided other than slabs shall be smoothed with a float to give a finish equal to that of the rubbed down face, where formwork is provided. The top face of a slab which is not intended to be covered with other materials shall be leveled and floated to a smooth finish at the levels or falls shown on the drawings or

as directed. The floating shall be done so as not to bring an excess of mortar to the surface of the concrete. The top face of a slab intended to be surfaced with other material shall be left with a spaded finish. Faces of concrete intended to be plastered shall be roughened by approved means to form key.

23 CONCRETE FOR FLOORING ON GRADE:

Concrete for flooring on grade shall be placed in alternate bays not exceeding more than 4m x 6m or as specified in the drawings including forming the joints or adjacent bays. The stiff mix shall be thoroughly vibrated and finished to receive the floor finish.

24 GROUTING OF BASE PLATES & BOLT HOLES:

a) Mixing :

Dry grout should be mixed in a mechanical mixer: the conventional 200/400-litre capacity concrete mixer can be used to mix four bags of dry grout; alternatively, paddle type mortar mixers can be used. The quantity of grout to be mixed at one time should not exceed that amount which can be placed in approximately 10 to 15 minutes.

b) Batching :

Batching of grout by fraction of a bag is not allowed. The quantity of mixing water should be the minimum commensurate with workability, compaction, and filling of the grout in all corners and crevices. Mixing should be done for a minimum of three minutes to obtain a fluid grout of uniform consistency.

c) Cleaning and preparation of the surface :

The base concrete should be clean and strong, and its surface should be properly hacked; all dust should be removed suction or compressed air. The surface should be thoroughly wetted with water for several hours. Before the grout is poured, all free water should be removed and the flat surfaces coated with a thin cement slurry.

d) Restraint :

Heavy back-up blocks of timber or concrete should be fixed on all sided of the base plate to prevent escape of the grout, when poured through the openings provided in the base plate. Adequate restraint must be ensured on all the sides for a period of 7 days to obtain effective expansion and shrinkage compensation.

e) Curing :

The grout should not dry out where external restraint is provided in the form of form- work, the top opening and all stray openings should be covered with wet sack for at least 7 days.

f) Placing and Compaction :

The grout should be placed quickly and continuously either through the holes in the base plates or from one side only to ensure complete filling without entrapment of air. Grout should be properly spread and compacted by rodding. Excessive vibration should be avoided.

Below the bed plates the grout should be compacted using long pieces of doubled-over flexible steel strapping or chains. The forward and backward movement of the strap or chain will assist in the flow of the grout into place. Steps must be taken to keep the grout in full contact with the underside of the bedplate until the grout sets; maintaining a small head of fresh grout in the forms.

g) Shrinkage Compensated Grout:

Shrinkage compensated grout or non-shrinkable grout of Associated Cement Companies Limited or any other approved manufacturer (Fosroc, Roff, Sikka) should be used. The batching shall be as per the manufacturer's specifications, other procedures being as above.

25 Tolerance

Tolerances for the finished concrete structures shall be as specified in the Contract.

26 Precast Concrete

26.1 Manufacture Off-Site

a. Casting of members shall not begin until a NONO has been given by the Engineer to the shop drawings, required computation and method of manufacture.

b. When the drawings and method of manufacture have been noticed, no changes shall be made without NONO from the Engineer

c. The Contract or shall in form the Engineer in advance of the date of commencement of manufacture and casting of each type of member.

d. Concrete reinforcement and work man ship shall be asper IS: 456.

e. A copy of all cube test results for the precast concrete works shall be sent to the Engineer as soon as these are available.

f. No members to which the tests relate shall be dispatched to the Site until the tests have been satisfactorily completed and noticed by the Engineer.

26.2 Forms

The design and fabrication of the forms and false work as well as their construction shall be the responsibility of the Contractor. Forms shall be inspected prior to authorizing casting operations. Details shown on the Drawings shall be built into the forms. Worn, damaged, or otherwise unacceptable forms shall be repaired be forecasting of any member is authorized. The forms may be made either of steel or of plywood. If the Contractor elects to use plywood forms, it shall be high quality plywood, 19mm minimum thickness marine

grade subject to NONO from the Engineer. Forms shall be structurally adequate to support the members within permissible tolerances. Forms shall be coated with a noticed form-release agent prior to use. Anchor devices may be cast into the concrete for later use in supporting forms provided the arrangement has Notice from the Engineer. Bottom/base should be true level without offsets and kinks of designed supports and sutterings over required PCC base with proper drainage arrangement for proper working and curing.

26.3 Curing

a) Steam curing with approved methodology can be adopted if required, for precast components subject to the approval of Engineer-in-Charge. No extra payment will be made for adopting steam curing. Before concrete products are subjected to any accelerated method of curing, the cement to be used shall be tested in accordance with accepted standards (relevant IS codes) especially for soundness, setting time and suitability for steam curing. In the case of elements manufactured by accelerated curing methods, concrete admixtures to reduce the water content may be allowed to be as permitted by applicable codes of practice subject to the approval of the Engineer-in- Charge. The normal aeration agents used to increase the workability of concrete shall not be allowed. The steam curing of concrete products shall take place under hoods, under chambers or in tunnels. Use of insulated tarpaulin may be permitted. The steam shall have a uniform quality throughout the length of the member. The precast elements shall be stacked with sufficient clearance between each other and the bounding enclosure, so as to allow proper circulation of steam. The surrounding walls, the top cover and the floor of steam curing chamber or tunnel or hood shall be so designed as not to allow more than 1 kcal/m2/h/ deg C. The inside face of the steam curing chamber, tunnel or hood shall have a damp-proof layer to maintain the humidity of steam. Moreover, proper slope shall be given to the floor and the roof to allow the condensed water to be easily drained away. At first, when steam is let into the curing chambers, the air inside shall be allowed to go out through openings provided in the hoods or side walls which shall be closed soon after moist steam is seen jetting out. Preferably, steam should be let in at the top of the chamber through perforated pipelines to allow uniform entry of steam throughout the chamber. In no case shall steam impinge directly on concrete products. The fresh concrete in the moulds shall be allowed to get the initial set before allowing the concrete to come into contact with steam. The regular heating up of fresh concrete product from 20 °C to 35 °C shall start only after a waiting period ranging from 2 to 5 hours depending on the setting time of cement used. The second stage in steam curing process shall be to heat up the concrete elements, moulds and the surroundings in the chamber. The air-space around the member shall be heated up to a temperature maximum to 70°C at a gradual rate, not faster than 10° per hour. This process shall continue 1

1/2 to 2 1/2 hours depending upon the outside temperature. The third stage of steam curing shall be to maintain the uniform temperature and pressure for a duration depending upon thickness of the section. This may vary from 3 to 5 1/2 hours. The fourth stage of steam curing shall be the gradual cooling down of concrete products and surroundings in the chamber and normalization of the pressure to bring it at par with the outside air. The maximum cooling rate, which is dependent on the thickness of the member, shall not exceed 30° per hour. In all these cases, the difference between the temperature of the concrete product and the outside temperature shall not be more than 60°C for concrete up to M 30 and 75°C for concrete greater than M 45. In the case of light weight concrete, the difference in temperature shall not be more than 60°C for concrete less than M 25. For concrete greater than M 50, the temperature differences may go up to 75°C. After the steam curing is completed, the elements shall be further water cured for about 3 to 7 days.

The curing shall be carried out as per approved Method Statement.

26.4 Storage

When members are stored, they shall be firmly supported only at the points specified.

a. The accumulation of trapped water and deleterious matter in the units shall be prevented.

b. Care shall be taken to avoid rust staining and efflorescence.

c. The area intended for the storage of pre-cast units should be surfaced in such a way that no unequal settlement can occur.

d. To prevent deformation of slender units, they should be provided with supports at fairly close intervals and should also be safeguarded against tilting. Lifting and hand ling positions should conform to the Engineer's directions and drawings. In addition, location and orientation marks shall be put on the members, as and where necessary.

26.5 Handling and Transport

a. Members shall be lifted or supported only at points specified or otherwise given a NONO from the Engineer and shall be handled and placed without impact.

b. The Contractor shall define the method of lifting, the type of equipment and transport to be used, and the minimum age of the members to be handled and shall submit to obtain approval from the Engineer.

26.6 Protection

At all stages of construction, pre-cast concrete units and other concrete associated there with shall be properly protected to prevent damage to permanently exposed concrete surfaces, specially arises and decorative features.

27 Falsework and Formwork

27.1 General

Falsework and formwork shall conform to the provisions laid down in IRS: CBC (CL. 6.1 to6.4) and IRC: 87, if not in contravention to the following provisions.

a. Falsework shall be designed in consideration of appropriate raising (camber) against sinking and deformation due to the weight of the concrete during construction and after completion. Furthermore, the Contractor shall submit the plan of the camber to the Engineer prior to the commencement of works for obtaining approval.

b. Ties shall not be welded to the reinforcement bars. Clear cover to the end of the ties shall not be less than 25mm. Filling of tie locations after removal of form work shall be carried out with dry pack cement mortar.

c. The form work shall be of steel plates of proper thickness to give good finish.

27.2 Design of Formwork

a. The Contractor shall submit the design and drawing of complete formwork (i.e. the forms as well as their supports) to the Engineer, before any erection work commences. If proprietary system of formwork is used, the Contractor shall furnish detailed information to the Engineer. However, the Contractor shall be entirely responsible for the adequacy and safety for formwork.

b. The foundation of all supports shall be designed to suit the bearing capacity of soil to support the designed loads without settlement.

c. The Contractor shall prepare detailed shop drawing showing the arrangement of form work for structural members including shoring system, horizontal and diagonal bracing system, details of foundation etc. The sizes of individual members shall be as per the design calculations.

27.3 Finishing of Formwork

a. Finishing shall conform to IRS: CBC (Cl.6.2.4 and Cl.6.2.5).

b. Formwork shall be made to produce a finished concrete true to shape, line, levels and dimensions.

c. Chamfers shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, bevelled edges and mouldings shall be made in the form work itself, conforming to the Drawings.

27.4 Cleaning and Treatment of Forms

Cleaning and treatment of forms shall conform to IRS: CBC(Cl.6.3).

27.5 Specialized Formwork

a. Specialized form work shall conform to the provisions laid down in IRC:87(Cl.10).

b. Specialized formwork may be required in the case of slip formwork, underwater concreting etc. Such specialized formwork shall be designed and detailed by

competent agencies and a set of complete working drawings and installation instructions shall be supplied to the Engineer. The site personnel shall be trained in the erection and dismantling as well as operation of such specialized formwork. If proprietary equipment is used, the supplier shall supply drawings, details, installation instructions, etc. in the form of manuals along with the formwork. Where specialized formwork is used, close coordination with the design of permanent structure is necessary.

c. For slip form, the rate of slipping the formwork shall be designed for each individual case considering various parametres including the grade of concrete, concrete strength, concrete temperature, ambient temperature and concreted mixtures.

d. In order to verify the time and sequence of striking or removal of specialized formwork, routine field tests for the consistency of concrete and strength development are mandatory and shall be carried out before adoption.

27.6 Inspection of Formwork

a. The Contractor shall inspect the formwork and shall submit inspection results by "Formwork Assembly Inspection Record" prior to concreting works.

"Formwork Assembly Inspection Record" describes the results of verification of inspection results of the formwork with design documents in which the shape and dimensions of the formwork, clear cover to the outermost reinforcement, effective height etc. are verified. The proposed form of "Formwork Assembly Inspection Record" shall be submitted by the Contractor for approval of the Engineer.

b. Concreting shall not be allowed unless approved for the formwork by the Engineer.

27.7 Stripping and Removal of Formwork

a. Stripping time shall conform to the provisions laid down in IRS: CBC(Cl.6.4).

b. The scheme for removal of formwork (i.e., de-shuttering and decentring) shall be planned in advance and submitted to the Engineer for scrutiny and approval. No form work or any part there of shall be removed without prior approval of the Engineer.

c. The formwork shall be removed in such a manner that does not cause any damage to concrete. Centring shall be gradually and uniformly lowered in such a manner that it permits the concrete to take stresses due to its own weight uniformly and gradually to avoid any shock or vibration.

d. Where the rear ere- entrant angles in the concrete sections, the formwork shall be removed at these sections as soon as possible after the concrete has set to avoid cracking due to shrinkage of concrete.

27.8 Reuse of Forms

The Contractor shall not be permitted reuse of timber facing formwork brought new on the works for more than 5 times for exposed concrete formwork and 8 times for ordinary formwork.5 or 8 uses shall be permitted only if forms are properly cared for, stored and repaired after each use. Use of different quality boards or the use of old and new boards in

the same form work shall not be allowed. If any other type of special or proprietary form work is used, the number of times they can be used shall begiven a NONO from the Engineer.

Appendix – OCS 2

REINFORCEMENT STEEL

1 General

a) High strength deformed steel bars for concrete reinforcement used in the works shall be Fe 500D TMT, conforming to IS 1786 and manufactured by SAIL/TATA STEEL /JSW STEEL/RINL/IISCO. No rerolled steel shall be used. The Contractor shall produce copy of original challan or voucher as a proof of having purchased the steel reinforcement from manufacturers or their authorized distributors having approval of the Engineer. Reinforcement steel shall be stored as per IS 4082.

b) Any steel specified for reinforcement shall conform in every respect to the latest relevant Indian Standard Specifications and shall be of tested quality under the ISI Certification Scheme.

c) All reinforcement work shall be executed in conformity with the drawings supplied and instructions given by the Engineer and shall generally be carried out in accordance with the relevant Indian Standard Specifications IS: 2502- Bending and Fixing of Bars for Concrete Reinforcement.

d) No work shall be commenced without the Engineer's approval for reinforcement bar bending schedule. The reinforcement bars shall be bent to conform to the dimensions and shape shown in the Drawings in a manner that will not damage the parent material. Bars shall be bent cold. Any reinforcement, which is bent, shall not be re-bent. However, when it is unavoidable to re-bend the reinforcement, the same shall have approval from the Engineer.

e) Placement of reinforcement shall conform to the provisions laid down in IRS: CBC (Cl. 7.1.3). Cover and spacing of steel shall be uniform and as specified in the specifications and as shown in the Drawings.

f) Uncoated reinforcement steel shall be protected from rusting or chloride contamination. Reinforcements shall be free of rust, mortar, loose mill scale, grease, oil or paint.

g) Procurement of reinforcement steel shall be so phased by the Contractor that the storage period before its actual use in the works is limited to the bare minimum as directed by the Engineer.

2 Inspection and Testing

a) Manufacturer's test certificate shall be submitted for each lot of supply brought at the Site by the Contractor. Physical tests shall conform to IS1387, IS1599, IS1608 and IS1786. Independent test on quality of steel from each lot shall be carried out as per IRS: CBC (Cl.4.5.2).

b) The frequency of tests on reinforcement consignments delivered at site from one manufacturer should be as per IS 1786:2008 (Cl. 11.1).

c) Specimens required for three tensile tests for each of the different size of bar for each consignment delivered shall be sampled and tested by the Contractor before use at Site.

Test results shall be duly supported by graph with respect to stress and strain. If first test of three test samples does not give the specified results, two additional tests shall be carried out. Both retests shall conform to the requirements as specified in IS 1786. The steel shall be rejected otherwise.

d) Reinforcement steel shall be inspected prior to the commencement of works and assembly on Site. Defective, brittle, excessively rusted or burnt bar shall be discarded. Cracked ends of bars shall be cut out. All reinforcement steel shall be free of loose small scales, rust and coats of paint, oil, mud etc.

e) The Contractor shall inspect the reinforcement works and submit inspection results by "Reinforcement Assembly Inspection Record". "Reinforcement Assembly Inspection Record" describes the results of verification of inspection results of the reinforcement work with the Drawing in which the diameter, number and length of the reinforcements, position of splices and joints, position and interval of the bent reinforcement bar, type and disposition of cover blocks are verified. The form of "Reinforcement Assembly Inspection Record" shall be proposed by the Contractor for approval of the Engineer.

f) The Contractor shall obtain approval of the Engineer for reinforcement work prior to the commencement of concrete work.

3 Tolerances and Criteria

a) Unless otherwise specified by the engineer, reinforcement shall be placed within the following tolerances:

i. For overall depth 200 mm or less : ±10mm

ii. For overall depth more than 200mm : ±15mm

The cover shall, in no case, be reduced by more than one third of specified cover or 5mm whichever is less.

4 Lapping and Joints

a) Lapped Splices: No splicing of bars shall be permitted without prior approval of the Engineer. Lengths of splice, wherever required, shall be as indicated on the drawings and approved by the Engineer. Lapped splices shall be staggered and located at points along the span where stresses are low.

b) Mechanical Joints: No jointing of bars shall generally be permitted. Mechanical joints may be permitted after prior approval of the Employer. It shall conform to the requirements of IRS CBC. Mechanical couplers of threaded type with enlargement at connection by cold forging may be used at appropriate locations after prior approval of the Engineer.

c) Welded Joints : Not permitted

5 Coupler Specifications

a) Introduction

Only cold-forged, parallel threaded mechanical coupler system are recommended. All mechanical couplers shall be of Type 2 (or Class H as

specified in IS-16172) and should be simple to install and which can be confirmed by quick visual inspection to have been correctly installed and to have achieved the required full strength connection. Any other types of mechanical coupler systems are not permitted provided the same meet the specification indicated below.

The couplers shall be of standard parallel thread type. Ends of the reinforcement bars, which are to be joined, shall be enlarged by cold forging/upsetting, threaded in such a way that root thread diameter is not lesser than the parent bar to be joined. The coupler shall be of TYPE – II and qualified/Certified as per UK CARES, IS code 16172:2014, ACI 318, ASME, Section III, and Div.2, Caltrans.

Couplers installed shall be strictly in accordance with the manufacturer's recommendations. Couplers shall preferably be located away from high stress zones in the various structural elements and shall be staggered.

All the couplers should be manufactured in a factory which is ISO 9001:2008 (or higher revision) certified for "Manufacturing of Mechanical Steel Rebar Couplers & Accessories" and also be certified for "Site Management of Threading & Processing of Rebar including Sales and Distribution". All the couplers shall undergo quality checks on uniformity of threads, dimensional accuracy etc. Each coupler shall be clearly stamped indicating batch number and diameter. This number shall be traceable to the original cast. The relevant material mill certificate shall be submitted with supply of a particular lot. The certificate shall give salient material properties. The coupler manufacturer shall operate at least an ISO 9000 approved quality assurance programme or equivalent for the manufacture of couplers.

a) Threading of ends of the reinforcing bars:

This threading activity shall preferably be done at Site. The various stages involved in threading are as given below:

i. Cutting (Rebar End Préparation):

The ends of reinforcement bars shall be cut by mechanical means to get a perfect plain and surface perpendicular to the axis of the bar.

ii. Cold forging & threading:

After cutting the ends of the bar shall be enlarged by cold forging such that the area of cross section after threading shall not be less than the area of cross section of the parent bar. The length of cold forging shall be adequate for proposed thread length as per manufacturer's design. Threading shall be done preferably on threading machine. The threads shall be square parallel type to suit the couplers. The thread length and depth shall be as per manufacturer's design. After threading is completed, the threaded length of the bars shall be protected by providing plastic end caps

before taking the bars out of the shop.

b) Quality control in making of threads:

Double forging of bars is not permitted. In case of improper cold forging the forged of the bar shall be square cut and fresh cold forging shall be undertaken. 100% threading at threaded rebars shall be checked with 'go' and "no go' gauges for the correctness of the thread profile on the rebar. A proper record for same shall be maintained at site.

c) Qualification tests

The coupler shall be qualified as per IS code 16172:2014, ACI 318, ASME - Section III, and Div.2, Caltrans and must have conducted & qualified for the following tests :

i. Static tensile test

Mechanical connections shall be tested for all reinforcing rebar sizes. For each rebar size, a minimum of three connections (3 joints + 1 Parent bar) in each load direction shall be tested in accordance with ASTM A370 test method to meet code requirement. A tensile test on an unsliced specimen from the same bar used for the spliced specimens shall be performed to establish actual tensile strength. The tensile strength of an individual splice system shall not be less than the 125% of the specified minimum yield strength (fy of rebar) of the spliced bar.

ii. Cyclic tension and compression test

Mechanical connections shall be tested in all reinforcing rebar sizes. For each rebar size, a minimum of three connections shall be tested for cyclic tension & compression test. Each specimen shall withstand cycles of stress variation of the specified minimum yield strength of the reinforcing bar. The test should be carried out as per the table mentioned below:

Loading Stages and Cycles per stage for cyclic load test

Stage	Tension	Compression	Cycles
1	0.95 fy	0.5 fy	20cycles
2	2 εy	0.5 fy	4cycles
3	5 εy	0.5 fy	4cycles

Note:

fy is specified yield strength of the reinforcing bar.

εy is the strength of reinforcing bar at actual yield stress

iii. Cyclic tensile test

Mechanical connections shall be tested in all reinforcing rebar sizes. For each rebar size, a minimum of three connections shall be tested for low cyclic tensile test. Each specimen shall withstand 100 cycles of stress variation from 5% to 90% of the specified minimum yield strength (fy) of the reinforcing bar. One cycle is defined as an increase from the lower load to the higher load & return.

iv. Low cycle fatigue test (for 10,000 cycles)

Fatigue test shall be conducted on splice sample from +173 Mpa to -173 Mpa for 10,000 cycles. A sine wave form @ 0.5 Hz shall be followed for bar dia 36 mm & above and

0.35 Hz shall be followed for bar dia less than 36 mm. Test shall be conducted confirming to IS 16172:2014 & Caltrans specifications. Past certificates for low cycle fatigue test shall be accepted; however these should not be more than 3 years old.

v. High cycle fatigue test (for 2,000,000 cycles)

In high cycle fatigue test, the test specimen is subjected to an axial tensile load which varies cyclically according to the sinusoidal wave form of constant frequency in the elastic range, as accordance with IS-16172. Past certificates for high cycle fatigue test shall be accepted; however these should not be more than 3 years old.

vi. Slip test

Slip Test Shall be performed on each diameter coupler specimen as per ASTM A 370 section 10. Test shall be conducted confirming to IS 16172:2014 & Caltrans specifications. Total slip shall not exceed the max value of 0.1 mm. Refer table below for more details:

Bar diameter	**TOTAL Slip (μ m)**
8 mm to 20 mm	250
25 mm to 28 mm	350
32 mm to 40 mm	450
45 mm	600

56 mm	750

vii. **Proof loading test**

Every cold-forged, threaded bar end shall undergo a proof load test prior to leaving system supplier's workshop. Every threaded bar must be subjected to proof load testing to a minimum test loading of 75% of the characteristic strength (theoretical fy). The system supplier shall essentially install a proof load tester equipment within its threading workshop premises and ensure to test each and every threaded bar. A positive indication shall be marked on the rebar to indicate that this operation has been carried out.

INSTALLATION OF COUPLERS IN THE FIELD:

The installation of couplers in the field, for joining reinforcing bars shall be undertaken by trained manpower and as per manufacturer's instructions. Threads of both the couplers and the bars shall be thoroughly cleaned just before installation.Where couplers are cast-in the concrete, but connection is not to be completed immediately, the couplers shall be internally greased and plastic capped to a protection detail acceptable to the engineer. This cap shall be removed only when next bar is to be attached, then the same to be cleaned before joining the next bar.

The contractor shall arrange for a suitably qualified manufacturer's representative experienced in mechanically connecting reinforcement to be present at site before the start of work for initial training of personnel, and also to demonstrate the equipment and techniques as necessary. The threading workshop is to be fully supervised by the manufacturer's representative.

The contractor shall submit to the Engineer-in-Charge, for his acceptance a method statement for mechanically connecting the reinforcement and for the installation and verification in the field. This shall take into account any special requirements for horizontal, vertical and inclined couplers and shall include a rectification procedure, if the connection is incorrectly made. It shall also cover the correct methodology for handling of tools and equipment for mechanical connection on site. The following information shall also be included:

1. Requirements for cleanliness
2. Equipment for threading bars
3. Method of locking the connections on both rebars
4. Method of verification of final rebars alignment and coupler integrity

Each coupler shall be visually examined prior to use to ensure the absence of rust and of any foreign material on the inside surface. All completed couplers shall be inspected and verified in accordance with the approved QAP. The Contractor shall ensure the acceptance of the Engineer for a procedure for documenting the inspection of the couplers. The contractor shall retain inspection records and shall submit copies to the Engineer-in-Charge within 7 days. The Couplers that do not meet the acceptance shall be completely removed and the bars re-connected as required.

6 BAR BENDING AND BAR BENDING SCHEDULE:

All bars will be carefully and accurately bent by approved means in accordance with IS: 2502, and relevant drawings. It shall be ensured that depth of crank is correct as per the bar cutting and bending schedule and bent bars are not straightened for use in any manner that will injure the material.

Prior to starting bar bending work, the Contractor shall prepare bar bending schedule from the structural drawings supplied to him and get the same approved by Engineer. Any discrepancies and inaccuracies found by the Contractor in the drawings shall be immediately reported to the Engineer whose interpretation and decision there to, shall be accepted.

7 SPACING, SUPPORTING AND CLEANING:

a) All reinforcement shall be placed and maintained in the positions shown on the drawings to be prepared by contractor.

b) The Contractor shall provide approved types of supports for maintaining the bars in position and ensuring required spacing and correct cover of concrete to the reinforcement as specified on the drawings. Cover blocks of required shape and size, Chairs and spacer bars shall be used to ensure accurate positioning of reinforcement. Spacers or chairs should be placed at a maximum spacing of 1m and closer spacing sometime be necessary. Cover blocks of approved proprietary should be pre-packaged free flowing mortars (Conbextra HF of Fosroc or equivalent). Cover blocks of concrete (not sand cement mortar) should be of the same strength as that of the surrounding concrete and properly compacted and vibrated on a vibrating table. They shall be cured for a minimum period of 14days before they are used in the works. The cost of cover block shall be deemed to have been included in the rates.

   Cover blocks shall be firmly placed at appropriate intervals to maintain specified concrete cover to the reinforcement. The number of cover blocks to be provided shall generally be about 4 pieces per m2 for the bottom surface of the member and about 2-4 pieces per m2 for the side surface of the member. Cover blocks shall be made of concrete or mortar having quality equal to or higher than that of the parent concrete.

c) Bars must be cleaned, before concreting commences, of all scale, rust or

partially set concrete which may have been deposited there during placing of previous lift of concrete. On no account shall the bars be oiled or painted nor shall mould oil used on the formwork be allowed to come in contact with the bars. Cement wash to bars will not be permitted.

d) Only Fe500D TMT bars complying to IS:1786 shall be provided.

e) 1.6mm dia. G.I. wire shall be used for binding reinforcement.

Annexure OCS-3

FABRICATION AND ERECTION OF STEEL BRIDGE GIRDER

1. General

Fabrication of all Steel Bridge Girders shall be performed within the plants and by fabricators having the experience, knowledge, trained manpower, quality controls, equipment and other facilities required to produce the steel work to desired quality. The plants where fabrication works are proposed to be performed shall be duly approved by RDSO for fabrication of OWG. The tenderer shall submit complete details of the plants along with his tender for the approval of the Engineer. Inspection and passing of fabricated elements/girder shall be done by the RDSO/Employer as per codal provisions and specifications.

Fabrication and erection of steel girder bridges shall be in accordance with IRS fabrication specifications (B1).

2. Material

a. Steel: Mild steel for welded/riveted bridge girders subjected to railway loading shall conform to IS: 2062, Quality "B0" Grade Designation E250, fully killed and with normalizing/ normalizing rolling/ controlled rolling. Plates less than 12mm thick need not be with normalizing/ normalizing rolling/ controlled rolling.

b. In case Rolled Steel Standard Sections conforming to IS:2062 Quality "B0" are not available in market, Engineer may permit use of steel conforming to IS:2062 Quality "BR" / "A" on case to case basis.

c. Steel shall have smooth and uniform finish and shall be free from rolling defects such as cracks, flaws, seams, laps, imperfect edges etc. and other defects such as loose mill scale, rust, pitting, or other defects affecting its strength and durability.

d. High Strength Friction Grip (HSFG) bolt assembly including Direct Tension Indicator (DTI)washers shall conform to EN: 14399 series.

e. All the steel sections used in the fabrication must have mill test certificate clearly indicating the specification to which the steel conforms and whether steel is killed and normalized.

f. The materials, on receipt, shall be carefully unloaded, examined for defects, checked, sorted, and stacked securely on a level bed, out of danger from flood or tide and out of contact with water or ground moisture. They will be supported on timber or concrete plinths so that they do not touch the ground.

3. Fabrication of steel work

a. The records of fabrication shall be maintained in the registers as per the formats given in the Appendix I of IRS: B1-2001.

b. The greatest accuracy shall be observed in the design, fabrication, and erection of every part of the work to ensure that all parts will fit accurately together on erection. Components of all the spans shall be fully interchangeable. Same jigs and assembly

fixtures duly approved shall be used. The tolerances in manufacture shall be in accordance with as shown in Appendix II of IRS: B1-2001.

c. There should be level, finished concrete floor of sufficient dimensions in the fabrication yard, on which the fabricator will precisely set out the outline of the structure (to full scale) as per drawings for the purpose of preparing templates. Only steel tapes shall be used for all measurements, and they will be held tight and level on the floor while measuring or marking.

d. Steel tapes used for marking out the work shall be calibrated at a temperature of 20° C.

e. The templates throughout the work shall be of steel bushed.

i. Flattening and straightening

All steel materials, plates, bars and rolled sections shall have straight edges, flat surfaces and be free from twist. If necessary, they shall be cold straightened or flattened by pressure before being worked or assembled unless they are required to be of curvilinear form.

ii. Cutting of Steel

Cutting of steel for fabrication may be done by shearing, sawing, or by gas using mechanically controlled torch/torches. All flame cut edges shall be ground to obtain reasonably clean square and true edges. Plasma-arc cutting method may also be employed. This process offers less heat input causing less distortion.

iii. Making of Holes

Marking and drilling of holes in members shall preferably be done with the use of templates/jigs. All bolt holes in members built up by welding shall be drilled after welding.

Holes for turned bolts, should be 1mm under drilled in shop and should be reamed at site to suit the diameter of turned bolt. Jigs shall be periodically checked for tolerances from master plates.

iv. Welding

Welded construction work shall be carried out generally in accordance with the provisions of Indian Railway Standard Welded Bridge Code and subject to further specifications as given below:

i. All welds shall be done by submerged arc welding process in shop. Site welding should not be undertaken except in special circumstances with the approval of the Engineer. Site welding should be confined to connections having low stresses, secondary members, bracings etc.

ii. Suitable jigs and fixtures shall be used to avoid distortion during welding. Components which are mass fabricated in the shop should be proved in master templates.

iii. Class and size of electrode for welding shall conform to IRS Specification M-28. For fabrication of steel bridge girder following class of electrode shall be used-

Class of Electrode as per IRS Specification No. M.28.66	**Type of work to be welded**	**I.S. Specification No.**	**Code (as per IS:815-66)**
Class B2 (Moderately high ductility)	For welding of mild steel to IS:2062-1962 (Fusion welding quality) or equivalent, for service conditions where the weldment is rigid and subjected to relatively high dynamic stresses	814-63	M 110 to M 997-H, J, K or P.

Brand and make of electrode on approved list of M&C wing of RDSO should be used.

i. No welding operator shall be employed on the work until he has, in the presence of the Engineer, passed the appropriate tests laid down in relevant codes.

ii. All main butt welds shall have complete penetration and shall comply with the requirements of IRS Welded Bridge Code. They shall be made between prepared fusion faces. Where possible they shall be welded from both sides. The ends of the welds shall have full throat thickness. This shall be obtained on all main welds by the use of extension pieces adequately secured on either side of the main plates. Additional metal remaining after the removal of the extension pieces shall be removed by machining, or by other approved means and the ends and surfaces of the welds shall be smoothly finished.

iii. In the fabrication of built-up assemblies all butt welds in the component parts shall be complete before the final assembly.

iv. A record of butt welds shall be kept to enable it to be identified with the welders responsible for the work but material shall not be marked by hard stamping for this purpose.

The welding techniques and sequence, quality, size of electrodes, voltage and current required shall be as prescribed by manufacturers of the material and welding equipment. The Contractor shall submit full details of welding procedure in proforma given at Appendix V of IRS: B1-2001 for approval of the Engineer.

v. Welding of Stud Shear Connectors:

i. The welding of stud shear connectors shall be done by "DRAWN ARC STUD WELDING WITH CERAMIC FERRULE" technique. The shear stud and ceramic ferrules shall conform to type SD1/UF as per BS EN ISO 13918-2008.

ii. The stud and the surface to which studs are welded shall be free from scale, moisture, rust and other foreign material. The stud base shall not be painted, galvanized or cadmium plated prior to welding. Welding shall not be carried out when temperature is below 10 degrees Celsius or surface is wet or during periods of strong winds unless the work and the welder are adequately protected. The welds shall be visually free from cracks and shall be capable of developing at least the nominal ultimate strength of studs. The procedural trial for welding the stud shall be carried out when specified by the Engineer.

iii. Testing of Stud Shear Connectors:

(A) Appearance Test

1) The weld to a shear stud connector should form a complete collar around the shank and free from cracks, excessive splashes of weld material, free from injurious laps, fins, seams, twist, bends or other injurious defects.

2) Weld material should have a 'steel blue' appearance.

(B) Test to check the fixing of shear studs

1) Ring Test: Involves striking the side of the head of stud with a 2 kg hammer. A ringing tone achieved after striking indicates good fusion whereas dull tone indicates a lack of fusion (BS 5400-6) All studs shall be checked by Ring test.

2) Bend Test: Test requires the head of a stud to be displaced laterally by approximate 25% of its height using 6kg hammer.

* The weld should then be checked for sign of cracking or lack of fusion.

* Stud should not be bent as back as this is likely to damage the weld.

* The testing rate should be 1 in 50 (BS 5400-6).

vi. Making of Joints

i. Joints shall normally be made by filling not less than 50 per cent of holes with service bolts and barrel drifts in the ratio 4:1. Only barrel drifts shall be used in erection. Drifts may be used for drawing light members in position; but their use on heavy members shall be restricted to securing them in their correct position. Any error in the shop fabrication or deformation resulting from handling and transportation which prevents proper assembling and fitting up of parts shall be reported immediately to the Engineer. No reaming shall be undertaken without the written authority of the Engineer.

ii. The erection of OWG shall be done in accordance with Appendix III of IRS: B1-2001. However, if the Contractor desires to adopt any other method of

erection, they shall submit the scheme and obtain the approval of the Engineer. It shall be ensured that when in position, the girder has the camber as per drawing.

vii. High Strength Friction Grip (HSFG) bolting assembly

The HSFG bolting assembly shall conform to EN 14399 Series (High strength structural bolting assemblies for preloading):

- EN 14399-1:2015- General requirements.
- EN 14399-2:2015- Suitability for preloading.
- EN 14399-3:2015- System HR- Hexagonal bolt and nut assemblies.
- EN 14399-5:2015- Plain washers.
- EN 14399-6:2015- Plain chamfered washers.
- EN 14399-9:2009- Direct Tension Indicator for bolt and nut assembly.

HSFG bolting assemblies are very sensitive to differences in manufacture and lubrication. Therefore, complete HSFG bolting assembly (i.e. bolt, nut, washers & DTI) including galvanizing shall be procured from single manufacturer. Use of Direct Tension Indicator (DTI) washers shall be mandatory in the HSFG bolting assemblies.

Grade and size of bolts shall be as per the Drawings. The surface preparation, tightening procedures and other details for HSFG bolts shall be as per RDSO standard Drawing No. RDSO/B-11760/R1.

Table: Composition of high strength structural bolting assembly and its component marking

Type of bolting assembly		System HR	
General requirements		EN 14399-1	
Suitability for preloading		EN 14399-2 and, if any, additional testing specified in the product standard	
Bolt & Nut		EN 14399-3	
Marking	Bolt	HR8.8	HR10.9
	Nut	HR8 or HR10	HR10
Washers		EN 14399-5[a] or EN 14399-6	
Marking		H or HR[b]	
Direct tension indicator and nut face washer or bolt face washer		EN 14399-9	
Marking	Direct Tension Indicator	H8	H10
	Nut Face Washer	HN	
	Bolt Face Washer	HB	

[a] EN 14399–5 can only be used under the nut.
[b] At the choice of the manufacturer.

The bolt length shall be chosen such that after tightening the following requirements are met for bolt end protrusion beyond the nut face and the thread length:

a) the length of protrusion shall be at least the length of one thread pitch measured from the outer face of the nut to the end of bolt

b) at least four full threads (in addition to the thread run out) shall remain clear between the bearing surface of the nut and unthreaded part of the shank.

Holes for HSFG bolts- The holes shall be made by drilling only. The actual diameter of hole shall be 1.5 mm more than the bolt diameter for less than 25mm diameter bolts and 2mm more than nominal diameters of HSFG bolts for diameters 25mm and above.

Surface preparation of steel interface before providing HSFG bolts–Wherever property class 8.8 bolts are used these should be hot dip galvanized as per ISO: 10684(latest version). Property class 10.9 bolts should not be hot dip galvanized since this may cause hydrogen embrittlement. So these bolts should be coated with zinc flakes as per ISO: 10683 (latest version). However, depending on the site conditions, locations of these bolts in the structure and corrosion proneness, use of zinc flake spray coating as per ISO: 10683(latest version) can be adopted even for property class 8.8 bolts as well.

Installation of HSFG bolting assembly- Installation /tightening of preloaded bolting assemblies shall be carried out as per clause 8.3 & 8.5 of EN 1090-2 and clause 5.2 of EN 14399-9. The following steps shall be followed for tightening of bolts:

i. The holes shall be brought in alignment by using drifts etc. such that bolt threads are not damaged/enlarged during insertion of bolts.

ii. The members being joined shall be held in position by insertion of few HSFG bolts (tightened to first stage only i.e. snug tight condition).

iii. After the alignment/geometry of members is verified to be correct as per drawings, balance bolts shall be inserted and tightened upto first stage of tightening. The drifts inserted as above shall also be replaced by HSFG bolts one by one.

iv. After first stage of tightening, the joint shall be checked to see if the plies are in close contact and clearances are not exceeded.

v. Second stage tightening shall be done with torque wrench. Bolts shall be tightened until indentation on the DTI indicate full tightening. In order to minimize loosening of already tight bolts, tightening in both the stages shall be done starting from the stiffest part to free edges.

vi. 100% bolts shall be checked for proper tightening using feeler gauge of 0.4/0.25 mm.

vii. Fully tensioned bolt, opened for any reason whatsoever, shall be rejected and removed from the site of work along with washers, nut and DTI.

4. Bearing and Expansion Gear

All bearings and expansion gears shall be procured from a reputed and experienced manufacturer qualified to undertake precision fabrication of this type and shall be approved by the Engineer.

5. Trial Shop erection

Trial shop erection shall be done in accordance with Cl.614 of IRBM.

6. Field erection

Field erection shall be done in accordance with Cl.616 of IRBM.

7. **Erection in contractor's Works**

The whole of the work shall be completely interchangeable. First span (of each type) shall be temporarily erected complete at the Contractor's Works for inspection by the Inspecting Officer to test the accuracy of the templates. Further spans or part span assemblies built from parts selected at random by the Inspecting Officer shall be erected from time to time to check the accuracy of the work as the Inspecting Officer may require.

8. Track work for OWG:

Track work for open web girder bridge on H-beam sleepers shall be done as per IRPWM, relevant RDSO drawings and codal provisions.

9. Camber

In order to eliminate secondary stresses in a span under loaded condition, the nominal length (i.e. the lengths which will give no camber) of member shall be increased or decreased by the amount shown on the camber diagram supplied by the Employer. Frequent checks shall be made of the camber of girders during erection and care taken to see that the camber as per

drawing is obtained when the girder is completely assembled. When span is supported on ends and intermediate supports are removed the dead load camber shall be recorded and entered in bridge register. This will provide the reference to compare the camber checked during technical inspection to ascertain the loss of camber.

10. Test certificates & testing

All materials for the work shall pass Mechanical test, Charpy test, Chemical Analysis, etc. prescribed by the relevant IS specifications or such other equivalent specifications.

For all materials including HSFG bolts, the contractor shall furnish copies of test certificates from the manufacturers including proof sheets, mill test certificates, etc. showing that the materials have been tested in accordance with the requirements of various specifications and codal provisions.

If any further testing of materials is required by Engineer in respect of these and other items, it shall be arranged for by the contractor at a reputed laboratory/National test house as approved by Engineer. For this, nothing extra shall be payable.

Even satisfactory outcome of such tests or analysis shall in no way limit, dilute or interfere with the absolute right of the Engineer to reject the whole or part of such materials supplied, which in the judgement of the inspecting authority does not comply with the conditions of the contract. The decision of the Engineer in this regard shall be final, binding and conclusive for all purposes.

The Engineer shall be empowered, at his/her discretion to make or have made under the supervision, any of the tests specified in the specifications mentioned herein in addition to such other tests as he/she may consider necessary, at any time up to the completion of the contract and to such an extent as he/she may think necessary to determine the quality of all materials used therein. In doing so, he/she shall be at liberty under any reasonable procedure, he/she may think fit to select, identify, have cut-off and take possession of test pieces from the material either before, during or after its being worked up into the finished product.

The Engineer shall also be empowered to call for a duly authenticated series of mechanical tests to be obtained from the maker for this materials used in the work and to accept the same in lieu of other tests to the extent he/she deems fit. The Contractor shall supply the material for the test pieces and shall also prepare the test pieces necessary.

The test shall be carried out by the Contractor, for which Contractor shall provide all facilities including supply of labour and plant. Engineer may at his/her discretion direct the Contractor to despatch such tests pieces as he/she may require to the National Test House or elsewhere as he/she may think fit for such testing purposes. The Engineer may at his/her discretion, check test results obtained at Contractor's work by independent tests at National Test House.

The Engineer shall at all times be empowered to examine and check the working of the Contractor's plant before and after using it. Should the Contractor's plant be found, in the Engineer's opinion, unreliable, he/she is empowered to cancel any tests already carried out in this contract and have these tests carried out at any National Test House or elsewhere, as he/she may think fit.

11. Fabrication drawings

The contractor shall prepare detailed shop drawings including drawing office dispatch lists (DODL's) on the basis of design drawings supplied by Engineer in such size and in such details as may be specified by Engineer. The shop drawings shall be submitted to Engineer in triplicate.

No work of fabrication will be started without such approval being obtained. Contractor has to arrange the proof checking of the working fabrication drawings from the nominated Institution / Consultant. The cost will be borne by the contractor.

12. Painting

a. Fabricated steel work shall not be painted over except to the extent specified in para (b) until it has been inspected and passed by the Engineer or his representative and any defect, pointed out by him has been rectified.

b. All surfaces which shall be in permanent contact and any others which will not be accessible for painting later on shall be cleaned thoroughly and given one coat of Zinc Chrome Red Oxide Priming to IS 2074 or other approved composition in the prescribed number of coats immediately prior to assembly.

c. Steel girders (including all components) shall be provided with protective coating by metalizing with sprayed aluminum as given in the Appendix-VII of IRS: B1-2001, followed by painting as per painting schedule given below-

   i. One coat of etch primer to IS:5666

   ii. One coat of zinc chrome primer to IS: 104 with the additional proviso that zinc chrome to be used in the manufacture of primer shall conform to type 2 of IS:51.

   iii. Two coats of aluminum paint to IS: 2339 brushing or spraying as required. One coat shall be applied before the fabricated steel work leaves the shop. After the steel work is erected at site, the second finishing coat shall be applied after touching up the primer and the finishing coat if damaged in transit.

Annexure OCS-4

PRESTRESSING

1 GENERAL

The work shall be carried out in accordance with the drawing and these specifications or as approved by the Engineer.

Concrete and un-tensioned steel for the construction of prestressed concrete members shall conform to the requirements of respective sections so far as the requirements of these Sections apply and are not specifically modified by requirements set forth herein.

Contractor shall ensure that different components of prestressing such as jacks, bearing plates, wedges, anchorages, strands, and HDPE ducts etc. are compatible to each other and the same shall be exchanged in between all the suppliers to ensure the same.

2 MATERIALS

a. Sheathing

i. The sheathing ducts shall be of the spiral corrugated type. Unless otherwise specified, the material shall be Cold Rolled Cold Annealed (CRCA) Mild Steel conforming to IS: 513 intended for mechanical treatment and surface refining but not for quench hardening or tempering.

ii. The material shall normally be bright finished. However, where specified, as in case of use in aggressive environment, galvanized or lead-coated mild steel strips shall be used. The thickness of sheathing shall be as shown on the drawing, but shall nevertheless not be less than 0.3mm, 0.4mm and 0.5mm for sheathing ducts having internal diameter of 50mm, 75mm and 90 mm respectively. For larger diameter of ducts, thickness of sheathing shall be based on recommendations of prestressing system supplier or as directed by the Engineer.

iii. For major projects, the sheathing ducts should preferably be manufactured at the project site utilising appropriate machines. With such an arrangement, long lengths of sheathing ducts may be used with consequent reduction in the number of joints and couplers. Where sheathing duct joints are unavoidable, such joints shall be made slurry tight by the use of corrugated threaded sleeve couplers which may be tightly screwed onto the outer side of the sheathing ducts.

iv. The length of the coupler should not be less than 150mm but should be increased upto 200mm wherever practicable. The joints between the ends of the coupler and the duct shall be sealed with adhesive sealing tape to prevent penetration of cement slurry during concreting. The couplers of adjacent ducts should be staggered wherever practicable. As far as possible, couplers should not be located in curved zones. The corrugated sleeve couplers are being conveniently manufactured using the sheath making machine with the next higher size of die set.

v. The internal diameter of the sheathing duct shall be in accordance with the recommendations of the system manufacturer and shall be about three times the area of the tendons. In case of 6T13, 12T13 and 19T13 sizes of tendons comprising 12/13mm dia strands, the inner diameter of the sheathing shall not be less than 50mm, 75mm and 90mm respectively or those shown in the drawing, whichever is greater.

b. Anchorages

i. Anchorages shall be procured from authorized manufacturers only. Anchorages shall conform to BS 4447. Test certificates from a laboratory fully equipped to carry out the tests shall be furnished to the Engineer. Such test certificates shall not be more than 12 months old at the time of making the proposal for adoption of a particular system for the project.

ii. No damaged anchorages shall be used. Steel parts shall be protected from corrosion at all times. Threaded parts shall be protected by greased wrappings and tapped holes shall be protected by suitable plugs until used. The anchorage components shall be kept free from mortar and loose rust and any other deleterious coating.

iii. Swages of prestressing strand and button heads of prestressing wire, where provided shall develop a strength of at least 95 per cent of the specified breaking load of the strand or wire as the case may be. Where swaging / button-heading is envisaged, the Contractor shall furnish details of his methodology and obtain approval of the Engineer, prior to his taking up the work.

c. Prestressing Steel

i. 12.7mm nominal dia stress relieved low relaxation high tensile steel strand (CLASS-II) conforming to IS: 14268 with ultimate tensile strength 1861 N/mm2 shall be used. Various test as recommended in IS: 14268 shall be conducted before transporting the lot to site. Apart from 1000 hrs relaxation test conducted by manufacturer, at least two such tests are required to be conducted by independent agency in the beginning of project.

d. Prestressing strands/Wires storage

i. All high tensile steel for prestressing work shall be stored about 30cm above the ground in a suitably covered and closed space to protect it from dampness. It shall also be invariably wrapped in gunny cloth or tar paper or any other suitable materials, as per approval of Engineer. Even if it is to be stored in an area at the site for short time during transit it shall be suitably covered. Protection during storage and repacking or application of washable protective coating to the H.T. steel shall be given by the contractor at no extra cost if the packing of H. T. Strand/wire during unloading and storage / handling in the stores gets damaged.

ii. Stock piling of H. T. Steel on the work site shall not be allowed any time, especially before and during the monsoon.

iii. The Engineer or his authorized representative shall always have an easy access to the store-yard for inspecting the H. T. Wire/strands/Bars and satisfying themselves regarding the condition thereof. Any modifications regarding storage suggested by the Engineer shall scrupulously be followed by the

contractor. During monsoon days, H.T wires/strands shall be kept in reasonable airtight store, if required by the Engineer, at no extra cost.

e. Testing of Prestressing steel and Anchorages

i. All materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.

ii. All wire, strand or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes. Anchorage assemblies to be shipped shall be like-wise identified.

iii. All samples submitted shall be representative of the lot to be furnished and in the case of wire or strand, shall be taken from the same master roll. The Contractor shall furnish samples of at least 5.0m length selected from each lot for testing. Also, two anchorage assemblies, complete with distribution plates of each size or types to be used, shall be furnished along with short lengths of strands as required.

3 WORKMANSHIP

a. **Cleaning**

i. Tendons shall be free from loose rust, oil, grease, tar, paint, mud or any other deleterious substance.

ii. Cleaning of the steel may be carried out by immersion in suitable solvent solutions, wire brushing or passing through a pressure box containing carborandum powder. However, the tendons shall not be brought to a polished condition.

b. **Straightening**

i. High tensile steel wire and strand shall be supplied in coils of sufficiently large diameter such that tendons shall retain their physical properties and shall be straight as it unwinds from the coil. Tendons of any type that are damaged, kinked or bent shall not be used.

ii. The packing of prestressing wire / strand shall be removed only just prior to making of cable for placement. Suitable stands shall be provided to facilitate uncoiling of wires / strands without damage to steel. Care shall be taken to avoid the possibility of steel coming into contact with the ground.

c. **Positioning**

i. Post-Tensioning

Prestressing tendons shall be accurately located and maintained in position, both vertically and horizontally, as per drawings.

Tendons shall be so arranged that they have a smooth profile without sudden bends or kinks.

The location of prestressed cables shall be such as to facilitate easy placement and vibration of concrete in between the tendons.

Sheathing shall be placed in correct position and profile by providing suitable ladders and spacers. Such ladders may be provided at intervals of approximately 1.0 m. Sheathing shall be tied rigidly with such ladders/spacer bars so that they do not get disturbed during concreting.

The method of supporting and fixing shall be such that profile of cables is not disturbed during vibrations, by pressure of wet concrete, by workmen or by construction traffic.

- Each anchorage device shall be set square to the line of action of the corresponding prestressing tendon and shall be positioned securely to prevent movement during concreting.
- The anchorage devices shall be cleaned to the satisfaction of the Engineer prior to the placing of concrete. After concreting, any mortar or concrete which adheres to bearing or wedging surfaces shall be removed immediately.

d. **Cutting**

i. Cutting and trimming of wires or strands shall be done by suitable mechanical or flame cutters. When a flame cutter is used, care shall be taken to ensure that the flame does not come in contract with other stressed steel. The location of flame cutting of wire or strand shall be kept beyond 75mm of where the tendon will be gripped by the anchorage or jacks.

ii. In post-tensioning the ends of prestressing steel projecting beyond the anchorages, shall be cut after the grout has set.

e. **Protection of Prestressing steel**

i. Prestressing steel shall be continuously protected against corrosion, until grouted. The corrosion protector shall have no deleterious effect on the steel or concrete or on the bond strength of steel to concrete. Grouting shall conform to these specifications or as directed by the Engineer or specified in Contract Specifications.

f. **Sheathing Joints and Couplings**

i. Joints in sheathing shall, if so, instructed be sealed with a heat shrink tape.

ii. Special attention should be paid to its junction at the anchorage. It should tightly fit on the trumpet end of anchorage and the junction should be sealed, preferably, with heat shrink tape.

iii. The heat shrink tape is supplied in the form of bandage rolls which can be used for all diameters of sheathing ducts. The bandage is coated on the underside with a heat sensitive adhesive so that after heating the bandage material shrinks on the sheathing duct and ensures formation of a leak-proof joint. The heating is affected by means of a soft gas flame.

iv. The sheathing and all joints shall be watertight. Any temporary opening in the sheathing shall be satisfactorily plugged and all joints between sheathing and any other part of the prestressing system shall be effectively sealed to prevent entry of mortar, dust, water or other deleterious matter. Sheathing shall be neatly fitted at joints without internal projection or reduction of diameter.

v. Enlarged portions of the sheathing at couplings or anchorages shall be of sufficient length to provide for the extension of the tendons.

g. **Grout Vents**

i. Grout vents of atleast 20mm diameter shall be provided at both ends of the sheathing and at all valleys and crests along its length. Additional vents with plugs shall also be provided along the length of sheathing such that the spacings of consecutive vents do not exceed 20m. Each of the grout vents shall be provided with a plug or similar device capable of withstanding a pressure of 1.0MPa without the loss of water, air pressure or grout.

h. **Anchorages**

i. All bearing surfaces of the anchorages shall be cleaned prior to concreting and tensioning. Anchor cones, blocks and plates shall be securely positioned and maintained during concreting such that the centre line of the duct passes axially through the anchorage assembly.

ii. The anchorages shall be recessed from the concrete surface as per drawings.

iii. After the prestressing operations are completed and prestressing strands are cut, the surface shall be painted with two coats of epoxy of suitable formulation having a dry film thickness of 80 microns per coat and entire recess shall be filled with concrete or non-shrink/pre-packaged mortar or epoxy concrete.

i. **Handling and Storage**

i. Care shall be taken to avoid mechanically damaging, work-hardening or heating prestressing tendons while handling. All prestressing tendons shall be stored clear of the ground and protected from the weather, from splashes from any other materials, and from splashes from the cutting operation of an oxy-acetylene torch, or arc-welding processes in the vicinity.

ii. In no circumstances shall prestressing tendons after manufacture be subjected to any welding operation, or 'on-site' heat treatment or metallic coating such as galvanizing. This does not preclude cutting as specified.

iii. All wires, strands or bars stressed in one operation shall be taken, where possible, from the same parcel. Each cable shall be tagged with its number from which the coil numbers of the steel used can be identified. Cables shall not be kinked or twisted. Individual wires and strands for which extensions are to be measured shall be readily identifiable at each end of the member. No strand that has become unraveled shall be used.

j. **Supervision**

i. All prestressing and grouting operations shall be undertaken by trained personnel only. A representative of supplier of the prestressing system shall be present during all tensioning and grouting operations and shall ensure, monitor and certify their correctness.

4 Tensioning Equipment

All tensioning equipment shall be procured from authorized manufacturers only and be approved by the Engineer prior to use. Where hydraulic jacks are used, they shall be power driven unless otherwise approved by the Engineer. The tensioning equipment shall satisfy the following requirements:

a. The means of attachments of the prestressing steel to the jack or any other tensioning apparatus shall be safe and secure.

b. Where two or more wires / strands constitute a tendon, a single multiple stressing jack shall be used which is capable of tensioning simultaneously all the wires / strands of the tendon. Suitable facilities for handling and attaching the multi-pull jack to the tendons shall be provided.

c. The tensioning equipment shall be such that it can apply controlled total force gradually on the concrete without inducing dangerous secondary stresses in steel, anchorage or concrete; and

d. Means shall be provided for direct measurement of the force by use of dynamometres or pressure gauges fitted in the hydraulic system itself to determine the pressure in the jacks. Facilities shall also be provided for the linear measurement of the extension of prestressing steel to the nearest mm and of any slip of the gripping devices at transfer.

e. Any indication in the loss of strength in tendons during the tensioning operation shall be brought to the attention of the Engineer. Any corrective measures which may be required in procedures and/or material shall be approved by the Engineer.

f. When friction must be reduced, water soluble oil may be used subject to the approval of the Engineer. This oil may be flushed from the duct as soon as possible after stressing is completed by use of water pressure. These ducts shall be flushed again just prior to the grouting operations. Each time the ducts are flushed, they shall be immediately blown dry with oil-free air.

5 Testing by the Contractor

For the purpose of accurately determining the tendon elongations while stressing, the Contractor shall bench test two samples of each size and type of strand tendon to determine the modulus of elasticity prior to stressing the initial tendon. The bench should be at least 6metres long, with concrete anchorage blocks having a constant area end section of at least four times that of the anchorage assembly area. The tendon shall be straight and centered on the cross-sectional area of the bench. The test procedure shall consist of stressing the tendon at an anchor assembly with the dead end consisting of a load cell. The test specimen shall be tensioned to 80 percent of ultimate in 10 increments. For each increment, the gauge pressure, elongation and load cell force shall be recorded. The data shall be furnished to the Engineer. The theoretical elongations shown on the post-tensioning working drawings shall be re-evaluated by the Contractor using the results of the tests and corrected as necessary. Revisions to the theoretical elongations shall be submitted to the Engineer for approval.

Apparatus and methods used to perform the tests shall be proposed by the Contractor and be subject to the approval of the Engineer. After the initial testing, five more tests shall be performed. These tests shall be spaced evenly throughout the duration of the Contract.

a. Post Tensioning Procedure

i. Tensioning force shall be applied in gradual and steady steps and carried out in such a manner that the applied tensions and elongations can be measured at all

times. The sequence of stressing applied tensions and elongations shall be in accordance with the approved drawing or as directed by the Engineer.

ii. It shall be ensured that in no case, the load is applied to the concrete before it attains the strength specified on the drawing or as stipulated by the prestressing system supplier, whichever is more.

iii. After prestressing steel has been anchored, the force exerted by the tensioning equipment shall be decreased gradually and steadily so as to avoid shock to the prestressing steel or anchorage.

iv. The tensioning force applied to any tendon shall be determined by direct reading of the pressure gauges or dynamo metres and by comparison of the measured elongation with the calculated elongation. The calculated elongation shall be invariably adjusted with respect to the modulus of elasticity of steel for the particular lot as given by the manufacturer.

v. The difference between calculated and observed tension and elongation during prestressing operations shall be regulated.

vi. Grouting of Prestressed Tendons: Grouting shall conform to provisions in **Annexure D** of "IRS Concrete Bridge Code: 1997". A record of grouting operations shall be maintained in a format given by Engineer.

6 Safety Precautions during Tensioning

These are applicable for both pre-tensioning and post tensioning operations.

a. Care shall be taken during tensioning to ensure the safety of all persons in the vicinity.

b. Jacks shall be secured in such a manner that they will be held in position, should they lose their grip on the tendons.

c. No person shall be allowed to stand behind the jacks or close to the line of the tendons while tensioning is in progress.

d. The operations of the jacks and the measurement of the elongation and associated operations shall be carried out in such a manner and from such a position that the safety of all concerned is ensured.

e. A safety barrier shall be provided at both ends to prevent any tendon, which might become loose from recoiling unchecked.

f. During actual tensioning operation, warning sign shall be displayed at both ends of the tendon. No person will stand behind in line with jacks while tendon / wire are being stressed.

g. After prestressing, concrete shall neither be drilled nor any portion cut nor chipped away nor disturbed, without express approval of the Engineer.

h. No welding shall be permitted on or near tendons nor shall any heat be applied to tendons. Any tendon which has been affected by welding, weld spatter or heat shall be rejected.

7 Transportation and Storage of Units

a. Precast girders or elements shall be transported in an upright position. Points of support and the direction of reactions with respect to the girder shall approximately be the same during transportation, and storage as when the girder is placed in final position.

b. When members are to be stacked, they shall be firmly supported at such bearing positions as will ensure that the stresses induced in them are always less than the permissible design stresses. Further, inclined side supports shall be provided at the ends and along the length of a precast girder to prevent lateral movements or instability.

c. Care shall be taken during storage, hoisting and handling of the precast units to prevent their cracking or being otherwise damaged. Units worked or damaged by improper storing or handling or transport shall be replaced by the Contractor at his expense.

8 Tolerances

a. Permissible tolerances for positional deviation of prestressing tendons shall be limited to the following:

i. Variation from the specified horizontal profile: 5 mm
ii. Variation from the specified vertical profile: 5 mm
iii. Variation from the specified position in member: 5 mm

Section VII: Employer's Requirements

Section VII-7: Particular Specifications (PS)-OHE and General Electrical Services

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CHAPTER – 1 INTRODUCTION AND OVERVIEW

1.1 INTRODUCTION & OVERVIEW: -

1.1.1 Site

The Site of the HORC Project in this tender comprises of Section from HORC km 49+700 to km 61+500 i.e. Manesar – Badsa(Excl.) Double Main line including two, single line connectivity i.e. 1. Patli to New Patli single line connectivity 2. New Patli to Sultanpur single line connectivity in the State of Haryana. The land and other structures comprising the Site are described below:

1.1.2 Transmission lines crossing the Right of Way

The Site includes the following transmission lines crossing in the Right of Way:

Manesar to Badsa (Excl.) section (LT/HT crossings up to 33 Kv): -

Sr. No.	Section	HORC CH	Description	OH/UG	Height above GL (Approx.)	Tentative date of Undergrounding/ shifting/modification of crossing
1	Manesar – Badsa(Excl.)	50+700	HT Line 11 KV	OH	10.00	30.9.2022
2	Manesar – Badsa(Excl.)	52+800	HT Line 11 KV	OH	9.00	30.9.2022
3	Manesar – Badsa(Excl.)	52+820	HT Line 11 KV	OH	7.00	30.9.2022
4	Manesar – Badsa(Excl.)	53+650	LT Line 440 V	OH	9.00	30.9.2022
5	Manesar – Badsa(Excl.)	53+690	LT Line 440 V	OH	9.00	30.9.2022

6	Manesar – Badsa(Excl.)	53+700	HT Line 11 KV	OH	6.00	30.9.2022
7	Manesar – Badsa(Excl.)	54+100	LT Line 440 V	OH	9.00	30.9.2022
8	Manesar – Badsa(Excl.)	54+400	HT Line 11 KV	OH	7.00	30.9.2022
9	Manesar – Badsa(Excl.)	54+820	HT Line 11 KV	OH	9.00	30.9.2022
10	Manesar – Badsa(Excl.)	55+014	LT Line 440 V	OH	9.00	30.9.2022
11	Manesar – Badsa(Excl.)	55+100	LT Line 440 V	OH	6.00	30.9.2022
12	Manesar – Badsa(Excl.)	55+860	HT Line 11 KV	OH	9.00	30.9.2022
13	Manesar – Badsa(Excl.)	55+970	HT Line 11 KV	OH	7.00	30.9.2022
14	Manesar – Badsa(Excl.)	56+040	HT Line 11 KV	OH	9.00	30.9.2022
15	Manesar – Badsa(Excl.)	56+140	HT Line 11 KV	OH	9.00	30.9.2022

16	Manesar – Badsa(Excl.)	56+145	HT Line 11 KV	OH	6.00	30.9.2022
17	Manesar – Badsa(Excl.)	56+515	HT Line 11 KV	OH	7.50	30.9.2022
18	Manesar – Badsa(Excl.)	57+675	HT Line 11 KV	OH	7.00	30.9.2022
19	Manesar – Badsa(Excl.)	57+830	HT Line 11 KV	OH	9.00	30.9.2022
20	Manesar – Badsa(Excl.)	57+900	HT Line 11 KV	OH	9.00	30.9.2022
21	Manesar – Badsa(Excl.)	58+660	LT Line 440 V	OH	7.00	30.9.2022
22	Manesar – Badsa(Excl.)	58+940	HT Line 11 KV	OH	9.00	30.9.2022
23	Manesar – Badsa(Excl.)	59+050	HT Line 11 KV	OH	6.00	30.9.2022
24	Manesar – Badsa(Excl.)	59+120	HT Line 11 KV	OH	7.50	30.9.2022
25	Manesar – Badsa(Excl.)	59+180	HT Line 11 KV	OH	9.00	30.9.2022

26	Manesar – Badsa(Excl.)	59+250	HT Line 11 KV	OH	6.00	30.9.2022
27	Manesar – Badsa(Excl.)	59+470	HT Line 11 KV	OH	7.50	30.9.2022
28	Manesar – Badsa(Excl.)	59+600	LT Line 440 V	OH	9.00	30.9.2022
29	Manesar – Badsa(Excl.)	59+890	HT Line 11 KV	OH	6.00	30.9.2022
30	Manesar – Badsa(Excl.)	59+895	HT Line 11 KV	OH	7.50	30.9.2022
31	Manesar – Badsa(Excl.)	60+430	HT Line 11 KV	OH	9.00	30.9.2022
32	Manesar – Badsa(Excl.)	60+770	HT Line 11 KV	OH	6.00	30.9.2022
33	Manesar – Badsa(Excl.)	61+550	HT Line 11 KV	OH	7.50	30.9.2022
34	Manesar – Badsa(Excl.)	61+560	HT Line 11 KV	OH	9.00	30.9.2022
35	Manesar – Badsa(Excl.)	61+620	HT Line 11 KV	OH	6.00	30.9.2022

36	Manesar – Badsa(Excl.)	61+710	HT Line 11 KV	OH	7.50	30.9.2022

Patli to New Patli Section (LT/HT crossings Up to 33 Kv): -

Sr. No.	Section	HORC CH	Description	OH/UG	Height above GL (Approx.)	Tentative date of Undergrounding/ shifting/modification of crossing
1	Patli – New Patli	1+600	LT Line 440 V	OH	6.00	30.9.2022
2	Patli – New Patli	1+900	HT Line 11 KV	OH	9.00	30.9.2022
3	Patli – New Patli	2+100	HT Line 11 KV	OH	9.00	30.9.2022

New Patli to Sultanpur Section (LT/HT crossings up to 33 Kv): -

Sr. No.	Section	HORC CH	Description	OH/UG	Height above GL (Approx.)	Tentative date of Undergrounding/ shifting/modification of crossing
1	New Patli - Sultanpur	1+500	LT Line 440 V	OH	7.50	30.9.2022

2	New Patli - Sultanpur	1+670	LT Line 440 V	OH	9.00	30.9.2022
3	New Patli - Sultanpur	1+960	LT Line 440 V	OH	6.00	30.9.2022
4	New Patli - Sultanpur	1+970	HT Line 11 KV	OH	7.50	30.9.2022
5	New Patli - Sultanpur	1+975	HT Line 11 KV	OH	9.00	30.9.2022
6	New Patli - Sultanpur	2+100	LT Line 440 V	OH	6.00	30.9.2022
7	New Patli - Sultanpur	3+000	HT Line 11 KV	OH	7.50	30.9.2022
8	New Patli - Sultanpur	3+430	LT Line 440 V	OH	9.00	30.9.2022
9	New Patli - Sultanpur	3+450	HT Line 11 KV	OH	6.00	30.9.2022
10	New Patli - Sultanpur	3+550	HT Line 11 KV	OH	7.50	30.9.2022
11	New Patli - Sultanpur	3+700	HT Line 11 KV	OH	9.00	30.9.2022
12	New Patli - Sultanpur	3+940	HT Line 11 KV	OH	7.50	30.9.2022
13	New Patli - Sultanpur	4+230	HT Line 11 KV	OH	9.00	30.9.2022
14	New Patli - Sultanpur	4+240	HT Line 11 KV	OH	7.50	30.9.2022

Note: -

1) The shifting/modification work (Undergrounding the Overhead LT/HT Crossing) is being executed by Employer seperately. Tentative date of completion is 30.9.2022.
2) The Nos. of above crossings are indicative & may vary at site as Nigam authority keep on executing their own works of LT/HT.

Manesar to Badsa(Excl.) section (EHT crossings): -

Sr. No.	Section	HORC CH	Feeder	KV (Owner)	Lowest Conductor from Ground	Tentative date of Undergrounding/ shifting/modification of crossing
1	Manesar – Badsa(Excl.)	46+853	Manesar - Pataudi Line	66 KV (HVPNL)	14.800	31.12.2022
2	Manesar – Badsa(Excl.)	49+815	Sec-95 - Mau Line LILO at Transport nagar Manesar	220 KV (HVPNL)	22.700	31.12.2022
3	Manesar – Badsa(Excl.)	51+182	Harsaru - Pataudi Line	66 KV (HVPNL)	8.500	31.12.2022
4	Manesar – Badsa(Excl.)	51+587	Sec-95 - Mau Line	220 KV (HVPNL)	9.500	31.12.2022
5	Manesar – Badsa(Excl.)	56+008	Harsaru - farukhnagar Line	66 KV (HVPNL)	13.307	30.09.2023
6	Manesar – Badsa(Excl.)	56+080	Dadri - Samaypur - Balabhgarh Line	220 KV (BBMB)	20.654	30.09.2023

7	Manesar – Badsa(Excl.)	57+020	Dhanonda - Daulatabad Line	400 KV (HVPNL)	25.030	30.09.2023

Sr. No.	Section	HORC CH	Feeder	KV (Owner)	Lowest Conductor from Ground	Remarks
1	Manesar – Badsa(Excl.)	47+479	Sec-95 - Mau Line LILO at Transport nagar Manesar	220 KV (HVPNL)	46.500	May not required to be modified
2	Manesar – Badsa(Excl.)	49+747	Sec-95 - Mau Line LILO at Transport nagar Manesar	220 KV (HVPNL)	29.560	May not required to be modified
3	Manesar – Badsa(Excl.)	49+787	Sec-95 - Mau Line LILO at Transport nagar Manesar	220 KV (HVPNL)	27.830	May not required to be modified
4	Manesar – Badsa(Excl.)	56+840	Agra - Jhatikra Line	765 KV (PGCIL)	32.197	May not required to be modified

Patli to New Patli Section (EHT crossings): -

Sr. No.	**Section**	**HORC CH**	**Feeder**	**KV (Owner)**	**Lowest Conductor from Ground**	**Remarks**
1	Patli – New Patli	2+450 (Connectivity line)	Sec-95 - Mau Line	220 KV (HVPNL)	23.144	May not required to be modified

2	Patli – New Patli	1+860 (Connectivity line)	Sec-95 - Mau Line	220 KV (HVPNL)	At centre of HORC Connecting line	Required to be modified

New Patli – Sultanpur section (EHT Crossings)

Sr. No.	Section	HORC CH	Feeder	KV (Owner)	Lowest Conductor from Ground	Remarks
1	New Patli - Sultanpur	2+150 (Connecting line)	Agra-Jhatikra	765 KV (HVPNL)	25.130	May not required to be modified
2	New Patli - Sultanpur	3+940 (Connecting line)	Dhanonda - Daulatabad Line	400 KV (HVPNL)	24.169	May not required to be modified

Note: - The shifting/modification work of EHT crossings as per Railway Board guidelines is being executed by respective owner of crossings as deposit work for Employer. Tentative date of completion for this Package area is 30.09.2023.

a) Network: -

Following table shows the approved Section under C-2 Package Area of HORC: -

Name of Section	Approx.Length (TKM)
Manesar to Badsa (Excl.)	28.50
Patli to New-Patli Connectivity	3.90
New-Patli to Sultanpur Connectivity	4.00
Total	**36.40 TKM**

1.2 SCOPE AND PURPOSE

The works to be executed under this Contract includes design, validation of design, delivery, installation, testing, including integrated testing and commissioning, technical support, maintenance, training of Engineer staff and documentation for a complete System necessary to deliver the requirements of this Specification.

1.2.1 Purpose of this Document

This Specification defines the objectives, guidelines and requirements for design, supply, installation, testing and commissioning of 25 kV High Rise Overhead Equipment (OHE) for HORC Section and SCADA system for Manesar to Badsa (Excl.) Double Main Line including Manesar & New Patli Station Yard (28.50TKM) and 02 Nos. single line connectivities: -

1. Patli to New-Patli single line connectivity (3.90 TKM)
2. New Patli to Sultanpur single line connectivity (4.00TKM)

In this section 4 SSP (2 at Manesar and 2 at New Patli) and 1 SP at Sultanpur will be constructed. Contractor shall have to install SCADA equipment at Sultanpur SP only as per site requirement**.**

SSP – Manesar-South will have CB arrangement for Maruti Siding.

In this section Manesar, New Patli & Sultanpur station building will be constructed (Detail shown in respective chapter). The Contractor has to do the electrification work of all these station buildings/Yard with allied facilities including provision of 03 Nos lifts (13 Passengers) at Manesar & New Patli station building each, On grid solar plant of rated at each Proposed station buildings, substation (11/0.44 kV, 2x500 kVA CSS with salient type DG of 160 kVA capacity including AMF & APFC Panel) for Manesar station and a substation (11/0.44 kV, 2x250 kVA CSS with salient type DG of 125 kVA capacity including AMF & APFC Panel) for New Patli station with all safety equipment as per specification.

1.2.2 Relevant Documents

This Specification should be read in conjunction with the General Conditions of Contract, the Particular Conditions of Contract (PCC), the General Specification (GS), the Engineer's conceptual drawings and any other document forming part of the Contract.

1.2.3 Design and Drawing

- The Responsibility for the complete design work as per RDSO/CORE & Railway Board guidelines lies with the Contractor.
- Notwithstanding anything given anywhere else all work execution shall be as per latest design and drawing of RDSO/CORE and latest guideline issued by Railway Board.
- The contractor should follow all the clearances as per latest CEA regulations.
- All materials used in the work shall be procured from RDSO/ CORE approved sources only.

1.3 OVERVIEW OF PROJECT

1.3.1 Approved Section for OHE (HIGH RISE) and General Services work: -

As stated in Para 1.2 above, the C-2 Package area of HORC comprises of following sections: -

- Manesar to Badsa (Excl.) - Double Main line

- Patli to New- Patli - Single line Connectivity
- New- Patli to Sultanpur – Single line Connectivity

1.3.2 Various General Services work details: -

Electrification of Proposed MANESAR, NEW PATLI & SULTANPUR Station Building, Platform, Circulating/yard area with allied facilities as per requirement and guidelines issued by railway board. Provision of (11/ 0.44 kV) sub- station of rated capacity and 03 Nos of lifts 13 Passengers) at Manesar & New Patli station as per RDSO/CPWD/Railway Board specification and On grid solar plants of rated capacity at each proposed station are also included in scope of this tender.

1.3.3 Power Supply for Section: -

The section covered under this tender will be charged by extending the existing feed at PATLI station of Indian Railway. All the material/equipment etc. required for feed extension shall also be in the scope of this tender.

CHAPTER – 2 SCOPE OF WORK

2.1 GENERAL

A general description of the broad scope of work, relating to works covered in this Tender, is given below. It shall, however, be clearly understood that the description is for the purpose of general guidance only and is not exhaustive. For complete appreciation of the Scope, the Specifications, drawings and other relevant paragraphs of the Tender documents shall be referred to.

2.1.1 Items of Work

The following items of work are within the Scope of this Tender:

- Design of 25 kV, 50 HZ single phase AC electrificationwith HIGH RISE OHE System, as per guideline issued by RDSO/CORE/Railway Board.
- Supply and Erection of 25 kV Traction Overhead Equipment for Tangent lines, Elevated lines and Bridge Masts on Bridge piers etc./Drop Arm arrangement on various Bridges in Section lines
- Provision of Switching Stations (SP and SSP) for sectioning and supply of traction power to rolling stock with necessary protection of the line.
- Civil works w.r.t OHE i.e Foundation work and w.r.t switching stations i.e Battery room, Control room, fencing work etc.
- Provision of track bonding and earthing system etc.
- Supply and Erection of 25 kV/415 V Auxiliary Transformers of rated capacity withall associated switch gears and equipment's at station and switching post.
- Supply and Erection of CLS PANEL with cabling arrangement of suitable size and rating at each station and switching post as per RDSO specification.
- Modifications to existing OHE including dismantling of OHE, removal of brackets, cutting of masts, dismantling and removal of existing auxiliary transformer.
- Supply and Erection of SCADA System, RTU'sequipment (installed only at Sultanpur SP) including Modification/up gradation, testing & commissioning in existing standard SCADA software at RCC Equipment's for configuration, integration/ hooking up of additional RTUs of adjacent section with master station at TPC/ control of delhi division.
- Electrification of Manesar, New Patli and Sultanpur station building with allied facilities and complete power supply arrangement as per standard railway practice and guideline issued by railway board/ RDSO/ CPWD specification.
- Supply, Installation, testing and commissioning of3 NosLifts(G+1) (13passengers,884 Kg) at Manesar and 03 Nos lifts(G+1) (13 Passenger,884 Kg) at New Patli station with all safety equipment and 02-year warranty including all schedule maintenance as per OEM, attending breakdown with in prescribed time.
- Supply, Installation, testing and commissioning of substation (11/0.44 kV, 2x500 kVA CSS with DRY type transformer (500 kVA) and salient type DG of 160 kVA capacity including AMF & APFC Panel) including earthing system and all Safety

equipment's with complete power supply arrangement at Manesar station as per specification.

- Supply, Installation, testing and commissioning of substation (11/0.44 kV, 2x250 kVA CSS with DRY type transformer (250 kVA) and salient type DG of 125 kVA capacity including AMF & APFC Panel) including earthing system and all Safety equipment's with complete power supply arrangement at New Patli station.
- Provision High Mast Towers (16 mtrs) and octagonal poles (5 mtrs) at yards, platform and circulating area with complete cabling arrangement to meet standard LUX level as per guideline issued be RDSO/ Railway Board.
- Supply, installation, Testing and commission of ON- Grid solar plantsof rated capacity with complete accessories in all respect and net metering system at Manesar, New Patli and Sultanpur station. (Location of solar plants will be proposed by contractor and to be got approved by engineer).
- Provision of Man power for maintenance of all the work that is to be done in this tender during DLP period as per latest SMI's and other instruction issued by RDSO/ Railway Board. This also includes manning of all switching post and 11 kVA substation round the clock as per specification. Under this, all labour law's will be applicable.
- Supply, Installation Testing and Commissioning of fire Detection & amp; Alarm system (air aspiration) as per RDSO/SPN/NEW /2010 at various location (A per guideline issued by Railway Board) of each station building.
- All equipment testing, integrated testing, and Commissioning of all erected equipments.
- Provision of all the construction drawings, documents and as-built drawings required to supply, install, test and commission the above installations.
- Deal and resolve in co-ordination with the Engineer the Interface with other Contractors to ensure timely completion of the Works;
- Ensure Technology Transfer and Training to Engineer's staff.

2.1.2 Section Covered in the Scope of the Tender

This Tender covers the relevant works in the following Section:

- Manesar to Badsa (Excl.) Double main Line including Manesar and New Patli Station Yard (28.50TKM)
- Patli to New-Patli single line connectivity (3.90 TKM)
- New Patli to Sultanpur single line connectivity (4.00 TKM)

2.2 SCOPE

2.2.1 General

In general, EPC Contractor is responsible for all electrical works relating to 25 kV Traction Overhead Equipment, SCADA system and electrification of station building/Yard including provision of (11/0.44 kVA) substation of suitable capacity in this Section.

2.2.2 Contractor's Scope

S.NO	NAME OF SECTION	SCOPE
1	Manesar to Badsa (Excl.) Double main Line	HIGH RISE OHE, SWITCHING POST &VARIOUS ELECTRICAL GENERAL SERVICES WORK
2	Patli to New-Patli connectivity	HIGH RISE OHE, SWITCHING POST &VARIOUS ELECTRICAL GENERAL SERVICES WORK
3	New Patli to Sultanpur connectivity	HIGH RISE OHE, SWITCHING POST& VARIOUS ELECTRICAL GENERAL SERVICES WORK
4	Design	OHE, SCADA, PSI, General Services Work
5	SCADA integration at SultanpurSP with Northern Railway RCC	SCADA work
6	Modification works	Modification to existing OHE at Sultanpur station of NR as per ESP
7	Extension of feed at Patli station of IR	All work related to the feed extension.

A) SCOPE FOR OHE WORK: - (High Rise OHE)

S.NO	Section	From km to km	Length (km)	Total TKM
1	**Manesar to Badsa (Excl.) Double Line including Manesar (2.28 TKM loop line)& New**	49.700 – 61.500	11.80	28.50

	Patli (2.585 TKM loop line) Station Yard			
2	**Patli to New-Patli single line Connectivity**	0.00 to 3.90	3.90	3.90
3	**New-Patli to Sultanpur single line Connectivity**	0.00 to 4.0	4.00	4.00
	Total TKM			**36.40 TKM**

B) Scope for Switching Stations

Design, supply, erection, testing and commissioning of single phase, 25 kV, 50 Hz, AC Switching Stations (SP/SSP) including foundations, structures and all ancillary equipment etc. as per following details along with earthwork, construction of buildings, fencing, retaining wall, internal wiring with switch/fittings/equipment's, battery set, PTFE in case of SP all types of caution, warning, instruction, protection, location/name and schematic diagram boards, earthing stations, safety items (i.e. Firefighting equipment, First Aid box, Shock treatment chart, key box etc.), manning till stabilization of SCADA (At least for a period of 06 months from commissioning) and all necessary documentation for EIG sanction and CRS Inspection, supply of required drawings and breakdown maintenance till maintenance period.

(a) The following works shall form part of this Tender:

i. Design, Supply, Installation, Testing and Commissioning of all Switching Stations (SP and SPP) inthe Section, including, but not limited to: -

- 25 kV Switchgears
- Jumpers and connecting cables
- Measuring and protection equipment
- LT and Control Cables for Switching Station
- Structures and foundations to support the equipment and all other related works to make the Switching Station complete for its successful and satisfactory working.
- All control cables required for switching post.
- All LT cables required for interconnection of equipment's etc. in the AT connection including CLS panel.
- Batteries and battery chargers at each switch post.
- Cable paths and earthing arrangements
- Safety equipment and all other items required for successful and satisfactory working of each switching post.

ii. Tentatively, the Switching Stations are located near the following Stations, in this Section

S.NO	Location	Centre Chainage	Length (Mtr)	Width (Mtr)
1	SSP NEW PATLI – South	57.100	21.00	06.00
2	SSP NEW PATLI- North	59.100	21.00	06.00
3	SP SULTANPUR	As per site feasibility	21.00	06.00
4	SSP MANESAR- South	47.700	21.00	06.00
5	SSP MANESAR - North	49.700	21.00	06.00

Note: -

1. The Location of SP/SPP are only indicative, the final location will be decided at the time of execution as per site feasibility, location of signals, location of overlaps, Location of Cross overs and operation requirement etc.
2. The SSP at Sr. No. 4above will have CB arrangement for Maruti Siding.

C) Site for Service Building: -

S.No.	Location	Length(m)	Width (m)
1	**2**	**3**	**4**

Service Building	MANESAR STATION BUILDING (G+3)	As per Details given in Civil Engineering part of this tender
	MANESAR SUB-STATION (11/.440 KV)	
	NEW-PATLI STATION BUILDING	
	NEW-PATLI SUB-STATION (11/.440 KV)	
	SULTANPUR STATION BUILDING	

D) 10 KVA/25 KVA Auxiliary transformer stations

Design, supply, erection, testing and commissioning of single-phase Auxiliary Transformer Station of different capacity as per following details, complete with all structures and fittings etc. along with anti-climbing device and all types of caution, warning, instruction, protection boards and location/Name boards, junction box and all necessary documentation for EIG sanction and CRS Inspection and supply of required drawings and Breakdown attention till maintenance period.

- **10 KVA AT requirements: -**

S.N.	Location	Capacity	Quantity of AT	Remarks
1	NEW PATLI SSP – South	10 KVA	01	Required at Station Building and Switching Post
2	NEW PATLI SSP- North	10 KVA	01	
3	SULTANPUR SP	10 KVA	01	
4.	SULTANPUR STATION	10KVA	02	
5	MANESAR SSP- South	10 KVA	01	
6	MANESAR SSP- North	10 KVA	01	
		TOTAL	**07 Nos**	

- **25 KVA AT requirements: -**

SN	Location	capacity	Quantity of AT	Remarks

01	MANESAR JN.	25 KVA	2 Nos.	Required at Station Building
02	NEW PATLI JN.	25 KVA	2 Nos.	
		TOTAL	**04 Nos.**	

E) Supervisory Control and Data Acquisition System (SCADA): -

i. Scope of SCADA work for supply, erection & commissioning through SCADA approved vendors with defect liability period of 2 years is a part of main EPC contract **as per RDSO Specification No. TI/SPC/RCC/SCADA/0130 (Rev-2) with A&C slip No.-1, 2 & 3 and latest amendments.** Brief of the scope for SCADA system given as below:

Section	**C-2 Package Area**		
Item No.	**Description**	**Unit**	**Qty.**
1	Design and Drawings required in connection with Modification/up gradation, testing & commissioning in existing standard SCADA software at RCC Equipment's for configuration, integration/ hooking up of additional RTUs of adjacent section with master station.	LS	01
2	Modification/up gradation, testing & commissioning in existing standard SCADA software at RCC Equipment's for configuration, integration/ hooking up of additional RTUs of adjacent section with master station.	LS	01
3	Supply, Erection, Testing & Commissioning of RTUs at remote stations.		
(a)	Sectioning Posts (SP) for Sultanpur SP	Nos.	01
(b)	Sub Sectioning Posts (SSP)	Nos.	NIL

ii. Modification Required at RCC (Remote control center) at Designated locations: - TPC control, State entry Road, Delhi division, New Delhi.

F) Various electrical General services work:

i. Electrification **of Proposed MANESAR, NEW PATLI AND SULTANPUR Station Building.**

Sr. No.	Description of Work	Manesar station Building (G+3) and substation	New- Patli Station Building (G+1) and Sub station	Sultanpur Station Building	Total Qty
1	Wiring for light/ceiling fan/exhaust fan/call bell/ Power plug/socket/ etc. points including circuit wiring, sub-main wiring with Fire Retardant (FR), PVC insulated, multistranded, copper conductor, single core cable on surface/in recessed PVC conduits, distribution boards, sub distribution boards, earthing with suitable number of modular switch and socket. Wiring shall be done as per standard sizes of cables. Number of points permissible in each circuit and sub main as per standard.It also includes fixing of DB (SPN, TPN) of suitable Nos of MCB and RCCB as per technical specification and standard.	490 Points	240 Points	115 Points	845 Points

2.	Supply, installation, testing and commissioning of prewired 22 watt energy efficient Tube light fitting(4 feet) on wall bracket of GI class "B" pipe & connections from junction box/overhead line/light point etc. to luminary with 1.5 sq.mm FRLS PVC insulated multistranded copper conductor single core/three cable as instructed & earthing etc. as required.	320 Nos	160 Nos	80 Nos	560 Nos
3.	Supply, installation, testing and commissioning of 230V A.C. ceiling fan (1200 MM) and fan Regulator as per requirement and specification	112 Nos	46 Nos	23 Nos	181 Nos
4	Supply, installation, testing and commissioning of Bus Trunking System (Rising Main structure) in station building as per requirement and specification.	1 Job (G+3)	-	-	01 Job
5	Provision of High Mast Tower (16 Mtr.) with LED Flood light fitting (200 Watt) with complete accessories and as per specification.	01 Nos	01 Nos	-	02 Nos
6	Provision of Octagonal poles (5 metres) with street light fitting (40 Watt) and 70-30% arrangement with complete accessories, as per requirement and specification.	75 Nos	70 Nos	30 Nos	175 Nos
7	Provision of Passenger Lifts (13 Passengers, 884 Kg) complete in all respect with all accessories as per requirement and specification.	03 Nos (G+1)	03 Nos (G+1)	-	06 Nos
8	Provision of Sub-Station	01 Job	01 Job	-	02 Job

	(11/0.440 KV) including CSS-1, CSS-2. Each CSS Shall be consisting of 11KV Compact VCB/SF6 CB panel (1 incoming isolator + 2 outgoing VCB/SF6 CB with air insulated BUS PT metering module) + Transformer (500 KVA)/250 kVA DRY Type + L.T. Switchgear with all HT & LT inter- connections, accessories, fittings & auxiliary equipment inside GI Enclosure as per technical specification. CSS also include 1 RMU 11KVA 630 Amp 21 KA, LT panel as per spec., APFC panel 200 KVAR MPP type heavy duty, all HT and LT cable with proper termination arrangement of suitable size and length, Suitable H-pole arrangement with GO/DO switch, supply, fixing and commissioning of 160 kVA DG set with AMF panel, Provision of Copper Plate earthing as per requirement and as per technical specification. This also includes supply & fixing of all safety items required for 11/0.440 substation as per rules.	02- CSS including (2X500 transformer with Salient type DG of 160 kVA Capacity and AMF and APFC Panel) and complete in all respect.	02- CSS including (2x250 kVA transformer with Salient type DG of 125 kVA Capacity and AMF and APFC panel) and complete in all respect.		
9	Provision of Inverter type Split AC (1.5 Ton, Heavy duty, 5 Star Rating with Stabilizer) and other accessories as per site requirement and specification.	12 Nos.	10 Nos.	09 Nos	31 Nos
10	Provision of LED Signage Board & LED Station Name Board (Single Sided/Double Sided) with all accessories. As per specification and satisfaction of Engineer.	300 Sqft	256 Sqft	186 Sqft	742 Sqft
11	Supply, laying. 1.1 kV grade LT XLPE insulated	Appox. Qty of cables: -	Appox. Qty of cables: -	Appox. Qty of	-

	armoured, aluminium conductor cable, in trench/ air/ HDPE pipe. making good the damages, end terminations with aluminium crimping sockets/lugs, provision of cable route markers, testing and commissioning as per specification and satisfaction of Engineer.	4x16=2500 mtrs 4x35= 1300 mtrs 4x50=600 mtrs 4x120= 500 mtrs 4x185= 500 mtrs	4x16=2200mtrs 4x35= 1300 mtrs 4x50=600mtr 4x120= 500mtrs 4x185=500 mtrs	cables: - 4x16=1000mtrs 4x50=500 mtrs 4x120= 500mtrs	
12	Provision of Water Cooler (150 Ltrs) capacity with around MS Cage & suitable protection arrangement (RCCB with enclosure) as per site requirement as specification.	10 Nos	05 Nos	03 Nos	18 Nos
13	Provision of Water Pumping Arrangement system with3 Phase ,10 HP Submersible Pump set of discharge- 310 LPM or Above and Head range: 85 Meters or above with rated capacity of soft starter and with 3 Phase ,10 HP Submersible monoblock Pump of discharge- 850 LPM or Above and Head range: 35 Meters or above with rated capacity of soft starter and 3 core copper cable 10 Sq. mm and other accessories as per site requirement and satisfaction of Engineer.	Submersible pump set (10 HP) – 02 Nos Submersible Mono block pump (10 HP) – 02 Nos 3x10 sqmm CU cable as per site requirement.	Submersible pump set (10 HP) – 02 Nos Submersible Mono block pump (10 HP) – 02 Nos 3x10 sqmm CU cable as per site requirement.	Submersible pump set (10 HP) – 02 Nos Submersible Mono block pump (10 HP) – 02 Nos 3x10 sqmm CU cable as per site requirement	06 Nos (10 Hp) submersible pump set. & 06 Nos(10 Hp) Submersible Mono block pump
14	**Provision of Earthing System**				
14 (a)	Provision of Earthing system with3-meter-long, 50 mm dia, G.I. pipe class 'B' earth electrode, adding of charcoal or coke and salt, providing masonry enclosure and cover plate with lifting arrangement	60 Nos	40 Nos	30 Nos	130 Nos

	etc. including connections with 8 SWG G.I wire from earth electrode as per specification.				
14(b)	Provision of Maintenance free Earthing as per specification	10 Nos	05 Nos	05 Nos	20 Nos
14(c)	Provision of Copper Earthing system with 600x600x 3 mm thick Cu earth plate and suitable size and length of 40x5 mm copper strip as per specification.	14 Nos	06 Nos	-	20Nos
15	Supply and fixing of suitable size feeder pillars and Junction Box as per requirement and specification.	10	05 Nos	02 Nos	17 Nos
16	Supply and fixing of CLS panel suitable for 25 kVA/10 KVA capacity AT supply with complete accessories and protection system As per RDSO specification.	02 Nos (25 kVA) for Station Building 02 Nos (10kVA) for each SSP	02 Nos (25 kVA) for Station Building 02 Nos (10kVA) for each SSP	02 Nos (10 KVA) for station Building 01 No(10kVA) for SP	04 Nos (25 kVA) & 07 Nos(10kVA)
17	Supply and fixing of Phase selector of size (610x450x190mm) with I/P MCCB- 100/ 63 amp and O/P MCCB- 63 Amp as per requirement and specification	01 Nos	01 Nos	01 Nos	03 Nos
18	Design, supply, testing Erection and commission of Indoor type LT panel with one incoming MCCB of suitable rating and Min 6 Nos of Output MCCB of suitable rating as per requirement and specification.	01 Nos	01 Nos	01 Nos	03 Nos
19	Supply, Installation Testing and Commissioning of fire Detection & Alarm system (air aspiration) as per RDSO/SPN/NEW /2010 at	01 Job	01 Job	01 Job	03 Job

	various location of each station, complete in all respect and satisfaction of Engineer.				
20	Supply, fixing commissioning, installation and testing of 2 Kva pure sine wave 24-volt online inverter consist of intelligent battery charging mechanisms with adaptive battery charging and 150 AH tubular battery of voltage 12 volt suitable for heavy duty application. Warranty of invertors is 24 months and for Battery -36 months And as per specification.	02 Nos	02 No	01 No	05 Nos
21	Supply, fixing, commissioning and installation of Perforated Cable Tray of size 150x50 mm made out of MS sheet and hot dip galvanized (85 microns) 1.6 mm thick with suitable fixing Arrangements as per requirement and specification.	500 Mtrs	200 Mtrs	100 Mtrs	800 Mtrs
22	Provision of Solar Plants with 380 watt panels, hybrid type inverter, Galvanised structure, DCDB, ACDB, connectors, MCCB, earthing system, LA, Surge protector and other wiring material complete in all respect and satisfaction of Engineer.	160 kWp	80 kWp	10 kWp	250 kWp

Note: -

1) All the Qty of above Electrical items is indicative it may vary as per site condition and Design and Drawing of station/service Building.
2) The Contractor will have to get approved the lay out plan and complete HT/LT power supply arrangement of each station buildings, Platform, Circulating/Yard areafrom engineer authorities appointed for this work before execution

a) Extension of LT power supply for CLS Work at Manesar, New Patli and

Sultanpur stations.

- **10 KVAAT Cable requirement: -**

S.N.	Location	Size of conductor (Approximately)	Quantity of AT	Cable Quantity in meter /AT	Remarks
1	**SULTANPUR STATION**	4X70 sqmm	02	50 Mtrs	1. One spare cable also to be provided of the same length and size. 2. In double line section, track crossing may also be involved with HDPE Pipe. 3. In platform area or concrete structure the cable may be required to laid by insertion of HDPE pipe by Boring/Drilling method. 4. Suitable capacity of CLS panel will be installed at each AT location with proper earthing arrangement.
2	**NEW PATLI SSP - North**	4 x 70 sqmm	01		
3	**NEW PATLI SSP - South**	4X70 sqmm	01		
4	**SULTANPUR SP**	4X70 sqmm	01		
5	**MANESAR SSP - North**	4X70 sqmm	01		
6	**MANESAR SSP - South**	4X70 sqmm	01		
TOTAL			**07 Nos**	**350 Mtrs**	

Note: QTY of Cable shown above Para is approximate and indicative only. It may vary as per site condition

- **25 KVA ATCable requirement**

SN	Location	Size of conductor	Quantity of AT	Cable Quantity in meter per AT	Remarks
01	MANESAR JN	4 X 95 sqmm	2 Nos.	900	1. (450+450=900 mts) For all locations. 2. One spare cable also to be provided of the same length and size. 3. In double line section, track crossing may also be involved with HDPE Pipe. 4. In platform area or concrete structure, the cable may be required to laid by insertion of HDPE pipe by boring method. 5. Suitable capacity of CLS panel will be installed at each AT location with proper earthing arrangement.
02	NEW PATLI JN	4 X 95sqmm	2 Nos.	900	
		TOTAL	**04 Nos.**	**1800 Mtrs**	

Note: QTY of Cable shown above Para is approximate and indicative only. It may vary as per site condition.

b) Extension/Augmentation of electrical power supply arrangements and associated works:

SN	Extension/Augmentation of electrical power supply
1.	New HT Connection (11 kV) of 190KWat MANESAR SUB STATION/JN.
2.	New HT connection (11 Kv) of80 KW Connection, at NEW PATLI JN.
3.	New LT connection (1 Phase, 230 Volt) of 10 KW (or as decided by Engineer at the time of execution) Connection, at SULTANPUR station.

G) Modifications to existing OHE including dismantling of OHE, removal of brackets, cutting of Masts Dismantling and removal of existing auxiliary transformer.

At following locations, the proposed electrified lines will be connected to existing electrified lines and may need modification in existing OHE:

SN	Station	Approximate. Qty
1	**SULTANPUR YARD**	**2.2 TKM**

Note: -

1. Qty of yard modification of Sultanpur station is indicative, it may change as per latest ESP and as per Site requirement for Civil work.

H) Inventory electrical:

List of inventory is given in Appendix 14.

I) Bridge Masts on Bridge piers etc. /Drop Arm arrangement/OHE Arrangement on variousBridges in Section

The scope of work also includes provision of bridge masts on piers/ abutments by drilling/bolting/grouting or other suitable arrangements as per site conditions, Cantilever Assembly on Vertical member of bridge, Drop arm arrangement, any other OHE arrangement on bridge as per site requirement.

SN	Section	No. of bridge masts
1	MANESAR –Badsa(Excl.) SECTION including two single line connectivities.	As per RDSO/CORE/Railway Board guidelines applicability on bridges in the section along with emergency arrangement.

NOTE: This item shall be part of OHE Electrification Work.

J) Design and Drawings: -

The complete design of OHE, PSI, SCADA, General Services work etc. will have to be as per design and specification of RDSO/CORE/Railway board.

2.3 DOCUMENTS AND MANUALS

The contractor shall have to supply documents and Manuals in English language as per RDSO/CORE/Railway board guideline.

2.3.1 As Built Drawings

- The contractor shall prepare the as built and other drawings defined as:
- As built drawing depicting the completed works that have been certified as complete.

- Shop drawings containing information related to the permanent works.
- Working drawings containing information related to the temporary works depicting the construction of permanent works.

2.3.2 Electronic Drawing Format

All the drawings shall be prepared in AUTOCAD 2018(or latest version) which shall be compatible with window 98/XP/7/10/10professional as well as in latest pdf.

2.4 Defects Liability Period (DLP)

The Contractor shall be responsible for all the Defects and deficiencies, till the expiry of a period of 01 (One) year. The Contractor shall repair or rectify all Defects and deficiencies observed by the Engineer during the Defects Liability Period with in time period as may be determined by the Engineer in accordance with Good Industry Practice.

2.5 Warranty Certificates from OEM:

- All Original Warranty Certificates of OEMs of all Electrical system or equipment including contract spare, Commissioning spare, DLP spares, inventory and Special tools & Test and Measuringequipment shall be valid for three years or as specified in RDSO Specification of the equipment whichever is later and registered in the name of Engineer. These warranty certificates received from the OEMs should be passed on to Engineer before final Taking over.
- Validity of period of Warranty Certificates shall start from date of Commissioning.
- Original invoice shall also be submitted with the OEM warranty certificates in a booklet form before Commissioning.
- Warranty support shall start from the date of Commissioning.

Coding and Tagging of Spare Parts and Special Tools and Test Equipment

- All Spares/Spare Parts and Special Tools and Test Equipment to be delivered to the Engineer shall each carry a tag suitably marked, bar-coded (as directed by the Engineer) and numbered.
- The numbers on the tags shall correspond with those on the coding system developed by the Contractor for all Signalling components, parts and equipment's.

2.6 Maintenance Activity:

All type of maintenance activity of all Works will be conducted by the contractor staff under his supervision. All type of Routine, preventative and schedule maintenance work will be carried out at regular intervals based on SMI's/ Instructions issued by RDSO/CORE/Railway Board and equipment manufacturers' recommendations. (List of SMI's issued by RDSO is attached at Appendix to Maintenance and Training chapter for reference).Under this, all the labour laws would be applicable and contractor has to submit all the records (EPF/ESI and other certificates) to Engineer.

To perform maintenance activity, the Contractor shall deploy supervisory staffs along with skilled staff who are expert in all levels of fault finding, maintenance and repair of the various systems supplied under the Contract. The detail of deploying staff is as under: -

S.No	Personnel	Qualification	Total work experience(in year)	Required No of staff	Remark
1	Maintenance In-charge	Graduate Degree in Electrical Engineering	Min. 05 Years of working experience on any OHEproject and Min 02 years' experience of General power supply arrangement.	01	Over all in charge of all type of Electrical(OHE+GS) maintenance work
2	Maintenance Engineer	Diploma in Electrical Engineering	Min. 03 Years of working experience on any OHE project or any OHE maintenance activity	01	Required as Site engineer for all type of OHE work
3	Maintenance Engineer	Diploma in Electrical Engineering	Min. 03 Years of working experience of General Services work of any GS maintenance activity.	01	Required as Site engineer for all type of General Services work
3	Skilled Staff for Maintenance activity	ITI in Electrical Trade	Min. 02 Years of working experience on any OHE project/General power supply arrangement	10	Required to perform day to day maintenance activity for OHE and GS work
4	Skilled Staff for Manning Purpose	ITI in Electrical Trade	Min. 02 Years of working experience on any OHE project/General power supply arrangement	21	Required for Manning of Switching post(SP/SSP) and 11 kV Substation of Manesar and New Patli station.

CHAPTER 3 — PROJECT PROGRAMME REQUIREMENT

3.1 General Requirements

(a) The Contractor shall develop in detail, a logical method of executing the Works taking into account their complex nature and different phases and shall provide programmes which reflect the detailed planning undertaken.

(b) The programmes shall start with the Commencement Date of the Works as day one, are to be realistic, achievable and shall be accompanied by the detailed supporting Management Plans.

(c) The Program activities shall be discrete items of work, which when combined and produces the definable elements, components, Milestones, Stages and Sections of the Works and clearly identify the completion obligations of the Contractor.

(d) Milestones shall be an integral part of all programmes and all activities. Sequencing and interrelationships required to achieve each completion obligation shall be shown. Milestones shall not impose constraints that in a way affect the programme logic. Milestones shall not be introduced into any programme as constrained dates.

(e) The critical path shall be clearly identified in the programme and fully described in the accompanying programme narrative.

(f) Activity descriptions shall clearly convey the nature and scope of the Works. Programmes shall take into account the activities of Precursor, concurrent, adjacent and follow on project contractors and any other activity that may affect the progress of the Works.

(g) The Contractor shall also incorporate the Engineers requirement for additional activities, to further explain or subdivide complex or long duration tasks, without affecting completion dates.

(h) The Contractor shall monitor its and its subcontractor's performance against programmes to ensure its compliance with its obligations under the Contract. Monitoring of the Works shall include direct, daily monitoring of the progress of the Works and the preparation of return and computerised reports to be submitted to the Engineer. The reports shall include all necessary supporting data to apprise the Engineer of the status of the completion of the Works as described below.

3.2 The Execution Phases

The execution activity will include various phases of the implementation as under.

(1) Design Phase,

(2) Manufacturing/Supply Phase,

(3) Construction/Installation Phase,

(4) Testing & Commissioning Phase and

(5) Operation & Maintenance Phase;

3.2.1 Design Phase

The contractor shall deploy a qualified team of the Design Engineers and

Experts asapproved by the Employer, evidencing the experience of the design in relevant field and technology with the approval of the Engineer, before commencement of Design Phase. The Design Phase shall have 4 stages as detailed below:

(a) Preliminary Design

(b) Detailed Design

(c) Construction / Installation Design

(d) As Built Documents

3.2.2 Manufacturing /SuppIy Phase

The manufacturing /suppIy will constitute the following:

(a) Manufacturing/Procurement;

(b) Factory Acceptance Tests (FAT);

(c) Delivery to the contractor's stores at site; and

(d) Storage at the site Stores, including establishing the Material Procurement tracking,receipt and issue procedures.

3.2.3 Construction/ Installation Phase

Construction/ Installation Phase will constitute of the following:

(a) Site Management including access/ ROW preparation;

(b) Availability of Construction reference Drawings;

(c) Installation preparatory works like Foundations, first fix, site safety and quality assurance procedures etc.;

(d) Equipment installation; and

(e) Training of Employer's Personnel

3.2.4 Testing and **Commissioning** Phase

Testing and commissioning phase will constitute of the following:

(a) Testing and Commissioning of all subsystems;

(b) Quality assurance;

(c) Integrated Testing & commissioning;

(d) Trial run including service trials; and

(e) Submission of verified and As Built Documents

3.2.5 Operation and Maintenance Phase

Operation and Maintenance Phase will constitute of the following

(a) Operation and Maintenance activity

(b) Defect rectification

(c) Workshop Repair Services

(d) Support and Call Out Services

(e) Supply of O & M Manuals, Maintenance schedules and Warranty certificates

3.3 Works Programme

(a) The Works Programme to be submitted under the contract shall be developed from theOutline Works Programme submitted and developed during the tender period according to Key Dates given in the bid documents.

(b) Within 30 days of the Commencement Date of the Works the Contractor shall submit for review by the Engineer, his proposed initial version of the Works Programme which shall provide full programme details for the first six months of the contract and shall provide outline details for the remaining period of the contract.

(c) Within 60 days of the Commencement Date of the Works, the Contractor shall submit for review by the Engineer the proposed full version of the Works Programme.

(d) The Works Programme shall demonstrate by reference to its Sub Programmes, Supplementary Programmes and associated Management Plans, the sequence and duration of the activities and any restraints there to that the Contractor shall adopt to achieve Milestones and to 34alvan all Contract obligations. The Works Programme shall become the basis of administration of the time-related aspects of the Contract.

(e) The Contractor shall provide the Engineer with substantiation for each constraint whether target start, target finish or mandatory constraint entered by the Contractor into the Works Programme. The number of constraints shall be kept to an absolute minimum.

(f) The Works Programme shall include activities for all the phases and stages of the Works, clearly showing all logical interdependencies and stages in the development of the Contractors design, procurement, installation, commissioning and setting to work. As a minimum, it shall include'

i. All works comprising the permanent works;

ii. Preparation, submission and review of Design Documents showing all items where review by the Engineer is required.

iii. Procurement of all major materials and items of Contractor's Equipment for the Works, including the dates orders are to be placed, manufacture period and the expected delivery date to the Site for each item.

iv. Any software development requirements and Validation time frames.

v. All manufacture or prefabrication of materials of components.

vi. All design and installation of major Temporary Works.

vii. All activities associated with securing necessary permits and other statutory approvals for the works.

viii. Access and availability dates for all Project Contractors.

ix. All interfaces related to the project that may affect the progress of the Works.

x. Testing and commissioning activities requirements.

xi. Training.

(g) The Works Programme shall be divided into Sub-Programmes of manageable size addressing in more specific detail, the content of the Management Plans. The Sub-Programme shall be as follows:

a) Design Submission Programme

b) Procurement and Manufacturing Programme;

c) Installation Programme

d) Testing and Commissioning Programme; and

e) Training Programme

(h) The submission of the full version of the Works Programme shall include the Design Programme, Procurement and Manufacturing Programme and a preliminary version of the Installation Programme and the Testing and Commissioning Programme identifying all major installation, testing activities and associated interfaces.

(i) The Sub-Programmes shall be further substantiated by the supplementary programmes as required by the Engineer.

(j) The Contractor's Works Programme shall comply with the following;

a) All programmes submitted in both hard copy and electronic data format.

b) All programmes shall be prepared using the latest version of CPM scheduling software Primavera Project Planner or similar.

c) A standard Gregorian calendar shall be used for planning and execution of the Works. All programme submissions shall include details of the Contractor's allowance for Public Holidays and known-work periods. If a Milestone falls on a public holiday or nonwork day it shall be effective the next working day.

d) The planning unit for the duration of all programme activities shall be the day. Any activity having a duration of more than thirty (30) days shall be divided into sub activities that shall not exceed thirty days.

e) CPM programmes shall reflect status using remaining duration and percent complete.

f) All programmes shall be fully resource loaded as appropriate or required by the engineer covering all stages and aspects of the Contract and shall include, but not be limited to:

(i) Major manpower for both design and installation.

(ii) Number of items of Contractor's Equipment.

(iii) Number of drawings and other design deliverables.

(iv) Principal quantities of components or parts.

(v) Principle quantities of bulk materials inclusive of cabling, pipe, ductwork andequipment item etc.

(k) All programmes constituting the Works Programme shall be organised in a logical work breakdown structure including work stages or phases. Each activity shall be coded to indicate, as a minimum, the work group or entity responsible for the activity, the area, facility or location and the Cost Centre in which the activity is included, from information provided in the pricing schedules. Milestones shall be coded so as to be separately identifiable. The Contactor may be required to assign additional activity codes as required by the Engineer.

3.4 Design Submission Programme

(l) The Contractor shall, within 30 days of the Commencement Date of the Works submit a Design Submission Programme covering all proposed submissions to the Engineer. The Design Submission Programme shall be broken down into a submission programme for each of the Management Plans of which shall define the dates for individual submissions and shall confirm to the base line dates shown in the Works Programme.

(m) The Submission Programme shall include the requirements of the Design Submission including the procurement activities of all sub-contractors and suppliers.

(n) The Submission Programme shall include each submission for every item listed in the Specification as being required to be submitted.

(o) The Submission Programme shall ensure that all submissions are properly co-ordinated with the Contractor's overall Works Programme, particularly in respect of the following:-

(1) Progress of design, manufacture, installation and testing work;

(2) Co-ordination with other Contractors; and

(3) Including due allowance for the Engineer review process to be undertaken, including the time needed for any re-submissions.

(p) The Design Submission Programme shall specifically include a date of submission by the Contractor of the Final Design on completion of the Preliminary Design stage. The Final Design shall include at least but not limited to; details showing all of the proposed equipment, interconnections, physical layout, installation locations and interfaces to other suppliers.

3.5 Procurement and Manufacturing Programme

(a) Within 60 days of the Commencement Date of the Works, the Contractor shall submit for review by the Engineer a procurement and manufacturing programme that shall be an integrated part of the overall Works programme.

(b) The Procurement and Manufacturing Programme shall show the interdependencies between Engineering disciplines as well as between the contractor and its subcontractors and suppliers. This programme shall demonstrate compliance with the requirements of the Submissions Programme.

(c) The Procurement and Manufacturing Programme shall include a separate breakdown, supported by Material Controlled Schedule, which shall be a complete amplification of the Contractor's Programme and equipment list, including those items which are subject to long lead time or component parts which are manufactured from countries outside the country of assembly and testing.

(d) The Material Controlled Schedule shall be automated, and shall detail the following information for each permanent major and minor material and significant component. The format such a schedule shall include:

(1) Name, description, supplier/sub-supplier details.

(2) Drawing information (where appropriate), title, drawing status, submission dates, shop drawings/fabrication drawing preparation etc.

(3) The manufacturing process, manufacturing of test pieces, trial production, Engineer inspection, monthly production of components and monthly supply of components.

(4) The assembly process, erection and assembly sequences (particularly for the first pieces) prior to shipment, test assemblies, monthly assembly requirement, Engineers inspection, testing of assemblies and

(5) Transportation process, quality release from factory, factory storage to dock and shipment.

(e) The Contractor shall continuously maintain this schedule and report upon the status of each item as part of the contractors regular progress reporting. From this based data, the Contractor shall prepare an exception report detailing all components that are in delay. This report shall be annotated with the reason for the delay and indicate what action the contractor is taking to recover the lost time.

(f) The Contractor shall submit, as part of the Procurement and Manufacturing Programme, a Factory Testing Programme that shall support all aspects of the Factory Testing Plan.

(g) The Factory Testing Programme shall be fully detailed, with the activities individually identifying all tests for which a certificate will be issued, and shall include activities for preparation, submittal and review of the test procedures.

(h) The Factory Testing Programme shall demonstrate the logical dependencies between the individual tests of the works, and shall also show the interfaces and dependencies with the contractors delivery programme.

(i) The Factory Testing Programme shall include details of inspection, testing and witnessing of the contractor's and sub-contractor's procurement and manufacturing activities. As a minimum, it shall include:

(1) First article inspection;

(2) Quality Hold Points;

(3) Quality Control Points;

(4) Type Tests; and

(5) Routine Tests.

(j) The galvanized/material shall be inspected by RDSO/RITES as the case may be. And the inspection charges for the same shall be borne by the Contractor. Material which are inspected by Consignee if required to be tested in the authorized Test labs as per the instruction of the Engineer, then such testing charges shall also be borne by Contractor.

3.6 Installation Program

(a) The Installation Programme shall be submitted as stated in the PS or as directed by the Engineer. The Installation Programme shall comply with the requirements of clause 3.3.10 above.

(b) The Installation Programme shall include detailed activities describing all aspects of the installation of the works, to meet all Milestones given in the contract. It shall be clearly linked to the Design Program, Procurement and Manufacturing Programme and Testing and Commissioning Programme to form an integrated part of the Works Programme.

(c) The Installation Programme shall be fully supported by the Construction and Installation Management Plan.

(d) The Installation Programme shall indicate the physical areas to which the contractors requires access, access dates, duration required and the required degree of completion for civil or architectural finishes prior to the access date.

(e) The Installation Programme shall take into account the requirements for arrival at port, delivery, storage, preservation and positioning of large items of the contractors equipment and permanent works and shall set out the contractors proposed delivery route for such items to the site.

(f) Installation tests shall be clearly shown in the Installation Programme and shall include those interface tests required to be carried out by others to establish a time table for these tests.

(g) Activities that may be expedited by the use of overtime, additional shifts or by any other means shall be identified and explained.

(h) In preparing the Installation Programme, the contractor should note that the following conditions shall apply:

(1) The Contractor shall not have exclusive access to any part of the site except by the specific consent of Engineer.

(2) The Contractor shall take note that concurrent time allocations

for certain areas may be given to more than one contractor. The contractor shall coordinate his works in such areas with that of project contractors through the Engineer.

(3) The absence of a programme date or installation period for the contractor in a specific area shall not prejudice the right of the Engineer to establish a reasonable programme date or installation period for that area.

(4) The Contractor shall comply with the identified Milestone Dates identified in the contract.

3.7 Testing and Commissioning Programme

(a) The Testing and Commissioning Programme shall be submitted as stated in the PS or as directed by the Engineer and shall comply with the requirements of the clause 3.3.10 above.

(b) The Contractor shall submit the Testing and Commissioning Programme that shall 39alvan all the on-site testing and commissioning requirements. The Testing and Commissioning Programme shall clearly demonstrate the logic and highlight topics listed in the On-Site Testing and Commissioning Plan.

(c) The Testing and Commissioning Programme shall be fully detailed, with activities individually identifying all tests for which a certificate will be issued, and shall include activities for preparation, submittal and review of the test procedures.

(d) The Testing and Commissioning Programme shall demonstrate the logical dependencies between the individual tests of the Works, and shall also show the interfaces and dependencies with all of the Project Contractor's tests required to commission the Works and support the Commissioning Plan.

3.8 Training Programme

(a) The Contractor shall, within 120 days of the Commencement Date of the Works, submit for review by the Engineer, a Training Programme covering all proposed formal training courses, delivery of training equipment and accesses by the Employer's personnel.

(b) The Training Programme shall be developed to the Training Plan as required.

(c) The Training Programme shall be sufficiently detailed that the Employer can ensure the availability of staff for all the courses.

(d) The Training Programme shall include the requirements of the Training activities of all sub-contractors and suppliers given in Chapter 6.

(End of Chapter-3)

CHAPTER – 4 INSTALLATION AND CONSTRUCTION

4.1 REQUIREMENTS

4.1.1 General Requirements

- The Contractor shall comply with all Enactments in executing the Works, including but not limited to all statutory provisions on occupational health and safety.
- The Contractor shall co-ordinate with Other Contractors in the execution of the Works.
- The Contractor shall also co-operate with all Relevant Authorities in the execution of the Works.
- The installation of all equipment shall be undertaken at all times by suitably trained and competent employees of the Contractor, to the satisfaction of the Engineer.
- Only appropriate tools, plant, equipment and vehicles shall be used.
- Installation of all equipment shall be in accordance with the Construction and Installation Plan described in the drawing/plan.
- Installation of all equipment shall conform to the best industry practices.
- Precautions shall be undertaken to ensure the safety of personnel and equipment for all installation works.
- The Contractor shall, prior to starting any installation and construction work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices.
- Further details on Site safety management are described in Conditions of Contract on Safety, Health and Environment.
- The Contractor shall ensure that all areas of work are sufficiently illuminated for the works to be undertaken and that a safe system of work is employed for all activities.
- The Contractor shall operate a robust system for the control of persons entering or working upon the site.

The Contractor shall co-operate, always, with the Engineer and Other Contractors to ensure that the Site is protected from unauthorised admission, either wilfully or otherwise.

The Contractor shall make due provision for the safe access and egress to the Site of Works for its staff and subcontractors.

This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the Works.

4.1.2 Specific Requirements

The installation and construction work pertaining to this Contract shall include, but not be limited to the following: -

- Finalisation of the Construction and Installation Programme;
- Survey on Site and review the technical requirements shown in this Specification and the Engineer's Drawings.
- Production of the calculation sheets and installation drawings for Site installation;
- Production of specific site designs and drawings based on typical designs and drawings supplied;
- Installation in accordance with the finalised installation drawings;
- Co-ordination with Other Contractors;
- Submission of the installation reports and records;
- Testing and commissioning, as per finalised protocol and programme.
- Production of as built drawings, documents, calculation sheets, and records.

4.2 Construction and Installation Plan

The Contractor shall undertake installation work in stages as shown in the detailed installation programme. Installation, testing and commissioning of later stages shall not impact revenue operation of earlier stages.

As a minimum, the detailed Construction and Installation Plan shall include but not be limited to all the activities, installation details and methods of all activities, equipment and tools to be used for installation, safety issues, supervision, temporary land occupation needed and the vehicles to be used for installation.

4.2.1 Manual Handling

To facilitate handling of equipment during installation and maintenance thereafter, the Contractor shall closely co-ordinate and interface with other contractors Travelling hoists and unloading jib cranes for traction substations. The entire material handling plan for movement of bulky item such as OHE Conductors, Steel and Concrete masts, 25 kV Switchgear and Auxiliary Transformer etc. shall be carefully planned. Crane of adequate capacity with a jib of requisite length will be arranged by the Contractor at his own cost. Road crane for handling heavy materials at the contractor's depot for loading and unloading of material will be arranged by the contractor who will also arrange his own crew for its operation and maintenance. All charges including pay and allowances of the crew and all running expenditure will be borne by the contractor.

4.2.2 Site Supervision and Safety Issues

- The Contractor shall set up a Site supervision system, which shall be part of the overall safety, system assurance and quality management system.

- The Contractor shall adopt an appropriate quality management system throughout the entire Site installation period to ensure that the System performance requirements as specified in this PS are achieved.
- The Contractor shall provide sufficient number of suitably experienced supervisors and skilled workers as per latest guideline issues by railway board to ensure that the progress and quality of the work, both on Site and in the Contractor's workshops, are maintained to the satisfaction of the Engineer.
- Maintenance in charge shall have a minimum of five years' or more previous experience in a supervisory capacity on similar projects and all the skilled workers including linesmen electrician's fitters and craftsmen, shall have a minimum of two years' previous experience in installation of similar systems.
- The Contractor's supervision system shall be responsible not only for the supervision of the concerned system installation but also for the supervision of the installation of the primary fixing system (mast foundation), the earth mats and systems, etc. The supervisors shall work on a full-time basis during the entire installation process.
- The Contractor shall maintain a set of drawings at each project site which accurately reflect the current status of field changes. The Contractor shall obtain letter of no objection from the Engineer for any such changes. The Contractor shall prepare final drawings showing the as built configuration. These drawings shall be developed in a logical format to facilitate routine system maintenance and troubleshooting. All drawings and details shall be endorsed by the Contractor.
- The Engineer reserves the right to undertake, at any time, checks on the proficiency of the Contractors staff, licensing and all associated documentation. If any of the Contractors staff be found incompetent or unlicensed he shall be removed from the site until their Competency has been established.

4.2.3 Installation of Cables

The Contractor shall co-ordinate with the Civil Contractors wherever necessary, for the installation of cables in cable galleries, trenches, ducts, troughs, risers and other locations.

The cable system shall, during installation, be fully protected from mechanical damage and be generally accessible at all points for inspection along its entire route. Suitable cable markers shall be provided for covered cables upon completion of installation.

Should it prove necessary to cut any cable during installation, all cut ends shall be properly sealed.

The maximum pulling force of any cable during installation shall not exceed the design force of cables.

All cables shall be installed in the formed cable trenches, shafts, hangers, trays and brackets. The minimum recommended bending radius of the cables shall be adhered to during installation.

All materials used for termination, jointing and installation of cables in confined spaces shall have flame retardant, low smoke, halogen free characteristics.

4.2.4 Workmanship

All the installation shall be carried out according to the instructions shown in these specifications and Engineer's Drawings (as approved).

All assemblies of equipment and their components and parts shall be completely interchangeable if they are of similar type

The style and procedure of the workmanship shall be consistent throughout the Works.

Unless otherwise specified, the Engineer shall decide the final colours for all paint work and other finishes to be applied to any part of the Works.

All parts, which are subject to, wear or damage by dust, shall be completely enclosed in dust proof housings.

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CHAPTER – 5 TESTING AND COMISSIONING

5.1 TESTING

This Chapter describes the testing & commissioning related to the Traction Overhead Equipment, SCADA and General Services equipment in conformity with the requirements of RDSO/CORE/Railway Board Standards and Railway practices.

Testing constitutes an essential obligation to satisfy the railway System.

5.2 Testing Conditions And Equipment Acceptance

The contractor will have to carry out all the tests and checks required guaranteeing the Engineer of the good construction and the satisfactory operation of all power supply installation.

Also, the contractor shall co-ordinate & arranges testing equipment etc. required for testing facilities.

The various high, medium and low voltage equipment will be subjected to all the tests required under equipment test sheets, (lists are not exhaustive) as per the relevant IEC or other standards mentioned in the technical specification of each equipment or otherwise.

It is reminded that the contractor is totally entrusted with full responsibility of assembly and installation of all pieces of equipment mentioned in this specification, with supplying the maintenance equipment and the special tooling which shall be delivered as soon as equipment installation will be completed and with the various duties he is bound to regarding witnessing of tests at commissioning and supervision after energising.

5.2.1 In-plant testing: -

In plant testing concern type, routine tests and factory acceptance test.

- Type tests are tests performed on one or two of an equipment series
- Routine test are tests performed on each equipment
- Factory acceptance Tests are tests on a sample size as per standards.

These tests will enable checking the quality of the equipment and its compliance with the specifications.

Following equipment, if desired by the Engineer shall be tested at third-party (duly approved by the Engineer)/ RITES during Factory Acceptance Test.:

- Catenary Wire
- Contact Wire
- Mast and Portal
- Transformer of any capacity
- Switch gears
- Parts cantilever assemblies
- Insulators or other OHE equipment

- Different size of cables (LT/HT)
- High Mast Tower
- Octagonal Poles (5 metres)
- Led light fittings
- CSS panel, DG and APFC panel

Once the equipment will have passed the in-plant acceptance tests, it shall be delivered and installed under the contractor responsibility.

Concerning some type tests, test certificates issued by recognised agencies will be able to be supplied if the contractor cannot carry out these tests himself and if the test certificates are related to a similar equipment of same capacity and design.

The final factory tests will be carried out on the fully assembled equipment as specified. Thereafter, if required and permitted by the technical features of the equipment, the equipment may be dis-assembled for transportation purposes. The dis-assembly should not, however, cause any deterioration of the technical performance of the equipment.

These tests will be carried out by the contractor, under his responsibility and in the presence of the Engineer and of the consulting engineer.

Each of these tests will be subjected to a certificate. Provisional acceptance will be granted only after execution of the both sets of tests.

NOTE: For type tests, the contractor can provide test reports performed according to the corresponding IEC standard, on similar equipment of same capacity and design.

5.2.2 Third Party Tests

- During execution stage Engineer may conduct the Test on any type of equipment from third party independent lab at its own cost, to ensure the quality of material supplies. If any of the samples fail in the test, the cost of the Test along with the complete replacement of whole lot shall be borne by the Contractor.
- If contractor represents, two random samples from the failed Lot shall be collected by the contractor in the presence of Engineer duly sealing the samples and send to two different NABL accredited labs (as approved by Engineer) for conducting all those tests, which were conducted on the failed sample. Cost of the testing including the collection of sample and transportation of sample will be borne by the contractor.
- If both the samples pass all the Tests, the Lot will be deemed as accepted by HRIDC, but in the case of failure of any of the samples collected by the contractor, complete Lot will be deemed as rejected and contractor will replace the whole Lot.
- The delay, if any for the procurement of the material due to failure, shall be considered as non-compliance and applicable penalty shall be imposed on the contractor.

5.3 COMMISSIONING

5.3.1 General

The Commissioning description, based on the following frame, will have to be defined by the contractor and submitted to the Engineer.

Once the contractor will have completed the above tests, and the various pieces of equipment installation, the assignment should include:

- Putting into service tests
- After energising

The engineer will be empowered to ask for any additional testing they may deem necessary.

The contractor will have to supply the testing installations and measuring apparatuses required to this effect.

In accordance with the stipulations, provisional acceptance will then take place, followed by final acceptance at the end of the guarantee time.

5.3.2 Putting into Service Tests

It should be performed at this stage the tests verifying that the different equipment is acting correctly when energised.

5.3.3 Integrated Testing and Commissioning

The general testing having shown proper operation, an overall integrated test of the installations, should be performed, after the first 15 days of operation, during which the various actuation and operation situation (putting into service, normal actuation, failure tripping) will be simulated.

5.3.4 Joint Test report / check List

Once the installation of the various pieces of equipment are complete, Joint tests and tests as per CRS checklist will be conducted at site by the contactor jointly with Engineer and submitted in standard format. (Given in Appendix 15).

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CHAPTER – 6 MAINTENANCE AND TRAINING

6.1 INTRODUCTION

This Chapter describes the maintenance philosophy and training of maintenance staff for power supply, OHE SCADA and General services system considering RDSO/CORE Railway board standards and Railway practices.

The Contractor shall provide comprehensive training and documentation to the engineer staff in accordance with the requirement of this chapter and the chapter of General Specifications.

This training shall enable all the installations, to be operated and maintained in the most efficient and safe manner, to achieve the maximum reliability and economy required by such System.

6.1.1 Maintenance Management

The management of the maintenance process entails defining various levels of responsibility and enabling them to implement the strategic orientations defined by the directing authority:

- by defining their respective missions,
- by setting objectives for each person,
- by translating these objectives into action plans,
- by implementing the means required to carry out action plans,
- by diagnosing the causes of any deviation from the set objectives,
- by taking corrective measures concerning the action plans or the objectives.

This management process requires a global approach and helps to improve the performance of the maintenance work of different components with quality, on time and at low cost.

It must be implemented at three levels:

- at the level of human resources and management in the context of the scheduling of work, the allocation of human resources and the training of personnel,
- at the skills level to ensure quality, safety and suitable working conditions,
- at an economic and financial level to ensure responsible management of production, spare parts, purchasing and miscellaneous costs.

The quality of this management depends on the capability of those entrusted with operation and maintenance responsibilities:

- to exploit the results of management within their field of responsibility,
- to react in the event of any deviation from the action plans defined with a view to achieving the set objectives.

Within the context of this approach, the management control function ensures timely advice to be given to those with operational and maintenance responsibility:

- by placing at their disposal, the tools and information required for piloting and diagnosis,

- by participating in carrying out this diagnosis,
- by participating in the task of defining the objectives to be achieved.

In conclusion, the process of maintenance management must incorporate two major components: the management of human resources and the study of the most suitable means of achieving the set objectives.

This is one of the first guidelines of maintenance organisation in the various relevant centres.

6.1.2 Determining Requirements in Terms of Facilities and Tools

The achievement of the objectives assigned to the maintenance division about quality, safety and regularity for the lowest possible overall cost requires the implementation of a number of resources which must be perfectly tailored to the requirements.

The facilities and tools are part and parcel of the resources placed at the disposal of the maintenance division to achieve the set objectives.

Owing to the cost of these facilities, the number of maintenance centres to be equipped and the necessity of keeping the maintenance actions consistent and uniform, the main choices of facilities and tools are integral part of the System maintenance policy and program.

When determining these requirements, in-depth knowledge in the dedicated maintenance plan is needed while taking due account of the experience acquired in similar fixed installation which has been in service for several years.

6.2 SUPERVISION AND PLANNING OF MAINTENANCE

6.2.1 General

The following outlines the Engineer maintenance strategy, various levels of maintenance, the Maintenance Management System and the arrangement for maintenance.

The Contractor shall make use of all relevant information to provide supervision of maintenance.

6.2.2 Engineer's Maintenance Strategy

According to the maintenance strategy, all equipment and infrastructure supplied for the 'Project' must be such as to ensure for minimum or no maintenance. Maintenance activities required must be capable of being performed with little or no impact on the train service. In addition, the maintenance work systems shall ensure safety of personnel and equipment.

The Contractor shall ensure that to supervise maintenance during the DLP, personnel are always available with the relevant skills and level of competence.

The Contractor, upon noticing any defects, deficiency in quality and quantity of spares and materials shall without delay, arranges for alternative source of supply and submit his proposal to the Engineer for review.

6.2.3 Planned Maintenance

Routine preventative maintenance will be carried out at regular intervals based on condition, reliability, usage, and service history and equipment manufacturers'

recommendations. The Operating and Maintenance Manual shall describe the different levels of planned maintenance.

6.2.4 Supervisory Staff

The Contractor shall provide supervisory maintenance staffs who are expert in all the different levels of fault finding, maintenance and repair of the various relevant systems supplied under the Contract:

- 25 kV OHE
- Switching Stations, including associated switchgear
- SCADA
- General Services work

6.2.5 Maintenance

Maintenance Management System (MMS) and Maintenance Arrangement. The contractor will develop maintenance management system and get it approved from Engineer for schedule maintenance of OHE, PSI, General Services and SCADA Installation's electrical as indicated in Appendix 15A.

Competency of Personnel

During the One-year Maintenance and DLP period the Contractor shall support the Engineer with sufficient trained and competent personnel (Detail given in scope of work chapter) Such persons shall have their generic competence established and must demonstrate their specific competence and knowledge in the particular systems, environment and procedures.

The Contractor shall provide evidence of specific competence and knowledge, which shall include:

- assessment and certified training in particular software applications and operations;
- recording of competence and work in the license holder's logbook; and
- Receiving or in receipt of sufficient and current exposure to the area of work that the holder is licensed for.

Routine spot checks on licensing may be carried out from time to time by the Engineer qualified personnel on the proficiency of the Contractor staff.

In the event of a failure, the Contractor shall undertake the management and investigation necessary to identify and rectify the cause.

If the Engineer, during the DLP requires further investigations at other Sites throughout the system, the Engineer will formally request the Contractor to undertake such investigations.

Maintenance requirements

- **Testing and Re-commissioning of System and Equipment**

In the event of a failure requiring modifications to the System, the Contractor shall undertake any testing and re-commissioning required.

Any such modification shall be submitted for Engineer review.

- **Temporary Alterations to Restore Service**

The Contractor shall undertake any temporary modifications necessary to maintain service.

Any such modification shall be submitted for Engineer review.

- **Discrepancies between Installation and Design Records**

Should the Contractor discover inconsistencies between the maintenance drawings and documentation and the installed equipment, the Contractor shall correct all such errors within two weeks.

Communications

The Contractor shall ensure that adequate communication facilities are provided to its staff during the DLP and maintenance period as per approval of Engineer.

Location of Staff

The Contractor shall be responsible for locating staff such that the Contractor meets its contractual obligations and as per approval of Engineer.

Storage of Equipment and Materials during the Maintenance Period

The Contractor shall ensure that no equipment is to be stored along the trackside.

The Engineer will provide defined storage locations for the support all the different levels of Maintenance as per approval of Engineer.

The Contractor shall satisfy itself and the Engineer that the storage locations for equipment and materials will meet the performance requirements of this PS.

Maintenance Regimes

The Contractor shall provide documented maintenance regimes to be followed by the Engineer upon substantial completion of various components of the work until the end of the DLP.

The Contractor shall produce a maintenance regime for the equipment that shall comprise two constituent parts, corrective and routine/preventative maintenance.

Routine/preventative maintenance shall be non-intrusive to the day-to-day operation of the train service and be capable of being pre-planned in advance of the work.

Corrective maintenance shall be available 24 hours per day, able to respond to all foreseeable circumstances.

The maintenance regime shall cover all parts and equipment of the system designed, installed and commissioned by the Contractor.

The Contractor shall take into account the requirements of the operations and maintenance when determining and proposing its maintenance regime.

Scope and Hours of Coverage

The regime and structure of corrective maintenance shall be robust in design.

The Contractor shall provide full 24 hour On-Call coverage and shall be such that initial response and rectification of failure are in accordance with the following:

- assistance to first level and corrective maintenance within 30 minutes, upon request of first line maintainer;
- All elements of preventative maintenance shall be carried out and completed during non-traffic hours without interrupting train services.

6.3 Routine and Corrective Maintenance Procedures

Routine and corrective maintenance procedures shall be supplied for all equipment. The format shall be as follows:

- Uniform format and layout irrespective of equipment supplier.
- Colour coding for each activity.
- Cross referenced to the Operation and Maintenance Manuals.
- Document control information.

6.3.1 Maintenance Manuals

The Contractor particulars of operating parameters, tools for dismantling and testing, methods of assembly and disassembly, tolerances, repair techniques and all other information necessary to set up a repair and servicing programme as per satisfaction of Engineer.

The Contractor shall provide documentation for all hardware and software for computer systems and other associated electronic equipment to meet the following requirements.

Such documents shall include but not be limited to:

- manufacturers' documentation supplied as standard with the equipment;
- hardware configuration with details of expansion capabilities and options;
- programme loading instructions, including runtime environment configuration;
- programme listing including comprehensive 'comment statements' in hard copy and soft format for source code, compilers and development tools necessary to modify and recompile software;
- flow charts, data flow diagrams and state diagrams as appropriate;
- description of software modules including purpose, linkage with other modules, error routines and any special considerations;
- memory maps for both internal and peripheral memory showing description of all programmes, data files, overlay areas, memory available for expansion and the like;
- loading and operating instructions for diagnostic programmes and specifically developed debugging tools; and
- Programming manuals relevant to operating systems, languages, development tools, etc.

The manual shall also include inspection/overhaul procedure and periodicity of various inspection/overhaul schedules in detail including the tools, special tools/plants, and facilities required.

6.4 TRAINING: -

The Contractor shall provide training for Engineer's staff to enable the Engineer to make proper use of any new versions. The Contractor shall detail any effect such fixes or patches are expected to have, upon the System.

6.4.1 General Requirements

The Contractor keeping the above aspect in view shall provide comprehensive training to the Engineer's staff in accordance with the requirements contained in this Particular specification and general specification. The training shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be in India, abroad, at place of manufacture, assembly or testing, or at such other locations as may be necessary. All places of training shall be subject to review by Engineer The training courses and/or sessions shall include system performance requirements and all major equipment and works designed, by the Contractor.

The specific objectives of each course, training facilities to be used, the qualification and experience of the training instructors and the assessment criteria shall be developed by the Contractor and submitted to the Engineer for review at least three months before any course is conducted.

The Contractor shall provide full-time on-Site management and co-ordination of the entire training programme to ensure the continuity of classes, and proper distribution of training materials, and be responsible for interfacing with the instructors.

The training courses shall be delivered to all relevant Engineer's staff, including instructors, operation and maintenance engineering staff.

The proposed training requirements are given at the end of this Chapter.

6.4.2 Mock-Up for Training

The Contractor shall install mock-up equipment for system and any such facility(s) considered necessary for the training of Engineer's staff in the training school.

The training mock-up shall include but not limited to the following: -

- Clear Cut Section drawings / photographs of various power supply equipment's such as Circuit Breakers, Interrupters, Current Transformers, Potential Transformers, Lightning Arresters and Isolators.
- Cut Section drawings / photographs of HV & MV cables
- Cut Section drawings / photographs of Gas Insulated Switchgear
- Clear photographs of transformers, their windings, bushings etc.
- Samples of various clamps and fittings used in OHE
- Samples of various conductors used in OHE
- Clear drawings and photographs of Control panel, protection schemes, earthing and bonding arrangement;

The Contractor shall submit full details of the training span and other mock up equipment, photographs etc. including proposed training activities and objectives, for the Engineer's review in accordance with clause 6.1 of this Specification.

6.4.3 Training of Engineer's Training Instructors (ETI)

The objective of the training is to enable the Engineer's Training Instructors to be competent to deliver future training courses for other employees of the Engineer.

The Contractor shall provide training to the Engineer's Training Instructors on the various Systems. Aspects covered shall include, but not be limited to, the following:

- Configuration of the entire System, including interface with the HVPNL/RVPN supply system at the feeding points;
- Feature and functional principles of the entire System;
- System design aspects including but not limited to design standards, design criteria and parameters, short-circuit and other calculations, insulation and protection co-ordination;
- Details of major equipment and material including but not limited to 25kV circuit breakers, interrupters, isolators, voltage and current transformers, OHE Conductors, fittings, assemblies and protection relays, and cables of different types and their joints used in the System;
- Details of 25 kV Switchgear and protection;
- System operation and maintenance management and procedures;
- Earthing and bonding arrangement, covering safety aspects of touch and step potential, safety to personnel, passengers and outsiders.
- SCADA System

Operations Staff Training

The objective of the training is to enable the Engineer's operations staff to be familiar with the Systems, with focus on the operational aspects under normal and emergency conditions.

The training shall also enable the trainee to acquire full capability for identification, trouble shooting and rectification of faults in the specified duration. After classroom training which includes mock ups of equipment, the staff shall be trained in actual operation.

Maintenance Staff Training

The objective of the training is to enable the Engineer's maintenance staff and Engineering staff to be familiar with the Systems focus on the maintenance aspects of the System including but not limited to the following: -

- Full understanding of all the equipment, sub-systems and system, their function, maintenance and overall requirements.
- Procedures to be followed for unscheduled maintenance and repair.
- Identification of failed components and sub-systems in electronic equipment by use of special test kit as necessary.
- Modification in the software to extend or modify the control, monitoring and protection functions

6.4.4 Training Requirements

Man weeks of contractor's Training Instructors for training Engineer's maintenance personnel in India.

Training	Man-Weeks
OHE	1
Circuit Breakers & Switchgear	1
General services Equipments/ Cables	1
Electrical safety & Earthing	1
SCADA	10

Man, weeks of contractor's Training Instructors for training Engineer's operating personnel in India.

Training	Man-Weeks
OHE	1
Circuit Breakers & Switchgear	1
SCADA	10

Man, weeks of Engineer's personnel for Off-Shore training at contractor works

Training	Personnel	Man-Weeks
ATD Maintenance	Maintenance Staff	1
	Engineer 's Training Instructors	1

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CHAPTER – 7 TECHNICAL SPECIFICATION

7.1 GENERAL:

a) STANDARDS FOR DRAWINGS:

All designs, legends note on drawings and schedules of materials shall be in English and shall be prepared in the metric system. All designs and drawings shall conform to specification RE/OHE/25 and ETI/PSI/31(5/76) or latest.

b) BASIC DESIGNS:

Where the Contractor adopts designs and drawings conforming to the standard designs, drawings, and specifications of the Research, Designs and Standards Organisation. Manak Nagar, Lucknow-226 011 (RDSO) for basic arrangements, equipment, components and fittings of traction overhead equipment, switching stations booster transformer stations and LT supply transformer stations, he shall verify such designs, drawings and employment schedules and satisfy himself that these are correct before use.

c) RESPONSIBILITY

It is to be clearly understood that all original designs and drawings shall be based on a thorough study. General designs and dimensions shall be such that the Contractor is satisfied about the suitability of the designs for the purpose. The engineer approval will be based on these considerations and notwithstanding the engineer acceptance; the ultimate responsibility for the correct design and execution of the work shall rest with the Contractor in terms of the conditions of Contract.

7.2 PARAMETER for HIGH RISE OHE

The contractor has to comply with the following parameters for HIGH RISE OHE during execution of work:

Height of Double Stack Container	:	7100 mm
Height of Contact Wire at Support from Rail Level	:	7570 mm
Height of Contact Wire at mid Span from Rail Level	:	7520 mm
Height of Catenary Wire at Support from Rail level	:	8970 mm
Pre-sag at mid span	:	50 mm

Maximum Span length	:	To be decided as per New wind zone as per Table 4.13(i) & 4.13(iii) (54 metres for wind load 155 kg/Sq. m)
Maximum Stagger at Tangent Track	:	+150 mm
Maximum Stagger at Curves	:	+250 mm
Standard Encumbrance	:	1.400 metres
Dropper Schedule to be followed	:	1.400/1.400 metres Encumbrance Generally. (Based on Site conditions other prescribed standard Encumbrance may be followed)
Speed	:	140 kmph
Type of Mast (Fabricated)	:	B-150/B–175/B-200/ B-225/B-250
Mast Length	:	11.4 metres
Minimum Implantation	:	2.8 metres
Tension in Catenary Wire	:	1000 kgf
Tension in Contact Wire	:	1000 kgf
Maximum Tension Length	:	1.5 km
Catenary Wire		65 Sq. mm
Contact Wire	:	107 Sq.mm
MERGING WITH EXISTING CONVENTIONAL OHE (IF REQUIRED)		
For Mainline OHE (Height of Contact Wire at support)	:	5.80 metres
For High Rise OHE (Height of Contact Wire at support)	:	7.57 metres

Difference	:	1.77 metres
The High Rise OHE shall be merged with Conventional OHE with the Contact wire gradient of @ 10mm/metre.		

(1) **OTHER DETAILS**

Type of Auto Tensioning Devices	:	Three Pulley modified Groove Auto Tensioning Device as per RDSO Specification No. TI/ SPC /OHE/ ATD /0060 with A & C Slip No. 1 to 3 – For total OHE Tension of 2000 kgf or latest
Stainless Steel Wire Rope	:	As per RDSO Specification No. TI/SPC/OHE/WR/1060 with A & C Slip No. 1 & 2 or latest (Length: 10 metres)
Anchor Height	:	As per RDSO Drawing No. TI/DRG/ OHE/GUYHR/RDSO/ 00001/13/0 (Sheet 1 to 4) or latest
Distance of bottom of Counter Weight Assembly from top of muff	:	2300 mm at 35o C
X-Y Adjustment Chart	:	As per RDSO Drawing No. TI/DRG/ OHE/ATD/RDSO/ 00003/99/0 – Three Pulley ATD or latest
Guide Tube	:	As per RDSO Drawing No. ETI/OHE/ G/01505 or latest

7.3 LIST OF STANDARD DRAWINGS AND SPECIFICATIONS

This Chapter contains list of documents, technical Specifications and referred to in various paragraphs of this Tender.

All references to drawings, charts, schedules, specifications, IS etc. given in this division or elsewhere in the tender document shall be taken to be the latest versions including all amendments. All other items not covered under the Drawing/Specification shall be referred to as per relevant IS and Railway practice in force.

The Drawing and RDSO specification can be purchased from TI Directorate of RDSO, Lucknow on payment basis.

The complete work will have to be planned and executed as per Drawings and specifications (Latest version) of RDSO, CORE & Railway Board.

7.3.1 LIST OF STANDARD DRAWING FOR HIGH RISE OHE: -

S.N.	Brief Description	Drawing		Mod No.
		Series	Number	
1	Design handout for Overhead equipment for running double stack containers under electrified routes (High Rise OHE) with speed potential of 140 Kmph based on revised wind zone.	TI/DESIGNS/OHE/2014/00001 (Rev-1) or latest	-	-
2	Terms of reference for consultancy contract for high speed OHE and high rise OHE.	RDSO Letter No. TI/Traction policy/2013 dated 25.04.2013	-	-
3	OHE span in view of changes in wind zones in country.	RDSO Letter No. TI/OHE/GA/2013 dated 25/30.04.2013	-	-
4	SPECIAL BFB PORTAL FOR 5 TRACKS (GENERAL ARRANGEMENT)	TI/DRG/CIV/BFB-POTAL	00001/13/0	Sh No. 1
5	SPECIAL BFB PORTAL DETAILS OF UPRIGHT	TI/DRG/CIV/BFB-PORTAL	00001/13/0	Sh No. 2
6	G-TYPE PORTAL DETAILS SPECIAL UPRIGHT AND END PIECE	TI/DRG/CIV/G-PORTAL	00001/13/0	-
7	HIGH RISE OHE Employment Schedule Mast (11.4 m) (Wind Pressure 178 kgf/m^2) (Basic Wind Speed 50 m/s) (Without Return Conductor and Without Earth Wire)	TI/DRG/CIV/ES/	00001/13/0	SHEET-1
8	HIGH RISE OHE Employment Schedule Mast (11.4 m) (Wind Pressure 155 kgf/m^2) (Basic Wind Speed 47 m/s) (Without Return Conductor and Without Earth Wire)	TI/DRG/CIV/ES/	00001/13/0	SHEET-2

9	HIGH RISE OHE Employment Schedule Mast (11.4 m) (Wind Pressure 136 kgf/m^2) (Basic Wind Speed 44 m/s) (Without Return Conductor and Without Earth Wire)	TI/DRG/CIV/ES/	00001/13/0	SHEET-3
10	HIGH RISE OHE Employment Schedule Mast (11.4 m) (Wind Pressure 105 kgf/m^2) (Basic Wind Speed 39 m/s) (Without Return Conductor and Without Earth Wire)	TI/DRG/CIV/ES/	00001/13/0	SHEET-4
11	HIGH RISE OHE Employment Schedule Mast (11.4 m) (Wind Pressure 73 kgf/m^2) (Basic Wind Speed 33 m/s) (Without Return Conductor and Without Earth Wire)	TI/DRG/CIV/ES/	00001/13/0	SHEET-5
12	TWO TRACK CANTILEVER STRUCTURE (TTC) GENERAL ARRANGEMENT	TI/DRG/CIV/TTC/	00001/13/0	SHEET-1
13	TWO TRACK CANTILEVER STRUCTURE (TTC) DETAILS OF UPRIGHT	TI/DRG/CIV/TTC/	00001/13/0	SHEET-2
S.N.	**Brief Description**	**Drawing**		**Mod No.**
		Series	**Number**	
14	11.4 M Long Standard Traction Mast "B" Series (B-150, B-175, B-200, B-225 & B-250 type Fabricated with Batten Plates)	TI/DRG/CIV/B- Mast/	00001/13/0	-
15	Volume Charts & Equivalent Charts of Foundations (Side Bearing, Side Gravity & WBC)	TI/DRG/CIV/FND/	00001/13/0	Sheet- 1

16	Volume Charts & Equivalent Charts of Foundations (NG Type)	TI/DRG/CIV/FND/	00001/13/0	Sheet- 2
17	Volume Charts & Equivalent Charts of Foundations for Dry Black Cotton Soil (NBC Type, 3.0 metre Depth)	TI/DRG/CIV/FND/	00001/13/0	Sheet- 3
18	Volume Charts & Equivalent Charts of New Pure Gravity Foundations (500 mm exposed)	TI/DRG/CIV/FND/	00001/13/0	Sheet- 4
19	Volume Charts & Equivalent Charts of Foundations for Dry Black Cotton Soil (NBC Type, 2.5 metre Depth)	TI/DRG/CIV/FND/	00001/13/0	Sheet- 5
20	Employment Schedule OHE Mast (11.4 metre) Wind Pressure 155 kgf/m^2	TI/DRG/CIV/ES/	00001/13/0	Sheet- 1
21	Employment Schedule OHE Mast (11.4 metre) Wind Pressure 136 kgf/m^2	TI/DRG/CIV/ES/	00001/13/0	Sheet- 2
22	Employment Schedule OHE Mast (11.4 metre) Wind Pressure 105 kgf/m^2	TI/DRG/CIV/ES/	00001/13/0	Sheet- 3
23	Schedule Anchor Blocks for BG Tracks	TI/DRG/OHE/GUYHR/	00001/13/0	Sheet- 1
24	Double Guy Rod Arrangement with Anchor Block for BG Tracks	TI/DRG/OHE/GUYHR/	00001/13/0	Sheet- 2
25	Schedule Anchor Blocks for BG Track Black Cotton Soil	TI/DRG/OHE/GUYHR/	00001/13/0	Sheet- 3
26	Guy Rod Ø 25 mm	TI/DRG/OHE/GUYHR/	00001/13/0	Sheet- 4
26 A	Dropper Schedule Encumbrance 1.4m/1.4m (For 25 kV AC Regulated OHE) (65 and 107 SQ. MM)	TI/DRG/OHE/DROP/	00001/10/1	Rev-1
26 B	Dropper Schedule Encumbrance	TI/DRG/OHE/DROP/	00002/10/1	Rev-1

	1.4m/0.9m (For 25 kV AC Regulated OHE) (65 and 107 SQ. MM)			
26 C	Dropper Schedule Encumbrance 1.4m/0.75m (For 25 kV AC Regulated OHE) (65 and 107 SQ. MM)	TI/DRG/OHE/DROP/	00003/10/1	Rev-1
27 D	Arrangement of mounting of 25kV/240V, 50kVA LT Supply Transformer for High Rise OHE (On separate mast)	ETI/OHE/HR/AT/G/	5522 Sheet-2	-
28 E	Mounting Arrangement of Auxiliary Transformer on High Rise OHE mast	ETI/OHE/HR/AT/G/	5522 Sheet-1	-
29 F	Anchor Arrangement with Dwarf Mast for conventional and High Rise OHE	ETI/OHE/HR/ G/	1402	-
30 G	Standard Arrangement of Drop Arm for supporting Cantilevers on the Booms of Portals and TTC (For Normal as well as High Rise OHE)	ETI/C/HR/	76	-
S.N.	**Brief Description**	**Drawing**		**Mod No.**
		Series	**Number**	
31 H	Drilling schedule for S-6H mast (length 13.0 m) (for High Rise OHE)	ETI/C/HR/	181	-
32 J	Drilling schedule for S-7H mast (length 13.0 m) (for High Rise OHE)	ETI/C/HR/	182	-
33 K	Drilling schedule for S-8H mast (length 13.0 m) (for High Rise OHE)	ETI/C/HR/	183	-
34 L	'P' Type Portal General Arrangement and details of upright & End Pieces (High Rise OHE)	TI/DRG/CIV/P-Portal/	00001/13/0	-

7.3.2 LIST OF STANDARD DRAWINGS FOR OHE

SI. No	Brief Description	Drawing		Modification (Mod.) No.
		Series	Number	
1	Extra allowance for setting of structures on curves (1676 mm Broad gauge)	ETI/OHE /G	00111 Sh-1	C
2	Standard setting of structures in the vicinity of signals (broad gauge)	-do-	00112	D
3	Typical design of side bearing foundation.	-do-	00131	-
4	Typical design of cantilever mast.	RE/33/G	00141 Sh.3	-
5	Span and stagger chart for (conventional OHE, Cad. Cu catenary & Cu cont. wire) wind pressure 75,112.5 & l50kgf/m².	ETI/OHE /G	202	-
6	Employment schedule of bracket tubes Conventional OHE (Cad Cu Caty& Cu contact wire 1000 kgf tension each) WP-75 Kgf/ m²	ETI/OHE /G	00158 sh.1 of 3	-
7	Employment schedule of bracket tubes Conventional OHE (Cad Cu Caty& Cu contact wire 1000 kgf tension each) WP-75 Kgf/ m²	ETI/OHE /G	00158 sh.1 of 3	-
8	Employment schedule of bracket tubes Regulated Conventional OHE (Cad. Cu Cat & Cu contact wire 1000 kgf tension in each) WP-112.5 Kgf/ m²	ETI/OHE /G	00158 sh.2 of 3	-
9	Employment schedule of bracket tubes Regulated Conventional OHE (Cad Cu Caty& Cu contact wire 1000 kgf tension in each) WP-150 Kgf/ m²	ETI/OHE /G	00158 sh.3 of 3	-
10	Dropper schedule for uninsulated Overlap spans	-do	169	A
11	Dropper schedule for insulated Overlap spans	-do	170	A
12	Dropper schedule for conventional regulated OHE. With Zero presag (1400/1400)	-do	177	A
SI. No	**Brief Description**	**Drawing**		**Modification (Mod.) No.**
		Series	**Number**	
13	Adjustment chart of Regulating equipment 3 Pulley Type (3:1 ratio)	-do	195	A
14	Schematic arrangement of regulated OHE	-do	2101	A
15	Schematic arrangement of uninsulated overlap (3 & 4 span overlaps)	-do	02121 Sh.4	A

16	Schematic arrangement of insulated overlap	ETI/OHE /G	02131 Sh.3	A
17	General distribution of droppers	ETI/OHE /G	161	-
18	Outline of Pantograph (Broad gauge and metre gauge).	RE/33/G	181	A
19	General formation of single track in Embankments and cutting (Broad gauge.)	RE/33/G	01101 Sh.1	A
20	General formation of double track in embankments and cutting (Broad gauge).	-do-	01102 Sh.1	A
21	General formation of multiple tracks (1676 mm gauge).	-do-	01103 Sh.1	A
22	Standard anchor arrangement	-do-	01401	E
23	Anchor arrangement with dwarf mast.	ETI/OHE /G	1402	B
24	Schedule of anchor block for B.G. track.	-do-	01403 Sh.1	E
25	Schedule of anchor block for B.G. track.	-do-	01403 Sh.2	D
26	Schedule of anchor block for B.G. track (Black cotton soil)	-do-	01403 Sh.3	D
27	Standard guide tube arrangement on a mast and structures.	ETI/OHE /G	1505	-
28	Trapezoidal counter weight arrangement on OHE structures.	ETI/OHE /G	1502	-
29	Arrangement of 3KV & 25 KV Pedestal Insulator supports on OHE masts and portals.	-do-	01601	-
30	Standard arrangements for mounting of number plate on OHE Structures.	ETI/OHE /G	1701	A
31	Schematic arrangement of regulated overhead equipment.	-do-	02101	A
32	Typical arrangements of OHE on cantilever masts for double track section.	-do-	02102	-
33	Typical arrangement for fixing of bracket assembly on 9.5 m mast and Structure to suit raising of tracks (in future)	-do	02102 Sh.3	-
34	Details of bracket arrangement on tangent and curved tracks	ETI/OHE /G	02106 Sh.1	A
35	Details of bracket arrangement for OHE	-do-	02106 Sh.3	C
SI. No	**Brief Description**	**Drawing**		**Modification (Mod.) No.**
		Series	**Number**	

36	Single bracket assembly on Structures and dropped arms.	RE/33/G	2107	D
37	Box type cantilever Arrangement.	ETI/OHE /G	2108	A
38	Arrangement at anticreep.	TI/DRG/ OHE/GE NL/RDS O/	00001/12/ 0	0
39	Standard cantilever arrangement for boom anchor anticreep location.	ETI/OHE /G	2113	-
40	Schematic arrangement of uninsulated over Lap (type-I) (3 & 4 Span overlaps)	RE/33/G	02121 Sh.1	F
41	Schematic arrangement of insulated overlap.	ETI/OHE /G	02131 Sh.1	
42	General arrangement of regulated OHE at turn-outs (overlaps & crossed type).	ETI/OHE /G	2141	C
43	General arrangement of regulated OHE at cross over (overlap & crossed type).	-do	2151	-
44	Arrangement of neutral section	-do-	02161 Sh.1	C
45	Arrangement of neutral section assembly (PTFE Type) at SWS.	-do	2162	-
46	Arrangement of short neutral section.	-do	02161 Sh.2	-
47	Standard termination of OHE (Regulated & un-regulated).	ETI/OHE /G	03121 Pt 1 of 3	E
48	-do-	-do	03121 Pt 2 of 3	E
49	-do-	-do	03121 Pt 3 of 3	E
50	General arrangement of pull off	-do-	03301	A
51	General arrangement of Head span	-do	3201	-
52	In span jumper connection between catenary & contact wire.	-do-	05101	-
53	Continuity jumper connection at un-insulated overlap turnouts and cross overs	-do	5102	C
54	Anti- theft jumper	-do	5107	A
55	Connections at turnouts	-do	5103	B
56	Potential equalizer connection at insulated overlap and neutral section	-do-	05104	-
57	Connections at diamond crossing.	-do-	05106	A
58	General arrangement of connections to OHE by copper cross feeder (150).	-do	05121 Sh.1	C
59	General arrangement of connections at switching station on double track section by copper cross feeder	ETI/OHE /G	05122 Sh.1	C

60	General arrangement of connections at switching station on multiple track section by copper cross feeder	-do-	05123 Sh.1	C
SI. No	**Brief Description**	**Drawing**		**Modification (Mod.) No.**
		Series	**Number**	
61	Suspension of 25kV feeder(Spider)on 25KV OHE masts	ETI/OHE /G	5143	B
62	Termination of feeder, return conductor & return feeder (copper & aluminum).	ETI/OHE /G	05145-1	A
63	Arrangement of suspension of double spider 25 KV feeder and return feeder between sub-station and feeding station	RE/33/G	5152	C
64	Assembly of section insulators	RE/33/G	5181	C
65	General arrangement of earth wire on OHE mast	ETI/OHE /G	5201	A
66	General arrangement of earth wire on OHE mast	ETI/OHE /G	05201-1	-
67	Arrangement of transverse bonds	ETI/OHE /G	5251	A
68	Connection of return conductor to track	-do-	05306	F
69	Suspension arrangement of aluminum return conductor (spider) on traction Structures	-do-	05307	B
70	Suspension of return conductor (spider) from boom of Structures (with clevis type disc insulators)	-do-	05312	A
71	Connections between OHE and aluminum return conductor at booster stations	ETI/OHE /G	5413	B
72	Mounting of 25kv Isolators on OHE Structures (General arrangement)	ETI/OHE /G	05513 Sh.1	A
73	Details of small part steel work for supporting 25kv Isolator on new T.T.C. boom	-do-	05513 Sh.2	A
74	Connection from Isolator to OHE	-do-	05516	A
75	Characteristics of conductors/ bus-bar for 25kv AC traction	-do-	05600	A
76	Mounting arrangement of Auxiliary Transformer on OHE masts	ETI/OHE /G	5522	-
77	Chart for portal foundation	-do-	0005/68	
78	Muff for OHE structures	-do-	0007/68	E
79	Structures muff for sand cored foundations	-do-	0012/69	E

80	9.5 m Standard traction mast (fabricated `K' series)	-do-	0018-2	D
81	Remote Control Cubicle at Stn, Foundation, RCC slab, Building plant & Steel door	-do-	0067	B
82	9.5 m long standard traction mast (fabricated with bottom plates `B' series)	ETI/C	71	E
83 A	Details of OHE foundation in soft rock (Bearing capacity 45,000 Kgf/m²).	ETI/C	59	C
83 B	Details of OHE foundation in Hard rock (Bearing capacity 90,000 Kgf/m²).	ETI/C	60	D
84	Details of foundation for fencing upright	-do-	0032	B
SI. No	**Brief Description**	**Drawing**		**Modification (Mod.) No.**
		Series	**Number**	
85	Employment schedule for switching and booster station main masts	ETI/C	185	B
86	Drilling schedule for S-1 mast	ETI/C	30	F
87	Drilling schedule for S-2 mast	-do-	0031	D
88	Drilling schedule for S-3 mast (length 11. 4 m)	-do-	0180	C
89	Drilling schedule for 8" x 6" x 35 1bs. RSJ mast 8.0 m long for booster transformer station Type S-4	-do-	0036	E
90	Drilling schedule for S-5 mast (11.4m long)	-do-	0042	E
91	Drilling schedule for S-6 mast (length 12.4m)	-do-	0181	C
92	Drilling schedule for S-7 mast (length 12.4m)	-do-	0182	C
93	Drilling schedule for S-8 mast (length 12.4m)	-do-	0183	C
94	Drilling schedule for S-9 mast (length 12.4m)	-do-	0184	C
95	General arrangement & details of fencing panels & gate for switching station	-do-	0186 Sh.1	E
96	Details of fencing uprights and anti-climbing device for switching station	-do-	0186 Sh.2	E
97	S-100 fabricated mast for mounting LT supply transformer and drop out fuse switch at switching station	-do-	0043	B
98	S-101 details of mast for supporting Isolator inside switching station	ETI/C	44	A
99	Details of anchor beam or SP, SSP, & FP	-do-	0033	D

100	Details of small part steel for switching station	ETI/C	0034 Sh.1	K
101	Details of bracing for switching & B.T. masts	ETI/C	0034 Sh.2	B
102	Details of small parts steel of out rigger for switching stations and booster transformer stations	ETI/C	37	C
103	Details of small parts steel for booster transformer stations	ETI/C	40	E
104	Details of pre-cast cable trench for switching station	-do-	0038	E
105	Standard 'R' type portal rod laced general arrangement	-do-	0011/69 Sh.1	C
106	'G' type portal special upright and end piece	-do-	0056	C
107	Short bored pile foundation for traction mast (permissible BM & volume)	-do-	0062	B
108	Dwarf mast foundation on wet & dry black cotton soil	CORE/ALD/OHE/SK/C	2	-
109	Typical design of new pure gravity foundation.	ETI/SK/C	131	A
110	Typical design of side gravity foundation (Soil pressure=8,000 Kg/ M²)	-do-	142	A
SI. No	**Brief Description**	**Drawing**		**Modification (Mod.) No.**
		Series	**Number**	
111	Rock Anchor for B.G. Track. –	ETI/SK/C	208	-
112	Bracket fitting for PSC Mast (cap 4200 Kgm) general arrangement and SPS details	ETI/SK/C	214 Sh.1of 2	E
113	SPS details for Earth wire clamp on PSC mast	ETI/SK/C	214 Sh. 2 of 2	A
114	Special arrangement of OHE under over line structure	ETI/OHE/SK	529	--
115	Earthing and bonding of PSC mast.	ETI/OHE/SK	537 Sh.1 of 2	D
116	Typical Earthing arrangement in SPUN PSC Mast with 18mm dia rod.	-do-	537 Sh.2 of 2	B
117	Arrangement of overlap	ETI/OHE/SK	566	-
118	Catenary dropper assembly	ETI/OHE/P	1190	B
119	Parallel clamp (20/20)	ETI/OHE/P	1550	E
120	Standard guide tube assembly.	ETI/OHE/P	5060-2	C

120 A	Counter weight assembly for Regulating Equipment (3:1 Ratio)	ETI/OHE /P	5090-5	E
120 B	Trapezoidal weight assembly for Regulating Equipment (3:1 Ratio)	TI/DRG/ OHE/AT D/RDSO/	00004/00/ 2	-
120 C	Trapezoidal weight assembly	ETI/OHE /P/	5090-1	G
120 D	Counter weight assembly	ETI/OHE /P/	5090	F
121	Standard anti-wind clamp	-do-	2550-1/2	L
122	Multiple cantilever cross arm assembly.	RE/33/P	3120	H
123	Anchor fitting assembly on rolled sections	ETI/OHE /P	3230	C
124	Anchor fitting assembly on 'K' series, TCC masts and 'P' type portal upright.	-do-	3240	D
125	Anchor assembly on 'N' and `O' type portal upright	-do-	3250	D
126	Structure bonds	-do-	7000	F
127	Earthing station	-do-	7020	B
128	Longitudinal rail bond	-do-	7030	F
129	Short super mast assembly	ETI/C/P	8010	G
130	Long super mast assembly	-do-	8020	C
131	Bracket attachment assembly on portal upright (N,O,R,P,G &BFB Type)	-do-	8030	B
132	Super mast assembly on portals	-do-	8050	C
133	Medium super mast assembly	ETI/OHE /P	8060	C
134	Compensating plate	-do-	5191-1/2	D
135	Suspension clamp	RE/33/P	1160	J
136	Double suspension clamp	-do-	1170	K
137	Double suspension lock plate.	-do-	1172	C
138	Catenary splice (65)	ETI/OHE /P	1090	-
139	Typical location & schematic connection diagram for a three interrupter switching station	ETI/PSI	3	C
140	Typical general arrangement of a three interrupter switching station	-do-	004	F
SI. No	**Brief Description**	**Drawing**		**Modification (Mod.) No.**
		Series	**Number**	
141	Typical location plan & general arrangement for sectioning & paralleling station	-do-	005	F
142	Typical location plan and general arrangement for a feeding station	-do	6	E

143	Typical number plate for Auxiliary Transformer	ETI/PSI/P	7525	-
144	Typical fencing and anti-climbing arrangement at switching stations	ETI/PSI	104	E
145	Typical earthing layout of sub-sectioning and paralleling station	-do-	201	B
146	Typical earthing layout of a sectioning and paralleling station	-do-	202	B
147	Typical earthing layout of a feeding station	-do-	203	B
148	Earthing details for interrupter L.T. supply transformer 25 KV Lightning Arrestors P.T. Type-I (S-100 masts, S-101 mast, fencing upright and main mast)	-do-	204	C
149	Typical cable run layout of a sub-sectioning & paralleling station	-do-	301	C
150	Typical cable run layout of a sectioning and paralleling station	-do-	302	C
151	Typical cable run layout of a feeding station	-do-	303	B
152	Typical drawing for a terminal board	-do-	501	C
153	36 mm Aluminum Bus terminal for 25kv Isolator (Rigid type)	ETI/PSI/P	6480	C
154	36 mm Aluminum Bus splices	-do-	6490	B
155	36 mm Aluminum Bus Tee connector	-do-	6500	C
156	36 mm Aluminum Bus Tee terminal	-do-	6510	D
157	36/15 mm Top connector	-do-	6520	B
158	36mm Aluminum flexible bus splice	-do-	6550	B
159	36 mm Aluminum bus splice cum tee connector	-do-	6560	B
160	Typical number plate for interrupter and double pole isolator	-do-	7520	B
161	Typical number plate for potential transformer Type	-do-	7521	B
162	Typical number plate for booster transformer	-do-	7522	B
163	Caution plate 25 KV AC	ETI/OHE /P	7531	C
164	General Caution notice at entrance to railway Station (Hindi & English)	RE/33/P	7551	C
165	Typical details of pressed steel door, window and ventilator	RE/Civil/ S	129/ 2001	R2
166	Bolted base connection for portals located in drains	ETI/C	10	C
	Brief Description	**Drawing**		

SI. No		Series	Number	Modification (Mod.) No.
167	Details of base plate for mast on drains in station yards	-do-	0002/68	A
168	Arrangement for false catenary under over line structure	ETI/OHE /SK	446	--
169	Typical arrangement of OHE with insulated copper catenary under over line structure	ETI/OHE /SK	570	--
169 A	Anti-Climbing Arrangement	TI/SK/OHE/ANTIMON/RDSO	00001/08/0	--
169 B	Anti-Climbing Arrangement	TI/SK/OHE/ANTIMON/RDSO	00001/09/0	--
169 C	GSSW Assembly	TI/DRG/OHE/GSSW	0002/09/0	--
169 D	18 mm Lug (Forged) (Compression type)	TI/DRG/OHE/GTBLUG/RDSO	00001/04/0	--

7.3.3 STANDARD TYPICAL AND PARTICULAR DRAWINGS FOR SCADA WORKS

The annexure contains reference to standard, typical and particular drawings & specification referred to in various paragraph of tender document.

SI. No	Brief Description	Drawing		Modification (Mod.) No.
		Series	Number	
1	General scheme of supply for 25 kV 50 Hz Single Phase AC	ETI/PSI	702-1	D
2	Typical layout of control room at TSS	TI/DRG/PSI/CPROOM/RDSO	00001/01	0
3	Typical layout of remote control cubicle at switching stations.	ETI/PSI	10	E
4	Schematic inter connection diagram for remote control of power gear & supervision equipments at TSS.	ETI/PSI	644	C
5	Schematic inter connection diagram	ETI/PSI	645	C

	for remote control of power gear and supervision equipments at controlled station (SP & SSP)			
6	High speed Auto reclosing Scheme for feeder Circuit Breaker at 25 kV A.C. Traction Sub-station.	ETI/PSI	0231-I	A
7	Control desk arrangement for 2 work stations of SCADA system.	ETI/PSI/SK	337	Nil
8	Setting up earthing station at switching posts (SSP & SP) with conventional earthing as per Special Maintenance No. TI/SMI/0032 Rev-1	-	-	-

Note: -

1. ThescopeofworkshallbeapprovedtosupplytheentireSCADAsystem/equipment/hardware/asperRDSOspecification No. TI/SPC/RCC/SCADA/00130/(Rev-2) with A&C slip no.1 or latest amendments. However, the software for RCC has to purchase from RDSO approved software vendors only.

2. RTUs supplied for the controlled posts shall include the necessary transducers, summation CT', PT, supply change over arrangement, digital analogue input modules, limit settings, CPU cards, power supply unit, surge arrestor, relays and contactors etc. at Traction sub-stations/ SPs/SSPs for different analogue parameters and measurements as per mentioned in the specifications and tender documents.

7.3.4 NEW WIND PRESSURES/SPEEDS AS PER RDSO: -

S.No.	Design Wind Pressure	Basic Wind Speed	
	(Kg/m^2)	**metre / second**	**Km / hour**
I	178	50	180
II	155	47	169.2
III	136	44	158.4
IV	105	39	140.4
V	73	33	118.8

7.3.5 LIST OF STANDARD DRAWING AS PER NEW WIND ZONES

S I. No	Brief Description	Drawing		Modification (Mod.) No.
		Series	Number	
1	Normal OHE Employment Schedule Mast (9.5 m) (Wind Pressure 178 kgf/m^2) (Basic Wind Speed 50 m/s) (Without Return Conductor and Without Earth Wire)	ETI/C/	0758 Sheet-1	A
2	Normal OHE Employment Schedule Mast (9.5 m) (Wind Pressure 155 kgf/m^2) (Basic Wind Speed 47 m/s) (Without Return Conductor and Without Earth Wire)	ETI/C/	0758 Sheet-2	A
3	Normal OHE Employment Schedule Mast (9.5 m) (Wind Pressure 178 kgf/m^2) (Basic Wind Speed 50 m/s) (Without Return Conductor and Without Earth Wire)(1100+1100) kgf tension CAT-65 mm^2, CONT-107 mm^2.	ETI/C/	759 Sheet-1	-
4	Normal OHE Employment Schedule Mast (9.5 m) (Wind Pressure 155 kgf/m^2) (Basic Wind Speed 47 m/s) (Without Return Conductor and Without Earth Wire) (1100+1100) kgf tension CAT-65 mm2, CONT-107 mm2.	ETI/C/	759 Sheet-2	-
5	Normal OHE Employment Schedule Mast (9.5 m) Basic Wind Speed 50 m/s Wind Pressure 178 kgf/m^2 (Without Return Conductor and Without Earth Wire) 1000 kgf tension in CAT. 65mm^2 1000 kgf tension in CONT. 107mm^2	TI/DRG/CIV/ES/RDSO/00001/18/0	Sheet-1/5	
6	Normal OHE Employment Schedule Mast (9.5 m) (Basic Wind Speed 47 m/s) (Wind Pressure 155 kgf/m^2) (Without Return Conductor and Without Earth Wire) 1000 kgf tension in CAT. 65mm2 1000 kgf tension in CONT. 107mm2	TI/DRG/CIV/ES/RDSO/00001/18/0	Sheet-2/5	-
7	Normal OHE Employment Schedule Mast (9.5 m) Basic Wind Speed 50 m/s Wind Pressure 178 kgf/m^2 (Without Return Conductor and Without Earth Wire) 1000 kgf tension in CAT. 65mm^2 1000 kgf tension in CONT. 107mm^2 (with implantation more than 2.8 m &upto 3.8 m)	TI/DRG/CIV/ES/RDSO/00002/18/0	Sheet-5/5	-
S I. No	**Brief Description**	**Drawing**		**Modification (Mod.) No.**
		Series	**Number**	

8	Normal OHE Employment Schedule Mast (9.5 m) (Basic Wind Speed 47 m/s) (Wind Pressure 155 kgf/m^2) (Without Return Conductor and Without Earth Wire) 1000 kgf tension in CAT. 65mm2 1000 kgf tension in CONT. 107mm2 (with implantation more than 2.8 m &upto 3.8 m)	TI/DRG/CIV/ES/RDSO/00002/18/0	Sheet-4/5	-
9	Normal OHE Employment Schedule Mast (9.5 m) Basic Wind Speed 50 m/s Wind Pressure 178 kgf/m^2 (Without Return Conductor and Without Earth Wire) 1000 kgf tension in CAT. 65mm^2 1000 kgf tension in CONT. 107mm^2 (with implantation more than 3.8 m &upto 4.85 m)	TI/DRG/CIV/ES/RDSO/00003/18/0	Sheet-5/5	-
10	Normal OHE Employment Schedule Mast (9.5 m) (Basic Wind Speed 47 m/s) (Wind Pressure 155 kgf/m^2) (Without Return Conductor and Without Earth Wire) 1000 kgf tension in CAT. 65mm2 1000 kgf tension in CONT. 107mm2 (with implantation more than 3.8 m &upto 4.85 m)	TI/DRG/CIV/ES/RDSO/00003/18/0	Sheet-4/5	-

7.3.6 LIST OF STANDARD RDSO SPECIFICATIONS FOR OHE, TSS AND SCADA

SI. NO.	TITLE OF SPECIFICATION	SPECIFICATION NO
1	Annealed stranded copper conductor for jumper wire.	ETI/OHE/3(2/94) with A&C slip No.1of (4/95)
2	Copper busbar	RE/30/OHE/5 (11/60)
3	Structural Steel tubes.	ETI/OHE/11 (5/89)
4	Hot dip zinc 73alvanization of steel masts (Rolled and Fabricated) tube and fittings used on 25 KV AC OHE.	ETI/OHE/13(4/84) with A&C slip No. 1of (5/86),2 of (4/90) & 3 of (4/90)
5	Stainless steel wire ropes	TI/SPC/OHE/WR/1060 with A&C slip No 1 of (11/06) & 2 of (05/07)
6	Solid core porcelain insulators for 25 KV 50 Hz single phase overhead lines	TI/SPC/OHE/INS/0070 (04/2007)
7	25 KV single and double pole isolators.	ETI/OHE/16(1/94) with A&C slip No.1 of (06/2000) & 2 of (3/2004)
8	Steel fasteners & Stainless Steel fasteners	TI/SPC/OHE/Fasteners/0120

9	Aluminum alloy section and tubes	ETI/OHE/21(9/74)
10	Standard for drawings for Traction Overhead equipment	ETI/OHE/25(3/66)
11	Light Weight Section Insulators assembly. OR Section Insulator assembly without sectioning insulator.	TI/SPC/OHE/LWTSI/0060 (8/2006) OR ETI/OHE/27(8/84) with A&C slip No.1 of (10/92)
12	Enameled steel plates	ETI/OHE/33(8/85)
13	Retro-reflective Structure Number Plates & Caution/Warning Boards	ETI/OHE/33A(12/97) Rev-8 (11/12)
14	Galvanised steel wire	ETI/OHE/36(12/73) with A&C Slip No.1 of (5/98)
15	3 pulley Type Regulating Equipment	TI/SPC/OHE/ATD/0060 (8/2006) with A&C Slip No1 of (10/2006), 2 of (5/2007) & 3 of (01/13)
16	Fitting for 25 kV 50 Hz AC Overhead equipment.	TI/SPC/OHE/Fitting/0130(10/13) {Old ETI/OHE/49 (9/95) with A&C}
17	Cadmium copper conductor for overhead Railway Traction	ETI/OHE/50 (6/97) with A&C slip No.1 to 3 (04/09).
18	Principles of OHE layout plans and sectioning diagrams for 25 KV AC traction.	ETI/OHE/53(6/88) with A&C slip no.1 of (12/88), 2 of (8/89), 3 of (6/90), 4 of (8/92) & 5 of (11/2006)
SI. NO.	**TITLE OF SPECIFICATION**	**SPECIFICATION NO**
19	19/2.79mm All Aluminum alloy stranded catenary wire.	ETI/OHE/54(2/85) with A&C slip No. 1 of (11/89) &2 of (10/92)
20	Bimetallic (Al-cu) strip	ETI/OHE/55(4/90)
21	Short Neutral Section Assembly (Phase Break)	TI/SPC/OHE/SNS/0000 of (2/2000) with A&C slip No. 1
22	Code for bonding and earthing for 25 KV, AC single phase, 50 Hz traction system.	ETI/OHE/71(11/90) with A&C slip no. 1 of (8/91) & 2 of (3/93)
23	Insulated Cadmium copper catenary 19/2.10 mm dia for provision under overline structures in the 25 KV AC Electric Traction.	TI/SPC/OHE/INSCAT/0000 of (4/2000)
24	Battery charger for 110 V battery, 40 AH.	ETI/PSI/1(6/81)
25	Lightning arrestor- 7.5 KV	ETI/PSI/3(8/75) with A&C slip No.1 of (2/91)

26	220 KV or 132 KV or 110 KV or 66 KV or 25 kV Potential transformers	TI/SPC/PSI/PTs/0990 with A&C slip No.1 to 5 (01/09)
27	25 KV Dropout fuse switch & operating pole for use with 10 KVA and 100 kVA 25 kV/ 230 V L.T. Supply transformer.	ETI/PSI/14(1/86) with A&C slip no 1 of (4/87)
28	25 kV/240 V, 5 kVA,10 kVA, 25 kVA & 50 kVA, 50 Hz single phase oil filled Auxiliary Transformers.	ETI/PSI/15(8/03)
29	Low maintenance Lead Acid 40AH & 200 AH cells.	RDSO/PE/SPEC/TL/0040-2003(Rev-0) with A&C slip no 1 of (9/2005)
30	150 KVA, 25 KV, single phase, 50 Hz. Dry type Cast resin Booster Transformers	ETI/PSI/97(6/87) with A&C slip No.1 of (9/88)
31	100 KVA & 150 KVA, 25 KV, single phase, 50 Hz, oil filled Booster Transformers	ETI/PSI/98(8/92) with A&C slip No.1 of (9/92), 2 of (1/94) & 3 of (6/94)
32 A	25 KV AC Single Pole, Double Pole mounted, Out Door Vacuum Circuit Breaker (VCB) and Vacuum Interrupter (BM).	TI/SPC/PSI/LVCBIN/0120 (December'2013) Revision-0)
32 B	220 kV/132 kV/110 kV/100 kV/66 kV Double Pole, Triple Pole, Out Door SF6 Circuit Breakers.	TI/SPC/PSI/HVCB/0120 (June'2014) with A&C slip No.1(March-16)
33	Hard drawn grooved copper Contact wire	ETI/OHE/76(6/97) with A&C slip No.1 of (4/01), 3 of (03/05) , 4 of (12/06), 5 of (7/09), 6 of (5/12) & 7 of (12/13)
34	Metal Oxide Gapless type Lightning Arrestor for use on 25kV side of Rly. Traction sub stations & switching stations	TI/SPC/PSI/MOGTLA/0100(07/10)
35	Technical Specification for Silicon Composite Insulators for 25 kV A.C. 50 Hz single phase over head traction lines.	TI/SPC/OHE/INSCOM/1070 (01/07) OR TI/SPC/OHE/INSCOM/1071 (04/13)
36	Specification for solid core porcelain cylindrical post insulator for systems with nominal voltage of 66kV, 110kV, 132kV & 220kV.	TI/SPC/OHE/POST/0100(01/2010)
SI. NO.	**TITLE OF SPECIFICATION**	**SPECIFICATION NO**
37	25kv/240V L.T. supply Transformer, 100 KVA	ETI/PSI/15 A (7/82) with A&C Slip No.1(9/89)
38	Battery charger for 110V Battery, 200 AH	ETI/PSI/24(6/81)
39	Low tension Distribution panels for Rly. A.C traction sub-stations	ETI/PSI/29 (12/79)With A&C Slip No.1 (2/93)

40	Standard for drawings for power supply Installations.	ETI/PSI/31 (5/76)
41	Low tension distribution panels.	ETI/PSI/63(7/82)
42	Technical specification for control and relay panel for 25kV ac TSS including specification for numerical type protection relays for traction transformer, 25kV shunt capacitor bank and transmission line for 25kV ac TSS on Indian Railways.	TI/SPC/PSI/PROTCT/6071
43	Technical specification for shunt capacitor & series reactor equipment for traction sub-station	TI/SPC/PSI/FC&SR/0100(01/10)
44	Technical specification for 25kV ac, 50 Hz, single phase, oil filled, current transformer with CT ratio of I-1000-500/5A (for general purpose), II-1500-750/5A (for heavy haul duties) for Railway ac traction sub station.	ETI/PSI/90 (6/95) with A&C Slip No.1, 2,3,4,5,6,7 (08/2007) & 8 (April 2009).
45	Technical specification for two zone static relay for distance protection for 25kV ac single phase 50 Hz traction overhead equipment.	ETI/PSI/101 (8/87) with A&C Slip No.1 (09/87)
46	Technical specification for current transformers. I. 220kV. 200-100/5A, II. 132kV. 400-200/5A, III. 110kV. 400-200/5A, IV. 66kV. 800-400/5A for Railway A.C traction substations.	ETI/PSI/117 (7/88) with A&C Slip No.1 (11/88), 2 (3/89), 3 (12/89), 4 (4/90), 5 (6/90), 6 (9/92), 7 (8/05), 8 (08/2007) & 9 (July 2008).
47	Specification for 21.6 MVA single phase, 50 Hz. I) 220/27kV ii) 132/27kV iii) 110/27kV, iv), 66/27kV traction power transformer for Railway A.C traction sub- station.	ETI/PSI/118 (10/93) with A&C Slip No.1 to 9 & A&C slip No.10 (08/12) or latest
48	Code of practice for earthing of power supply installations for 25kV A.C., 50 Hz, single phase traction system.	ETI/PSI/120 (2/91) with A&C Slip No1 (10/93)
49	Technical specification for i) 245 kV, (ii) 145 kV, (iii) 123 kV, (iv) 72.5 kV double pole & triple pole Isolator for Railway traction sub stations.	ETI/PSI/122 (3/89) with A&C Slip No.1(4/90)
50	Specification for Metal Oxide gapless type lightning arrestors (combined) for use on 220/132/110/66 kV side of Railway A.C. traction sub station.	ETI/PSI/137 (8/89) with A&C Slip No.1,2,3 (Embodying) A&C slip No. 4(8/94) 5(04/01), 6 (9/05) & 7(07/2007)
51	Technical specification for 220 kV or 132 kV or 110 kV or 66kV or 25 kV potential transformer.	TI/SPC/PSI/PT_S/0990 with A&C Slip No.1,2,3,4,& 5 (April 09)

52	Delta I type High resistive fault selective Relay for 25 kV AC Single phase 50 Hz traction system.	TI/SPC/PSI/PROTCT/1982(12/2003) with A&C slip No.1(10/13)
SI. NO.	**TITLE OF SPECIFICATION**	**SPECIFICATION NO**
53	Panto flashover protection relay for 25 kV A.C. single phase 50 Hz traction system.	TI/SPC/PSI/PROTCT/2983 (09/2001)
54	Technical Specification of SCADA system for 25kV, AC Single phase Traction supply on Indian Railway.	TI/SPC/RCC/SCADA/0130(04/2014)
55	Technical Specification for Galvanised Steel Stranded Wire for Traction Masts	TI/SPC/OHE/GSSW/0090 (10/2009)
56	Technical specification for galvanized steel stranded wire for traction bonds	TI/SPC/OHE/GALSTB/0040(09/04) Rev. 1 (08/05)
57	Setting up Earthing Station at switching posts (SSP & SP) with conventional Earthing.	Special Maintenance Instruction No. TI/SMI/0032 Rev-1
58	Design handout for Overhead equipment for running double stack containers under electrified routes (High Rise OHE) with speed potential of 140 Kmph based on revised wind zone.	TI/DESIGN/OHE/2014/0001 upto latest version.
59	OHE span in view of changes in wind zones in country	TI/OHE/GA/2013 DATED 25/30.04.2013
60	Technical guidelines and Standard Instruction for Railway Electrification Works including OHE, TSS, Transmission Line, SCADA, Electrical General Works, signaling Works, Telecom works & Civil Engineering Works.	CORE/RE TENDER/EPC/2014/STANDARD INSTRUCTIONS AND GUIDELINES

7.3.7 LIST OF IS SPECIFICATION

S. No.	IS Code No.	Descriptions
1	IS:210-1993	Grey iron castings
2	IS:269-1989	Specification for 33 grade ordinary Portland cement (4th Rev)
3	IS:282-1982	Dropper Wire
4	IS:306-1983	Tin bronze castings

5	IS:335-1993	New Insulating oil (4th Rev) Reaffirmed 2000
6	IS:371-1999	Ceiling rose spec.((3rd Rev)
7	IS: 383-1970	Specification for coarse & fine aggregates from natural sources for concrete
8	IS:398(PT.I)-1996	All Aluminum conductor
9	IS:398 Pt.II-1996	Al. conductor for overhead transmission purposes
10	IS:398(Part-III) 1976.	Aluminum conductors galvanized steel reinforced
11	IS: 432 Pt.1-1982	Specification for mild steel & medium tensile steel bars and hard drawn steel wires for concrete reinforcement
12	IS: 456-2000	Plain & Reinforced concrete Code of practice (3rd Rev)
13	IS: 516-1959	Method of tests for strength of concrete
14	IS:617-1994	Aluminum castings
15	IS:694:1990	Al. Jumper wire
16	IS:702-1988	Specification for industrial bitumen (2nd Rev) reaffirmed 1999
17	IS:731-1971	Porcelain Insulator for overhead power lines with a nominal voltage greater than 1000V
18	IS:732-1989	Code of practice for electrical wiring installation (3rd Rev)
19	IS:800-1984	Code of practice for general construction in steel (2nd Rev)
20	IS:808-1989	Dimensions for hot rolled steel beam, column, channel & angle sections
21	IS:816-1969	Welding
S. No.	**IS Code No.**	**Descriptions**
22	IS:875 (Part-3) 1987 (Reaffirmed)	Code of practice for design loads (other than earthquakes) for building and structures – Part 3: Wind loads second revision.
23	IS:1293-2005	Plugs & socket outlets of rated voltage upto and including 250V and rated current up to 16 Amp(3rd Rev)
24	IS:1387-1993	General requirements for the supply of metals and metal products
25	IS: 1489 Pt. I 1991	Specification for Portland-Pozzalana cement Pt .I Fly ash based (3rd Rev)

26	IS:1554(Part-I) 1988	PVC insulated cables
27	IS:1608-1995	Mechanical testing of metal- tensile testing
28	IS:1731-1971	Dimensions for steel flats for structural & general engineering purpose
29	IS:1777-1978	Industrial Luminaries with metal reflectors (1st Rev)
30	IS:1786-1985	Specification for high strength deformed steel bars and wires for concrete reinforcement
31	IS:1897-1983	Copper strip for formed fittings
32	IS:2004-1991	Carbon steel forgings for general engineering purpose
33	IS:2062-2011	Steel for general structural purpose
34	IS: 2074-1992	Ready mix Paint, air drying, Red oxide, Zinc chrome
35	IS:2121-1981	Aluminium and steel cord Aluminium conductors for (Part I & II) overhead power lines.
36	IS:2141-2000	Galvanized stay strand
37	IS:2312-1967	Propeller type AC ventilating fans (1st Rev)
38	IS: 2386 Pt.III-1963	Method of tests for aggregates for concrete Pt. III Specific gravity, density voids, absorption & buckling
39	IS:2673-2002	Dimensions for Aluminum Tubular Busbar.
40	IS:2675-1983	Enclosed distribution fuse boards ad cut-outs for voltage not exceeding 1000V AC & 1200V DC (2nd Rev)
41	IS:3043-1987	Code of practice for earthing (1st Rev)
42	IS:3091-1999	Aluminum bronze castings
43	IS:3188-1980	Characteristics of string insulator units
S. No.	**IS Code No.**	**Descriptions**
44	IS:3837-1976	Accessories for Rigid steel conduit for electrical wiring
45	IS:3854-1997	Switches for domestic & similar purposes(2nd Rev)
46	IS:4826-1979	Specification for hot dipped for galvanized coatings on round steel wires (1st Rev)

47	IS:5082-1998	Material for Aluminum tubular busbar.
48	IS: 6403-1981	Code of practice for determination bearing capacity of shallow foundations (1st Rev)
49	IS:7098 (Part I) 1988	LT XLPE cables
50	IS:7098 (Part II) 1985	HT XLPE cables
51	IS: 8130-1984	Conductor for Insulated electric cables & flexible cords (1st Rev)
52	IS:9537 Pt-I-1980	Conduits for electrical installations
53	IS:9968(Pt.2)-2002	Annealed Copper Jumper Wire
54	IS:13947 Pt. III 1993	Specification for low voltage switchgear & control gear Pt.-3, disconectors& fuse combination unit
55	IS:14329-1995	Malleable iron castings

7.4 ABBREVIATIONS

General abbreviations used in the PS shall have the following meaning: -

Abbreviations	Meaning
AC	Alternating Current
ACOCB	Alternatingcurrentoutgoing circuit breaker
ACRC	Alternatingcurrentrectifiercontactor
ACRCB	Alternatingcurrentrectifier circuit breaker
AMS	AuxiliaryMain Sub Station
ASS	AuxiliarySub Station
AT	Auxiliarytransformer
ATCB	Auxiliary Transformer Circuit Breaker
ATIS	Auxiliary Transformer Isolator
B	Traction bus bar
BA	Batteries
BAIT	Batteries interrupter
C&C	Control & Communication
CAMS	Computer Aided Maintenance System
CB	Circuit Breaker
CCB	Coupling circuit breaker
CIS	CouplingIsolator
CTATP	Current Transformer for protection of Auxiliary Transformer
CTC	Currenttransformer for coupling
CTIM	IncomingCurrent Transformer for Measurements
CtT	Currenttransformer for traction transformer
CTTTP	Current Transformer for Protection of Traction Transformer
DC	Direct Current

DCAC	Direct currentauxiliarycontactor
DCACC	Direct currentauxiliarycouplingcontactor
DCOCB	Direct currentoutgoing circuit breaker
DCRC	Direct current rectifier contactor
DTN	Data Transmission Network
TRANSCO	Transmission Company (erstwhile DVB)
ECC	Energy Control Centre
EIS	EarthingIsolator
EMIS	Energy Management and Information System
GRC	General Remote Control
IED	Intelligent ElectronicDevice
IS	Isolator
IR	IndianRailways
IT	Interrupter
OCC	Operations Control Centre
ITC	Couplinginterrupter
L	Hand operated traction isolator
LAAT	Surgearrester for Auxiliary Transformer
LAN	Local Area Network
LATT	Surgearrester for Traction Transformer
Abbreviations	**Meaning**
LBCB	Lighting bridge circuit breaker
LBCCB	Lighting bridge coupling circuit breaker
LBCCT	Lighting bridge couplingcurrent transformer
LBCT	Lighting bridge current transformer
LBCVT	Lighting bridge coupling voltage transformer
LBEIS	Lighting bridge earthingisolator
LBVT	Lighting bridge voltage transformer
LEIS	Line EarthingIsolator
LFCB	Lighting feeder circuit breaker (spare)
LFEIS	Lighting feeder earthingisolator
LIS	Line Isolator
LV	Low Voltage
LVACB	Low voltage auxiliary circuit breaker
LVACCB	Low voltage auxiliarycoupling circuit breaker
LVAT	Low voltage auxiliarytransformer
LVATCB	Low voltage auxiliarytransformer circuit breaker
LVATEIS	Low voltage auxiliarytransformerearthingisolator
LVCB	Low voltage circuit breaker
LVCCB	Low voltage coupling circuit breaker
MC	Metro Corridor (Underground)
MCCB	Metro corridor circuit breaker
MCEIS	Metro corridor earthingisolator
MCIS	Main couplingisolator
MMI	Man Machine Interface
HMI	Human Machine Interface
MVCB	Medium Voltage Circuit Breaker

NMS	Network Management System
NGR	NeutralGroundResistor
OCC	Operation Control Centre
OHE	Over-Head Equipment
PCW	Power Control Workstation
PICOP	Person In Charge Of Protection
PLC	Programmable Logic Controller
PNCT	Primaryneutralcurrenttransformer
PNEIS	Primaryneutralearthingisolator
PNLA	Primaryneutralsurgearrester
RC	Rail Corridor
RCCB	Rail corridor circuit breaker
RCEIS	Rail corridor earthingisolator
RSS	ReceivingSub Station
SCADA	Supervisory Control And Data Acquisition System
SNCT	Secondaryneutralcurrenttransformer
SNEIS	Secondaryneutralearthingisolator
SNLA	Secondaryneutralsurgearrester
SP	Sectioning and Paralleling Post
SSP	Sub-Sectioning and paralleling Post
Abbreviations	**Meaning**
T	Transformer
TCB	Traction Circuit breaker
TEIS	Transformer EarthingIsolator
TSS	Traction Sub Station
TT	Traction transformér
TTCB	Traction Transformer Circuit Breaker
TTIS	Traction Transformer Isolator
UPS	Un-interruptible Power Supply
VDU	Video Display Unit
VT	Voltage Transformer
VTB	Voltage Transformer for traction bus bar
VTBB	Bus Bar Voltage Transformer
VTC	Voltage transformér for coupling

Further abbreviations may be defined within the body of the GS or PS where there is only local applicability. Where such abbreviations exist the Contractor shall exercise great care that the abbreviation is not used out of context when communicating with the Engineer or any Third Party.

7.5 MAIN APPLICABLE RDSO STANDARDS/SPECIFICATIONS/DRAWINGS

RDSO Drawing/Standard/Specification No.	Title/ (Applicable for)
ETI/OHE/13(4/84).	Hot dip galvanization
TI/SPC/OHE/ FASTENERS/0120:	All Steel Fasteners and Stainless Steel Bolts, Screws, Nuts, Lock Nuts, Plain and Spring Washers

RDSO drawing no. ETI/OHE/G/04207 Sh-1.	Section Insulator in tramway OHE
ETI/OHE/42	107 sq. mm contact wire
ETI/OHE/50, Latest version	Bridle wire for Tramway OHE
RDSO drawing no. ETI/OHE/G/04204	Tramway OHE cantilever arrangement
ETI/OHE/16(1/94)	25 kV Isolators
ETI/PSI/71 (1/87) with A&C slip no. 1 to 7 or Latest Version	25 kV Lightning Arrester
ETI/OHE/16(1/94) as per to latest version	25 kV Switchgears
ETI/PSI/98 (08/92) with all latest amendments	For Booster transformers
TI/SPC/OHE/SNS/0000	Location for SNS (SP)
ETI-C-0068	horizontal or vertical awnings for mechanical protection
ETI/OHE/33 A (12/97) Rev.-7	Number Plate, caution boards/Notice such as caution board on mast, caution board at neutral section etc.
ETI/OHE/P/7503 or Latest Specification	for retro reflective number plates

Note: -

1. All the required drawings like General Power supply arrangement, sectioning diagram, wiring diagram, LOP, Cross Sectioning diagram, SED, Location plan, pegging plan, OHE arrangement on bridges drawing with emergency provision, Bridges mast drawing, switching post diagram etc as per Railway Electrification practice being followed by Indian Railways shall be prepared by the contractor. Indicative drawings for GPS cum sectioning arrangement are attached with tender documents for reference.
2. All the required machines & Equipment's like Tower Wagon, Diesel Loco, BRN wagon, Conventional Coach, BRN mounted 5 MT rail crane etc. shall be arranged by contractor.
3. All materials used in the work shall be procured from RDSO/ CORE approved sources only and of the best quality and of the class suited for the purpose specified.
4. The contractor shall be solely responsible for the correctness of the position, levels and dimensions of the works according to approved drawings, notwithstanding that he may have been assisted by the Purchaser or his men in setting out the same.

5. The contractor is bound to follow IR ACTM and IR SOD Up to latest correction slip in design, installation and other electrification work.

1)

6. Notwithstanding anything given anywhere else all work execution shall be as per latest design and drawing of RDSO/CORE and latest guideline issue by Railway Board.

2)

7. The contractor should follow all the clearances as per latest CEA regulation.

8. Meet the Project Safety and Environment requirements as per "Project Safety and Environment Manuals".
9. Meet the all protective provisions relating to electrical safety.
10. Above Note shall be applicable to the complete work in this tender.

7.6 TECHNICAL SPECIFICATION OF GENERAL SERVICES: -

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
1.	Wiring for light/ceiling fan/exhaust fan/call bell etc. points including circuit wiring, sub-main wiring with Fire Retardant (FR), PVC insulated, multistranded, copper conductor, single core cable on surface/in recessed PVC conduits, distribution boards, sub distribution boards, earthing and suitable number of modular switch and socket.	1. The point/ circuit wiring is to be done by 03 x 1.5 sqmm insulated multi-strand copper wire for phase, neutral and earth inside pvc duct/ conduit 19/20 mm. 2. Wiring of sub-main with single core insulated, multi-stranded 3x2.5/3x4.0/3x6.0 sqmm PVC CU cable in PVC conduit ISI mark 19/20mm concealed in stone/ bricks masonry wall separate conduit & 2.5/4.0/6.0 sqmm PVC CU cable insulated multi-stranded for earth wire respectively. 3) 3. Wire for phase, neutral and earth shall be laid/done in concealed with heavy duty ISI marked PVC conduit pipe,	• IS: 694-2010 for PVC conductor. • IS: 3854/1997 for switches 8) • IS: 1293/2005 For Plugs & socket • IS: 371/1999 for celling rose. 9)	• PVC CU conductor- Finolex / Polycab / KEI / Havells or similar as approved by Engineer. • Modular switch/ socket – Anchor /Roma / Schneider / Legrand / Havells or similar as approved by Engineer. 12) • MCCB/RCCB/ MCB/DB – Legrand, ABB, Schneider and similar. 13)

		minimum 19/20 mm dia and thickness 1.5 mm along with bend / junction. 4) 4. SITC of 5/6 and 15 Amp plug 5-pin 230V or above modular type switch socket of standard size on existing board and connection with 2.5sqmm and 4.0 sqmm PVC CU cable respectively. 5) 5. Supply and fixing of PVC cable duct 40 x 60 (w x h) 1 M STD slot greenish grey. 6. SITC of Double Pole MCB of 32 Amp, 10 kA C series is to be provided in the metal enclosure. 6) 7. SITC of 02/04/08/12 Module modular Plate MS Box (GI) for fixing of switches and sheet metal box of thickness 2/3 mm, of good quality and standard size.	• IS: 8828/1996 for MCB • IS 13947 (Part -1) 1993 for MCCB 10) • IS:9537/2000 for PVC conduit • The Electricity Act-2003 or 11) Latest. • All CPWD Norms for electrical wiring	• PVC conduit – BEC / AKG / Polypack or similar as approved by Engineer. 14)

		8. SITC of Double Door MCB DB SP 12 way (10+ 2 module), neutral and earth link and suitable IP protection, with one no DP MCB 40amp, one no DP RCCB 40 amp 30 mA and eight no SP MCB 32/25/16/10/6 amp. 'C' series. 7) 9. SITC of Double Door MCB TPN DB 8 modules 4 row, neutral and earth link, and suitable IP protection with one no 4 pole MCB 40 amp, one no FP RCCB 40 amp 30 mA and twenty-four no SP MCB 40/32/25/16/10/6 amp. Min 02 Nos of DB should be installed at each floor of station building or as per requirement.		
2	Supply, installation, testing and commissioning of pre-wired 22 watt energy efficient Tube light fitting(4 feet) on wall bracket connections from	1. SITC of LED tube light (22 Watt) suitable for IP-20 for indoor application operating voltage (140-270) V minimum 2000 Lumens, Colour temperature 6500°K, CRI>65, CRCA steel sheet type enclosure.	• CEE Spec No:CEE/NR/121-Elect/PS/2019(REV-04) Dated-04.11.2019 or latest for LED light.	• Bajaj, Philips, Crompton or similar as approved by Engineer.

	junction box/light point etc. to luminary with 1.5 sq.mm FRLS PVC insulated multistranded copper conductor single core/three cable as instructed & earthing etc.	**2.** SITC of rechargeable batten type Emergency light 60 LEDs, 4 watt or higher with one-hour minimum backup. Minimum 40 Nos in overall C-2 Package area.		
3	Supply, installation, testing and commissioning of 230V A.C. ceiling fan (1200/1400MM)/Exhaust fan and fan Regulator.	1. SITC OF ceiling fan 230V A.C. 1200/1400 mm ISI mark 5-star energy rating issued by BEE. 2. SITC of heavy duty exhaust fan 300mm sweep with louver shutter. 3. SITC of modular type electronic fan regulator, 5 step type on existing board.	• IS: 374/1979 for ceiling fan • 2312/1967 for Exhaust fan 15) • IS:11037/1984	• Crompton Greaves / Usha / Bajaj /Havells / Schneider or similar as approved by Engineer. • Anchor /Roma / North-West / Schneider / Legrand / Havells Crabtree or similar as approved by Engineer for fan regulator.
		1. SITC of sandwich type rising main 800 Amp straight runner (Rising Main -1) for		

4	Provision of Bus Trunking System (Rising Main structure) In Manesar station building (G+3) as per requirement and specification.	use on 3 phase 4 wire 415 Volt 50 Hz AC supply temp. rise as per requirement with enclosure having IP 54 rating after fixing the tape of boxes and all accessories made of GI/Aluminium sheet enclosure IP 54 duly power coated in convenient sections complete with 4 nos. copper Bus bar having current density of 1.6 Sqmm per Amp at nominal current rating, necessary joint & expansion joints, Fire barrier at each floor, provision of taping at every meter, continuous earthing with 2 nos copper strip of suitable size (1 on each side) including all accessories for fixing. 2. SITC of 800 A capacity End feed unit for the existing sandwich type rising mains for use on 3 phase 4 wire 415 Volt 50 Hz AC supply made with GI/Aluminium sheet enclosure (IP 54) duly power coated with provision of MCCB complete with necessary fitting accessories. 3. SITC of sandwich type rising main 250 Amp straight runner (Rising Main –II) for use on 3 phase 4 wire 415 Volt 50 Hz AC supply temp. rise as per requirement with enclosure having IP	• IEC-61439 • IEC 60439-1 and IEC 60439-2 16) .	• Any reputed make of ISI mark

		54 rating after fixing the tape of boxes and all accessories made of GI/Aluminium sheet enclosure IP 54 duly power coated in convenient sections complete with 4 nos. copper Bus bar having current density of 1.6 Sqmm per Amp at nominal current rating, necessary joint & expansion joints, Fire barrier at each floor, provision of taping at every meter, continuous earthing with 2 no's copper strip of suitable size (1 on each side) including all fitting accessories. 4. SITC of 125 A plug IN/Tap off box on the existing sandwich type rising mains for use on 3 phase 4 wire 415 Volt 50 Hz AC supply made with 1.6 mm thick sheet steel enclosure IP 54 duly power coated with provision of MCCB complete etc. as required. "Danger" warning signs of an approved type shall be provided at the front panel of all tap-off units. 5. Bus duct joints shall be of removable type with clamping bolts that can be checked for tightness without de-energizing the whole bus duct length and The cross-sectional area (CSA) of copper conductors shall be 270Sqmm.		

5	Provision of High Mast Tower (16 Mtrs) with LED Flood Light fitting (200 Watt) complete in all respect and as per requirement. Minimum 06 Nos of LED light fitting at each HMT.	1. SITC of hot dipped galvanised (inside & outside), 16m high mast system (in two sections), complete with accessories, foundation bolts with nuts, washers, anchor plates & templates etc. manufactured from special steel, head frame, 2-point suspension system with steel wire rope 6mm dia (7/19 construction), double drum winch, galvanised lantern carriage arrangement suitable for required luminaries symmetrically arranged & control gear boxes and lighting finial etc. The mast shall have integral type power tool at the base compartment for its raising and lowering operation, twin dome LED aviation obstruction lights. construction of foundation as per recommendation of manufacturer and approved drawing and its fixing arrangements etc. 2. SITC of Control Panel consist of - (a) 1X63 A TPN MCB for incoming suppl (b) 3X32 A SPN MCB for outgoing (50% lighting, 100% lighting, motor) (c) Automatic timer with Power contactor for controlling above lights of suitable capacity. (d) 1 no multi plug socket 16A 3. High mast shall be provided with fencing panel of size 2Mx2Mx1.5M in square shape (If required by Engineer) for	• IS:875(Part-3)/1987 for High mast Structure, • BSTN-10025/1993 for High Mast Shaft, • IS:2026 for other component IS: 2629 / 1985, BSEN ISO-1461 for Galvanization	Bajaj, Philips, Crompton or similar	

		protection of erected high mast tower wherever required as directed by Engineer. **4.** SITC of LED flood light fitting (200 Watt) pre die cast aluminium, IP-66 protection, with high power LED lamp complete with all accessories. **5.** Provision of Pipe Earthing system of each HMT. (Minimum 02 earth is required for each high mast tower).	CEE Spec No:CEE/NR/121-Elect/PS/2019(REV-04) Dated-04.11.2019 or latest for LED light.	
6	Provision of Octagonal poles (5 metres) with street light fitting (40 Watt) and 70-30% arrangement with complete accessories.	1. SITC of 5 mtrs. long octagonal pole made with 3 mm thick GI sheet, Top Dia 70 mm, Bottom dia 130 mm with single /double arm hot dip galvanized steel octagonal Poles with galvanized base plate of 220 x 220x 12 mm (as per IS 2062) and GI bolt size M20 X 600mm X4 no in position including excavation of pit and filling the same with concrete M-20 including supply of material as required or recommended by pole manufacturer. 2. SITC of 40-Watt LED Energy efficient LED based street light fitting with pressure die cast aluminium housing with driver & suitable fixing arrangement, IP-65 for	• IS:2629/1985, BESN ISO-1461 for Galvanization. • CEE Spec No:CEE/NR/121-Elect/PS/2019(REV-04) Dated-04.11.2019 or latest for LED light.	• Bajaj, Philips, Crompton or similar as approved by Engineer.

		outdoor application, operating voltage (140-270) V, System efficacy more than 100 lm/W, colour temperature 6500K, CRI>65. Complete with all accessories. 3. SITC of modular digital timer for automatic operation of platform, circulating area, street light etc. complete with required power contractor, digital timer and MCB etc. in enclosure of suitable size and power Contractor.		
7	Provision of Passenger Lifts (13 Passengers, 884 Kg) (G+1) with complete accessories at Manesar and New Patli Staion.	1. Supply fixing testing and commissioning of passenger Lifts (13 Passanger,884 Kg) gearless machine room less, single landing(GF&FF), Minimum load 13 persons speed 1m/s to 1.5 m/s, Automatic door with two side opening, microprocessor base variable frequency, variable voltage derive controller with ARD, Stainless Steel Hairline Finish Car and Car Door, 1.00 MPS. Simplex Collective, Selective Control, Emergency Light, Fireman's switch, Alarm Button, Phase Failure & Phase Reversal Protection, Automatic Rescue Device, Vacuum fluorescent display in Car and other safety device with minimum guarantee/ warranty of 02 years.	• IS-14665/2000 for Lift • RDSO/2013/EM/SPEC/0016 Rev (0) for Lift • All CPWD Norms for installation of Lifts.	• OTIS, KONE, Mitsubishi, Jonson or similar as approved by Engineer.

		2. Contractor should provide all the safety parameters/ License/ Insurance certificate and other required clearness issued by state authorities. 3. During Warranty period contractor will ensure all preventive and schedule maintenance/checks will be done by OEM only with in time interval as given by Engineer. 4. During warranty period all the Breakdowns like defective/ broken of lifts Light, Fan, Batteries ARD and various electronic cards with in 3 hrs otherwise penalty may be imposed as per decision of Engineer. (See also Para 7.7 for detail technical specification of lift)		
8.	Provision of Sub-Station (11/0.440 KV) including CSS-1 and CSS-2. Each CSS Shall be consisting of 11KV Compact VCB/SF6 CB panel (1 incoming isolator + 2 outgoing VCB/SF6 CB with air insulated BUS PT	1. Each CSS comprising of 11 kV compact substation suitable for outdoor installation with natural cooling, having type tested equipment comprising of dry-type (CRT) distribution transformer and SF-6 insulated compact switchgear enclosed in robotically sealed stainless steel tank, low – voltage switchboard, interconnection between HT switchgear and transformer using cables and transformer to LT-switchgear using	• IEC 62271-202	• ABB/Raychem/Voltamp/Schneider/Siemens/CG or similar as approved by Engineer.

	metering module) + DRY type Transformer (500 KVA) Capacity + L.T. Switchgear with all HT & LT inter- connections, accessories, fittings & auxiliary equipment inside GI Enclosure as per technical specification. CSS also include 1 RMU 11KVA 630 Amp 21 KA, LT panel as per spec., APFC panel 200 KVAR MPP type heavy duty, all HT and LT cable with proper termination arrangement of suitable size and length, Suitable H-pole arrangement with GO/DO switch (if required) supply, fixing and commissioning of 160 kVA DG set with AMF panel, Provision of Copper Plate earthing as per requirement and as per technical specification and supply & fixing of all safety items required for 11/0.440 substation as per	aluminium bus bars, factory built ready for connection type, internal GI earthing provided complete with other associated equipment etc. complete as required as regards to design, manufacturing, type-testing, route-testing, pedestrian and operator safety (IAC AB 21ka/1-sec). The enclosure shall have modular construction using G.I. Sheet and shall be power-coated from exterior. The transformer compartment will have IP-54 protection. 2. HT SWITCHGEAR shall comprise of 03-Way Ring Main Unit having 01nos. Fixed-Type VCBs feeding to transformer in CSS, all enclosed in common tank, made of robotically welded non-magnetic/non-ferritin Stainless Steel Sheets, and filled with SF6 gas acting as insulating medium to suitable pressure, the tank design meeting IP-67 criteria with SF6 gas leakage rate less than 0.1% per annum, whereas it shall be Arc-Proof design with internal Arc classification IAC 20ka/1-sec individually. The complete Ring Main Unit should be a front-accessible design with associated Capacitive Voltage LED Indicators for each arc-proof cable box,		

	rules.	along with associated Terminal Protector boots and front-facia semaphore mechanical indication for isolator/breaker ON/OFF/EARTH. The breaker will have provided with integrated Self-Powered 30C +1EF relay with low and high set for over current and earth fault. Relay should have facility to display the maximum loaded phase current also. Relay shall record minimum 5 fault records with time stamping, and shall be actuated via Resin cast Ring Core Protection CTs of suitable ratio and burden installed in the cable box. 3. 01no. 500 KVA 11KV/433V Dyn11 Dry Type Distribution transformer having cast resin design Bushings for HT and LT with Off load tap switch of rating +5% to -5% @2.5% and WTI scanner. Temp Rise – 115 deg C, Class 'H' insulation, Losses = 2.2 kW (NLL/7.25KW(FLL) (Subject to IS Tol.), Impedance 5% (Subject to IS Tol.) and 01no. WTI Alarm/Trip Scheme and Surge arrestor in the HV side. 4. LV-PANEL shall be a totally enclosed, floor/Wall mounted, dead-front access, min IP2X protected panel which has a type tested design, aluminium		

		busbars, suitable switchgear configuration and indication scheme as describe below 01no. 433V, 800 Amp, Aluminium Busbar Arrangement with suitable colour coding scheme for identification for each phase.01no. 800A, 433V, 50Ka, 4P Fixed, Manual ACB with microprocessor based over current, short circuit and earth fault release acting as IC-OG arrangement 01set. LED based ON/OFF/TRIP Indication for mains ACB. 01no. Multifunction Meter for measurement of various parameters like Voltage, Amp, kVA, kw, PF etc. of reputed make for mains ACB. (along with associated CT where applicable) 5. OUTDOOR ENCLOSURE shall comprise of having construction of Galvanised Sheet Steel of thickness at least 1.5mm. The Enclosure shall have IP54 degree of protection for HT & LT switchgear compartment & IP23 degree of protection for Transformer compartment. The enclosure shall be Power coated. Each compartment will be provided with the door and pad locking arrangement. The compartment illumination lamp with the door operated switch shall be provided for HV and LV compartment.		

		6. LT Panel: - One additional LT panel (technical specification same as S. No-18) will be installed at Substation for further LT power supply distribution CSS, HT Switchgear, transformer and LT switchgear should be of same make. The successful tenderer shall submit the arrangement GTP and other relevant drawings for approval as per standard make prior to supply and execution of work. Note: - Indicative drawings of Sub-station are attached at page No- 117 and 118 of this chapter.		
9.	Provision of Inverter type Split AC (1.5 Ton, Heavy duty, 5 Star Rating with Stabilizer) and other accessories as per site requirement	1. SITC of 1.5 Ton heavy duty, 5-star inverter type split air conditioner with required suitable size nuts, bolts, fasteners, cu pipe & petty hard ware in all respect. Top up the required refrigerant & maintain the pressure (If required) as per company recommendation or latest Eco-friendly refrigerant.	• IS:1391/1992 for Air conditioning	• Voltas, Blue Star, Carrier, Hitachi, O -General, Mitsubishi or similar as approved by Engineer. .

		2. SITC of Metal Clad Plug Socket 20A single phase with 32A MCB 10kA ,c series including fixing and sheet metal enclosure box with one 20A plug top (Ray roll type) to be supplied with board for each AC.		
10.	Provision of LED Signage Board & LED Station Name Board (Single Sided/Double Sided) with all accessories	1. Design, SITC of LED back lit single & double-sided signage boards with IP-65 CRCA housing, vinyl print on acrylic sheet which is back lit with high grade, high brightness LED modules inbuilt SMPS driver, without battery backup. Operating voltage 80-270VAC. LED with L70 life of minimum 50,000 hours, LPM technology, including fabrication and supply of clamping arrangements as desired. 2. The pictogram and letter of desired colour and size made by translucent vinyl sheet cut through computerized machine shall be pasted on acrylic sheet. Acrylic sheet with pictogram shall be fixed on CRCA/GI sheet powder coated box with suitable arrangement. Subject matter and pictogram can be seen in the standard book of signage available in office. 3. Depth of box shall be approximately 3.5 inches (for single sided) 5.5 inches (for double sided) and made by 0.8 mm thick CRCA/GI sheet with powder coated having louvers for ventilation on two	• IS:16101-2012 and 16102-2012 part 1 and 2.	• PHILIPS, NICHIA, OSRAM and SEOUL or similar as approved by Engineer.

		sides having suitable gaskets for protection against water and vermin ingress.		
11	Supply and laying of different sizes 1.1 kV grade LT XLPE insulated armoured, aluminium conductor cable, in trench/ air/ HDPE pipe. making good the damages, end terminations with aluminium crimping sockets/lugs, provision of cable route markers, testing and commissioning etc.	1. Supply of 1.1 KV grade 4x16/4x35,4x50,4x70,4x95,4x120 and 4x185 sqmm LT XLPE insulated armoured aluminium conductor cable, making good the damages, end terminations with aluminium crimping sockets/lugs, gland, testing and meggering etc. as per required Technical specifications. 2. The contractor shall arrange inspection of cable at manufacture's works before dispatch at his own cost if required by the Engineer. 3. supply & laying of HDPE pipe in already excavated trench under road/ground/floor/railway track etc. as per site requirement size 75/80 and 50 mm Dia wall thickness 3mm PN-4 conforming to IS 4984:1995 or latest as per site requirement. Pipe should be laid in trench such that It shall be possible to withdraw the cables for repair or replacement without disturbing the work. 4. supply & laying of HDPE pipe in already excavated trench under road/ground/floor/railway track etc. with technical specification 160 mm dia (OD), wall thickness between 6.2 mm to 7.1	• IS: 7098 Part-II-1985 for cable • IS: 8130-1984 for cable • IEC-502 standards with latest amendment. • IS 4984:1995 or latest for HDPE pipe	• KEI, Finolex, Havells and Universal or similar as approved by Engineer for cable. • Duraline / Godavari / Rex Polyextrusion/ Eflex or similar

		mm, material grade PE-80 and class of pipe should be PN-4. 5. Laying of underground cable under the road/Railway track, recessing in platform /wall along with Railway Track. in laid HDPE /GI pipe as required 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable including making chase & plastering after laying of cable/digging of cable trench, sand cushioning, protective covering with second class bricks, provision of cable route marker (200x150x3mm thick M.S. Plate and welded to MS rod of min 5 mm dia including bending and fixing) as per tech. spec. 6. Excavation & Refilling of 0.5 Mtr Width 1.20 Mtr Deep trench in all kinds of soil for laying of HDPE/GI pipe for underground cable crossing. Contractor will clear all metallic parts & stones etc. in trench. 7. Drilling of horizontal bore below Rly track by pushing method for laying of HDPE/SPUN/DWC/CI/GI pipe up to 450 mm by pushing method. Horizontal boring will be done at minimum 1.5 Mtr. Below or as per site requirement from ground level.		as approved by Engineer for HDPE pipe. • Comet / Dowells / Lapp Kabel / Hummel or similar as approved by Engineer for Lugs and glands.

		8. SITC of LT heat shrinkable straight through joint with required accessories complete in all respect suitable for LT XLPE 4 core cable as per site requirement. Note: - Indicative Drawing of Cabling arrangement of any station is attached at page No 119 of this chapter.		
12	Provision of Water Cooler (150 Ltrs) capacity with MS Cage & suitable protection arrangement as per site requirement.	1. SITC of self-contained drinking water cooler 150 litres capacity (cooling capacity 150 Lts. per hour), ISI marked, min 3 star rated, suitable for operation on 230 volts+/-10%, 50Hz, AC supply system complete with all connected standard fittings, accessories etc. and 5KVA, wall mounted, I.C. controlled electronic auto-voltage corrector.	• IS:1475/2005 • IS: 1475 Part-1/2001	• Blue Star, Kelvinator, Shriram, Voltas or similar as approved by Engineer. .

13	Provision of Water Pumping Arrangement system with 1 HP Submersible Pump set,120 LPM or Above; Head range: 160M or above; Phase: 3 Phase; HP: 10 and 2 HP Monoblock submersible pumps with Suitable Starter , 3 core copper cable 10 Sq mm and other accessories as per site requirement.	1. SITC The pump set shall Energy Efficient Pumps (3 star or above) confirm to latest relevant IS and shall be guaranteed for the pump discharge range of head between +25% and - 10% of the specified head. The pump set shall be suitable for 8" dia bore well. Rotor dynamically balanced suitable for operation on 3-phase 50Cycles 415Volts -10% +5% AC Sup-ply. Motor squirrel cage induction type and shall be adequate capacity to provide the pump discharge within the range as specified. The Electric motor shall be water-cooled and water lubricated sealed against pollution from outside water. The thrust bearing shall be hydrodynamic Mitch well type preferably and provided with tilting thrust pads de-signed to make up all outward loads at the most unfavourable conditions. The motor shall be of ISI 410grade material; starter of motor should be impregnated with superior quality epoxy paint having type it thermal insulation as per IS5831-1970 or latest the rotor shall be dynamically balanced. All nut-bolts in contact with water of bore well should be of stainless steel. 2. Supply, fixing, testing and commissioning of single stage Mono-block open well submersible pump set with	• IS:8034/2002 for submersible pump set. • IS: 9283/1995 for Motor of submersible pump set. • IS: 14220/1994 for open well submersible pump set. • IS 694 Part-I 1964 or latest for CU cable.	• ABB / BBL / Crompton Greaves / Kirloskar or similar as approved by Engineer. • Finolex / Polycab / KEI / Havells / Lapp or similar as approved by Engineer for CU cable.

		control panel rating 2HP/1.5KW, Head range (M) :26 meters and above, size (MM) suction X delivery 50X40, Discharge (LPM):180 or above at 26-meter head suitable for single phase 50Hz AC supply make as per ref list. 3. Supply and laying of flat submersible cable copper 3Cx10 sq.mm for pump set ISI mark as per requirement.		
14	Provision of Earthing System	1. The earthing shall be done with 3 meters long 50 mm dia. 'B' class G.I. Pipe earth electrode with l2 mm dia. holes around the pipe at distance of 30 cm, down side tapered. Earth electrode to be put vertically 3-meter-deep with alternate layer of salt & charcoal approx. 50 kg charcoal and l0 kg salt. 8 SWG hot dip G.I. or 7/4 mm dia. galvanized steel stranded earth wire shall be connected from earth electrode top with l2 mm dia. G.l. nut bolt to main board / equipment with masonry / RCC earth enclosure of size 300x300x300 mm (ln side to inside) with I25 mm wall thickness & suitable size MS/RCC pull out cover. The G.l. wire shall run in l2 mm 'B'class G. I. Pipe along with wall / pole up to height of 1.5 meter. The depth of 8 SWG hot dip G. I. or 7/4 mm dia galvanized steel stranded earth wire including connections from earth pipe	• IS:1239 or latest • IS: 3043	• TATA, Jindal, Prakash, Surya Sail or similar as approved by Engineer for MS pipe for earthing.

		to main board / equipment /H pole/Tower in ground shall be 30 cms. 2. Supply and providing of Maintenance Free Earthing with primary MS conductor 40 mm dia 3000 mm long and secondary MS Electrode 80 mm dia 3000 mm long includes digging pit of size 5ft.x5ft.x10ft. And using earth enhancement chemical compound minimum 75 kg. Per pit suitable for 40 KA current capacities. 3. supply of Copper earthing of size (600x600x3 mm) thick copper earth plate & suitable size of 40 X 5 mm copper strip. The price shall also cover erection including digging of earth pit in any kind of soil at the specified location. The work shall also cover the earth treated to obtain earth resistance of less than 1 ohm. Connection of earth electrode should be made by providing Copper clamps nuts, bolts.	• RDSO specification No. RDSO/PE/SPEC/PS/0109(REV-0)-2008	• Erico / Indlec / Duvalmession or similar as approved by Engineer for maintenance free earth.
15	Supply and fixing of suitable size feeder pillars	1. Supply, erection, testing and commissioning of feeder pillar size 900x600x300 mm fabricated from 16 SWG MS sheet (tolerance as per IS permitted) hut shape suitable for outdoor	• Relevant IS code	• Popular make of ISI mark

	and Junction Box	installation, painted/ with red oxide and enamel/ powder coated complete enclosed type dust and vermin proof, with gland plate in bottom as required including connecting incoming & outgoing cables with aluminum lugs and brass glands, with 63 amp MCCB and 4 nos. aluminum bus bars suitable for 200A, complete with locking arrangement with MS angle stand 2 feet height angle size 40 x40 x6 mm Grouted in cement concrete mixture 1:3:6. 2. Supply and fixing of junction box size 390x305x170mm comprising of SMP/FRP material with rubber gasket, padlock arrangement, zinc pas- sivated earth bolt, etc. similar to Sintex model no. GSJB 3525 or similar with 4 no. aluminums bus bar cap 200 Amp. Suitable for 415-volt supply requirement. The box shall be fixed robustly with clamps at pole/ wall as per requirement.		
16	Supply and fixing of CLS panel suitable for 25 kVA/10 KVA capacity AT supply with complete accessories and protection	1.SITC of CLS panel including automatic changeover complete as per connections as required.	• RDSO specification No.TI/SPC/PSI/CLS/0020 (12/02) with A&C slips No. 1 to 4 or latest,	• RDSO approved make.

	system as per RDSO specification			
17	Supply and fixing of Phase selector of size (610x450x190mm) with I/P MCCB- 100/ 63 amp and O/P MCCB- 63 Amp	1. SITC of 1.6 mm thick CRCA power coated box of size 610 x 450 x 190 mm approximate with Din rail. The distribution board shall be indoor type dust vermin proof Knock out/glands plates as applicable shall be provided in the box for incoming and outgoing cables. Earth terminals shall be provided. Danger notice shall be provided at appropriate place. The complete internal wiring for each phase selector is to be done with copper wire of size 10 sqmm. 2. It consists of 01 no. 100 amp TPN MCCB as incomer,01 no. 100/63 amp (as per requirement) SPN MCCB as outgoing, 04 nos. integrated LED pilot lamp (3 incoming+1 outgoing),01 no. 63-amp selector switch (phase selector switch) without OFF Three pole three ways (Three phase incoming & only one phase outgoing.	• Relevant IS code	

18	Design, supply, testing Erection and commission of Indoor type LT panel with one incoming MCCB of suitable rating and Min 6 Nos of Output MCCB of suitable rating.	1. SITC of 1.5 mm CRCA sheet steel fabricated, cubicle, having outdoor type LT panel distribution board, having suitable IP protection, floor mounted front operated, mounted on MS base channel of suitable size, with top / bottom removable cable gland plate as required, earth bus, hinged and lockable doors, dust and vermin proof, complete with all inter connections, small wiring by min 2.5 sq mm copper wires. The panel should consist of(A) incoming 2x250 amp 4 pole MCCB's with changeover provision (if required) with microprocessor release having integral overload, short circuit, earth fault and neutral protection and breaking capacity 60 KA (Ics=100%Icu). (B)outgoing 2x125 amps, 2x100 amps and 2x63 amp 4 poles MCCB's with adjustable overload and adjustable short trip unit and breaking capacity 36KA (Ics=100%Icu). the panel is to be provided with over voltage protection with suitable relay. The bus bar shall be insulated by heat shrinkable sleeves. The instrument shall be of flush type ammeter, voltmeter, and selector switches with CTs, feeder name & danger board.	• IS: 2147-1952 IS:2675-1966	• Rittal / ABB / Schneider or similar as approved by Engineer.

19	Supply &Installation of fire Detection & Alarm system (air aspiration) as per requirement and standard railway practice.	1.SITC of Automatic fire detection & Suppression System (AFDSS) including heat detector, Smoke Detector, Aspiration type smoke detector for relay room, Alarm & Control Unit (ACU), Fire Extinguish System, Change over switch for switching extinguish system. 2. The AFDSS shall be self-checking & diagnostic type.	• RDSO/SPN/NEW /2010.	• RDSO approved make .
20	Supply, fixing commissioning, installation and testing of 2 Kva pure sine wave 24-volt online inverter consist of intelligent battery charging mechanisms with adaptive battery charging and 150 AH tubular battery of voltage 12 volt suitable for heavy duty application. Warranty of invertors is 24 months and for Battery -36 months	1. SITC of 2 Kva, 24-volt pure sine wave Online UPS cum inverter. 2. SITC of 150 AH 12 volt heavy duty tubular Battery with 3 year warranty.	• IS:13314/1992 for Inverter	• Luminous, Microtek, Exide, Amaron or similar as approved by Engineer. .
21	Supply, fixing, commissioning and installation of Perforated Cable Tray of size 150x50 mm made out of MS sheet and hot dip galvanized (85 microns) 1.6 mm thick	1. SITC of 150x50 mm and 1.6 mm tick galvanised cable tray for laying of cable with all accessories.	• Relevant IS code	• Adarsh / Indiana / Mahesh Wari or similar as approved by Engineer.

	with suitable fixing Arrangements.			
22	Provision of Solar Plants with 380 watt panels, hybrid type inverter, Galvanised structure, DCDB, ACDB, connectors, MCCB, earthing system, LA, Surge protector and complete wiring material.	1. SITC of 380 watt or above mono crystalline solar system. 2. Supply of hybrid type inverter suitable for solar system with all in built safety features. 3. Supply of galvanised iron solar structure suitable for panel installation. 4. Supply of DCDB and ACDB of including MCB of suitable rating and capacity. 5. SITC of net meter and metering CT suitable for solar plant. 6. SITC of different size of cu cable for connection of panel and other accessories.	• IS: 12834/1989 • IEC 61215/2005 • IEC 60904-2006	• TATA BP, REIL, CEL, BEL and BHEL or similar as approved by Engineer.

7.7 DETAILED SPECIFICATION FOR PASSANGER LIFTS

(FOR 13 PERSONS)

1	Type of Lift	Passenger lift
2	Number of lift required	As per requirement
3	Load: no. of person	13 Person
4	Related speed	1.0 metre per second
6	Number of floor served	2
7	a) Inside size of lift well	Approx. size 2500 mm x 1900 mm deep or as Per site feasibility
	b) Pit depth	1600 mm or as per site feasibility
	c) Head room	4800 mm or as per site feasibility
8	Clear inside size of lift car	Approximate size : 2000x1100x2200(H) mm or as per site feasibility
9	Dimension of machine room	Not Applicable(No machine room is being provided)
10	Position of counter weight	At the back / side of the car
11	Position of machine room	Not applicable
12	a) Type of control	Microprocessor based AC variable voltage variable frequency
	b) Type of operation	Simplex selective – collective without attendant
	c) Potential free contacts	Yes potential free contacts for each floor position and up and down movement of the lift shall be provided in the controller which can be used for the building automation system at later
13	Car entrance door	
	a) Number	1 No. center/side opening stainless steel
	b) Size	Approx. size900x2000 mm high or as per site feasibility
	c) Type of doors	Horizontal sliding-center / side opening
	d) Car open in front only or open through	Open in front at ground floor and opposite / reverse opening at first floor
14	Construction design and finish of car body work	Stainless steel Hairline finish with stainless steel drop ceiling and led lights fittings for lightning inside the car and axial flow fan, 5 mm thick antiskid PVC flooring. All other item as per CPWD general specification for lifts 2003 with up to date amendments.
15	Type of signal system	(a) Digital floor position indicator in the car and all landings (to be provided above the car/ landing doors).
		(b) Travel direction indicator in the car and at all landings. (to be provided above the car/ landing doors).

		(c) Gongs & visual indication through directional arrows on all landings pre arrival of the car at all floors.
		(d) Over load warning audio & visual indica-tor , inside the car (lift should not start on overload)
		(e) Battery operated alarm bell and emergency light.
		(f) Car operating panel with fade proof luminous buttons in in the car and with intercom. Braille switches to be provided in the lift.
		(g) Luminous hall buttons at all landings with Braille switches.
		(h) Fireman's switch at ground floor.
		(i) Voice annunciation system. This will announce the position of the car landing in Hindi & English facilities for any other announcement to be made from the central control room / reception of the building.
		(j) Protection against over – voltage, under voltage and single phasing should be provided.
16	Landing entrance	
	a) Location of landing entrance in different floors	Front at ground floor and opposite / reverse at first floor
	b) Number	2 pairs
	c) Size	Approx. size 900 mm wide x 2000 mm high or as per site feasibility
	d) Type of doors	Horizontal sliding – canter / side opening
	e) Lift in use / lift out of order sign	Suitable box above the landings with LED illuminated bilingual (in English & Hindi) sign of "LIFT OUT OF ORDER" coming up simultaneously on all floors.
17	Electric supply	a) Power 415 V, AC, 50 Hz, 3 Phase, 4 Wire system.
		b) Lighting : 230 V, AC, 50 Hz, 1 Phase
18	Is neutral wire available for control circuits	Yes
19	Proposed date for commencement of site	One month from the date of issue of LOA or as per site readiness.
20	Proposed date for completion	06 months. (CAMC 5 YEAR AFTER COMPLETION OF WARRANTY PERIOD.)
21	Environmental condition at site of installation	Summer condition Winter condition Monsoon condition Height above sea level
22	Storage space provided	_
23	Additional item, if any	

	a) Firemen's switch	Required for all lifts
	b) Emergency power supply	Available
	c) The firm's offer should include beam and all structural steel required for work	
	d) Automatic Rescue Device (ARD)	Provisions of automatic rescue device for the purpose of bringing the lift car to the nearest floor should be provided, one each for individual lift. ARD's are to be provided. The each shall consist of 1. Control panel with necessary interface /integration of device with main controller 2. Invertor of required capacity 3. Maintenance free batteries of Ampere –hours 4. Battery charging unit 5. "Rescue Operation On "indicator in the lift car.

S.NO.	**Particulars of detail**	
A	General	
1	Name of manufacture	As per CPWD approved 'A' category manufacture
2	Capacities (Persons/Weight)	13 Person/884 kg
3	Service	Passenger
4	Speed of travel	1.0 MPS
6	No. of floor served	02
7	No. of openings	02
8	Position of counterweight	At the back / side of the car or as per site feasibility
9	Type of levelling method	Automatic +/- 5 mm
B	**Machine**	

1	Position of machine	Top of lift shaft in hoist way / Machine room less
2	Motor	Permanent magnet synchronous Motor, Gear less machine
3	Electric supply particulars for which it is suitable for operation	3 PH 415 V 50 HZ 4 wire system
C	**Brake**	
1	Type	Electromagnetic brake
D	**Car & Doors**	**Horizontal sliding, centre / side opening**
1	Outside dimension of car	AS PER SITE CRITERIA
2	Inside clear dimension	Approximate size : 2000x1100x2200 (H) mm or as per site feasibility
3	Construction of car	Stainless steel Hairline finish with stainless steel drop ceiling and LED lights fittings for lighting inside the car and axial flow fan. 5 mm thick antiskid PVC flooring. All other item as per CPWD general specification for lifts 2003 with up to date amendments.
4	Design/ type of enclosure of car	Rectangular / as per site condition, stainless steel scratch proof (HAIR LINE FINISH)
5	Details of flooring	6 mm thick aluminium/5 mm SS Chequered plate
6	Attachment and fitting inside the car	Axial flow fan & LED light fittings with anti – theft arrangement (As per requirement)
7	Car doors	HORIZONTAL SLIDING, CENTRE/SIDE - OPENING
	a) Size	Approx. size 900mm x 2000 mm or as per site feasibility
	b) Operation	Power operated automatic door
	c) Construction, design & finish	Stainless steel scratch proof (HAIR LINE FINISH)
8	**Landing Doors**	

	a) size	Approx. size 900 mm x 2000 mm high or as per site feasibility
	b) operation	Power operated automatic door
	c) Construction, design & finish	Stainless steel scratch proof (HAIR LINE FINISH)
E	**SAFETY DEVICE**	
1	Car safety type	Progressive / instantaneous type
2	Counter weight safety- type	-
3	Door inter locks in car- type	Electrical type
4	Door locks in landing- type	Electromechanical type
F	**For physically challenged**	Note below
	Voice Response System.	Required in Hindi, English / local language if needed
	Luminous Push Button with Brail script.	Required
	Hand Rails	Stainless steel hair line finish, SS - 304

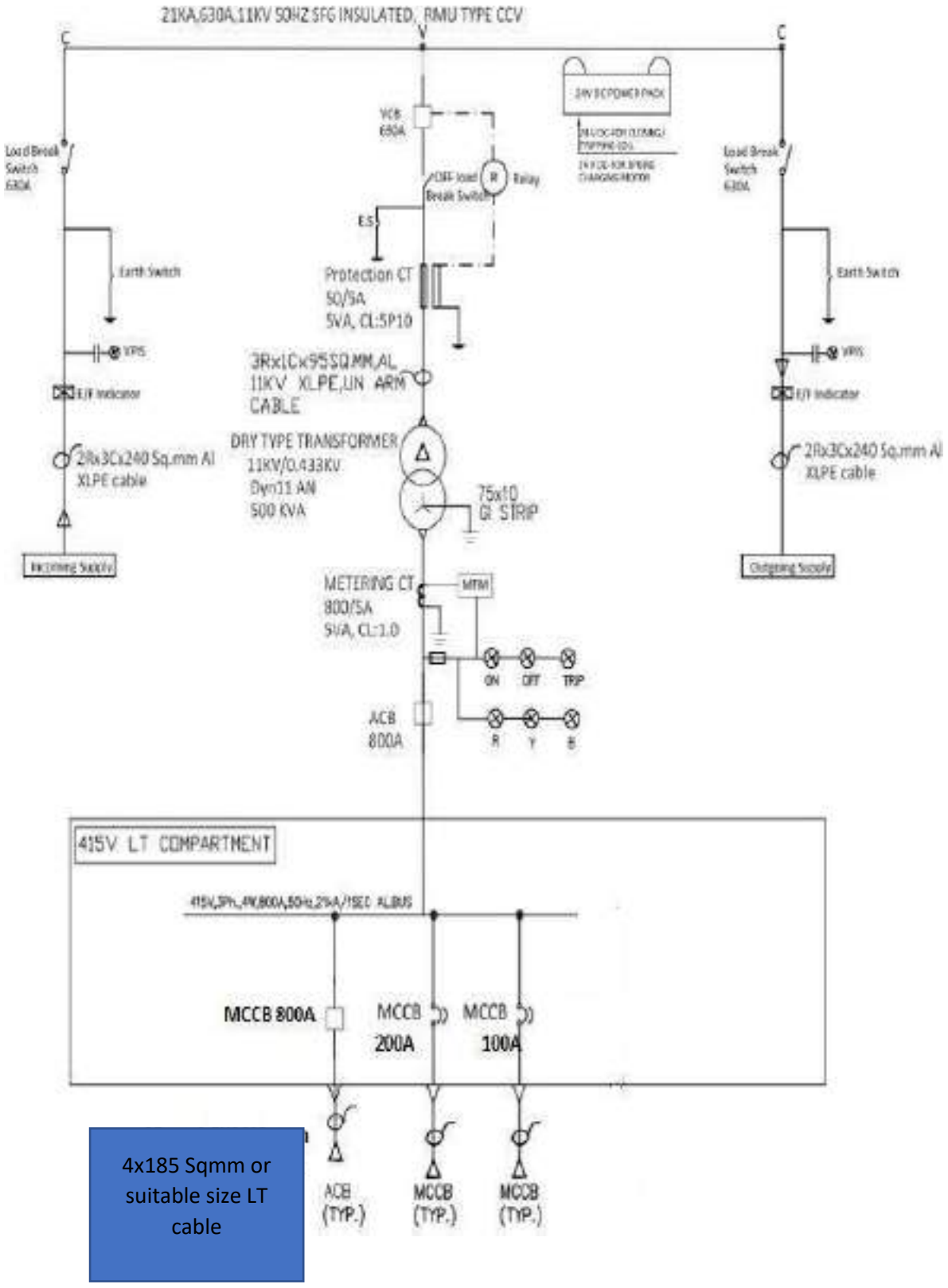
7.8 DESIGN LIFE OF ELECTRICAL ASSETS

All the equipment supplied and erected by contractor have to comply with the following Codal life standards.

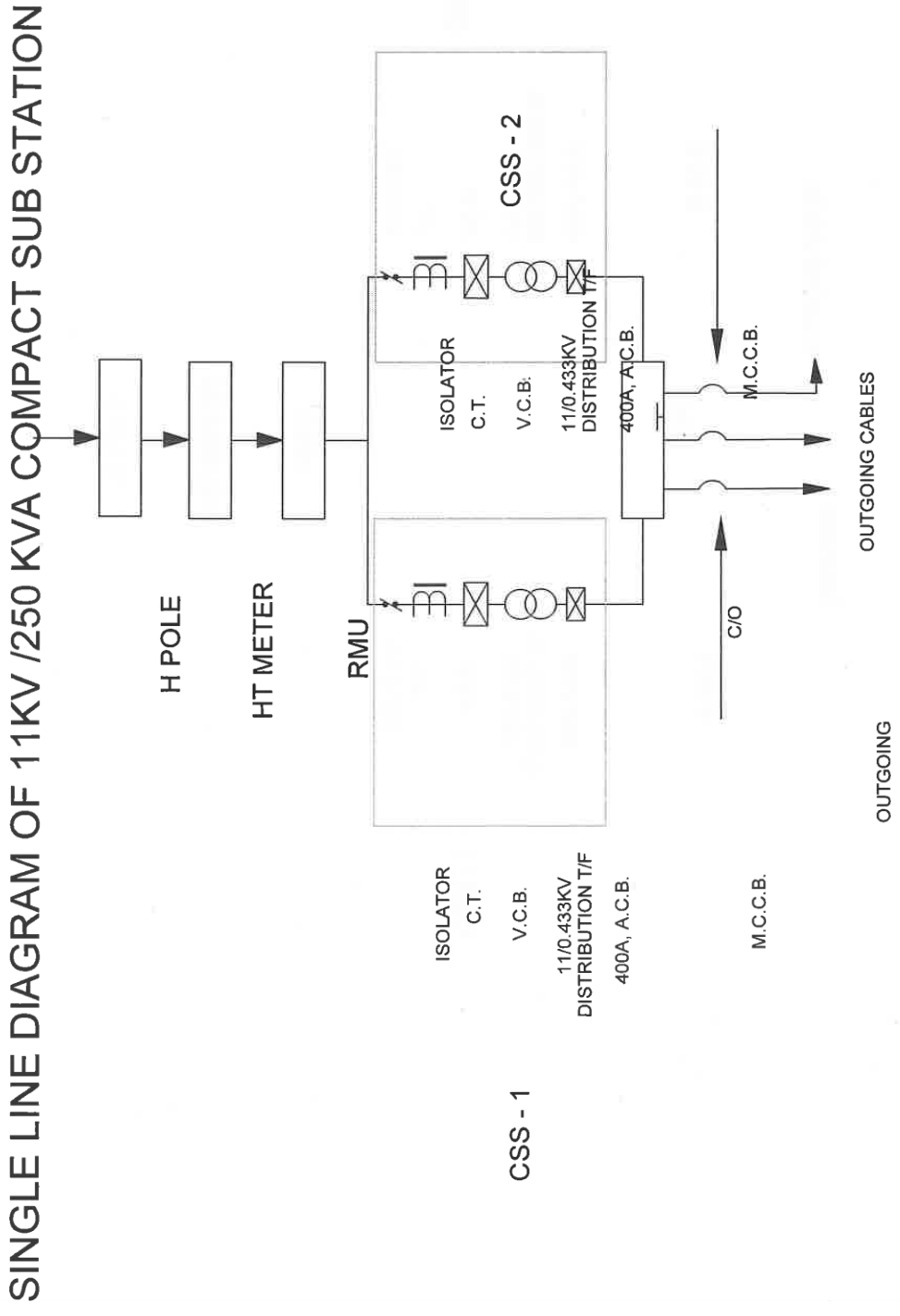
S.NO.	Class Of assets	Average life in years
1	Over Head Power Lines	40
2	Over Head Traction Line excluding contact wire	60
3	Electric underground Cables	30
4 (a)	Electric contact wire (Alm.)	25
4 (b)	Electric contact wire (Copper)	40

5	Electric Power Plant excluded oil engine driven	25
6	Electric Plant above 25 HP	25
7	Electric Power Plant oil engine driven (diesel)	15
8	Overhead traction lines contact wire	40
9	Electric Machinery others	30
10	Electric Sub Station Building	50
11	Water Cooler, Refrigeration, Air Conditioner, hospital and domestic appliance	5
12	Internal wiring of building	10
13	Switch Gear	25
14	Electric Pumps	20
15	Electric Lifts & Hoist	20
16	Ceiling Fans	20
17	Electric Battery charging set	15
18	Flood Light Projection	10
19	Battery lead Acid/VRLA	4

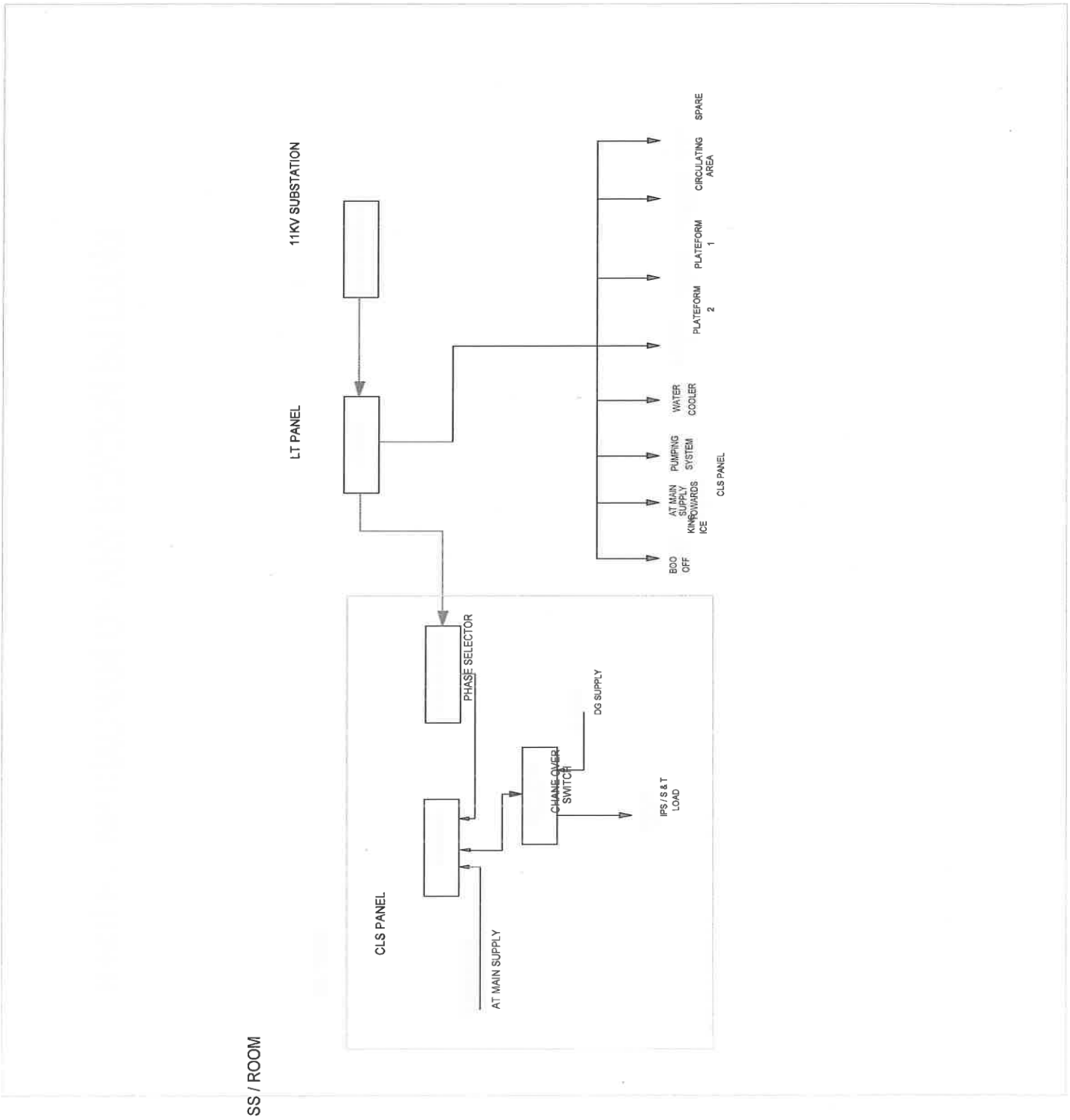
SINGLE LINE DIAGRAM OF 11 KV / 0.44 kVA COMPACT SUB STATION (For indicative purpose only)



(For indicative purpose only)



SINGLE LINE DIAGRAM OF ANY STATION BUILDING **(For indicative purpose only)**



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CHAPTER 1 - GENERAL

1.1 Definitions

In addition to the words and expressions defined in the Conditions of Contract, following words and expressions shall have the meaning assigned to them except where the context otherwise requires:

(i) "As-Built Documents" means those drawings & documents produced by the Contractor and endorsed by it as true records of construction/Installation of the Permanent Works and which have been agreed with the Engineer.

(ii) "Auxiliary/Subsidiary signals" Shunt signals — Independent or below Main signals, Calling-on signals, Route indicators.

(iii) "Availability" means the probability that an item will be in a state to perform a required function under given conditions, at a given instant in time or over a time interval, assuming that the given external resources are provided.

(iv) "Apportionment" process whereby the RAMS elements for a system are sub-divided between the various items which comprise the system to provide individual targets

(v) "Combined Services Drawings" means drawings showing the services details of all the Utilities in a combined drawing indicating locations, layouts and sizes of all electrical and mechanical services

(vi) "Compliance" demonstration that a characteristic or property of a product satisfies the stated requirements.

(vii) "Condition of Contract" shall mean General Conditions of Contract read in conjunction with Particular Conditions of Contract as in Part 3 of Bidding Documents.

(viii) "Construction/Installation and/or Manufacture Documents" means all drawings, calculations, computer software, samples, patterns, models, operation and maintenance manuals and other manuals and information of a similar nature to be submitted by the Contractor.

(ix) "Construction/Installation Drawings" shall be derived directly from the Detailed Design and shall detail and illustrate in full the Permanent & Temporary Works. These drawings /documents are the ones which the Contractor considers sufficient in detail for construction/Installation and is cleared by the Engineer for construction/Installation.

(x) "Corrective Maintenance" means maintenance performed to correct the occurrence of an equipment or system fault.

(xi) "Defect" is any part of the Work which is not in accordance with the Contract.

(xii) "Detailed Design" prepared and accepted part of drawings, documents, standards and instructions which is the authorization for manufacture, procure/supply, construction/Installation and testing. "Detailed Design" has the meaning identified in Chapter-4, Design Requirements of this Document.

(xiii) "Design Criteria" means the governing specifications and conditions as specified in Chapter-4 of this Document.

(xiv) "Design Data" means all survey and investigations, specifications, plans, drawings, details, graphs, sketches, models, levels, setting-out dimensions, calculations and other documents related to the design of the Works.

(xv) "Design life" The design life is the period of time during which the system is expected to work satisfactorily within its specified parameters.

(xvi) "Design Manual" means the manual to be prepared and submitted by the Contractor as part of the Preliminary Design and as described in Chapter-4 of this Document.

(xvii) "Design Phase" has the meaning identified in Chapter-4 of this Document.

(xviii) "Designer" means the Contractor or part of the group forming the Contractor, person, firm or company or group of companies or any replacement carrying out the Design of Works or part thereof.

(xix) "Down time" time interval during which a product is in a down state.

(xx) "Drawings" means the Employer's Drawings and the Drawings submitted by the Contractor and modification of such drawings, if any, furnished from time to time or for which the Engineer has issued a Notice of No Objection.

(xxi) The "Engineer" means the PMC Representative / the person appointed by the Employer to act as the Engineer for the purposes of the Contract or other person appointed from time to time by the Employer and notified to the Contractor

(xxii) "Factory Acceptance Tests" all Type/Routine/ acceptance/special Tests as specified in relevant standards & specifications as needed before dispatch of material and conducted at the premises of Original Equipment Manufacturer.

(xxiii) "Failure mode" predicted or observed results of a failure cause on a stated item in relation to the operating conditions at the time of the failure.

(xxiv) "Flank Protection" Protection of a train running on route set for it from trains or vehicles on neighbouring lines through setting & locking of concerned points in required position is called Flank protection.

(xxv) "Hazard" physical situation with a potential for human injury and/or damage to environment

(xxvi) "Interfacing Contractor" means the Contractor engaged by the Employer or other agencies having an interface issue with the Contractor for this Work.

(xxvii) "Interfacing Parties" comprises the designated contractors/ consultants/ service providers. Other Contractors who are engaged in part of the works and relevant statutory authorities, relevant public utility agency and adjacent contractors who are or will be working adjacent to the site.

(xxviii) "Interface coordinator" is an official appointed by the contractor to Coordinate the Interface requirement and organize the interaction between interfacing parties and organize interface.

(xxix) "Interface Manager" Is the official appointed by the contractor, directly responsible to identify, assess the interface requirement with other systems and incorporate in the Detailed Interface Designs to identify the boundaries of responsibilities, get it agreed with interfacing parties and manage the interface requirement within its agreed scope

(xxx) "Line Replaceable Unit (LRU)" means equipment that can be replaced as a single complete unit and can be handled by a single person.

(xxxi) "Main running signals" Home signal, Starter signal, Intermediate Starter signal, Advance Starter signal.

(xxxii) "Maintainability" A characteristic of design and installation, expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when the maintenance is performed in accordance with prescribed procedures and resources.

(xxxiii) "Man Machine Interface (MMI)" means the visual interface between the Controller and the control system. The MMI consists of the computer screens, displayed objects, icons, and equipment as well as the facilities by which the Controller executes control.

(xxxiv) "Mean Time to Restore (MTTR)" means the average time to restore equipment, subsystems, systems to full functionality.

(xxxv) "Notice" means a Notice of No Objection.

(xxxvi) "Other Contractor" means the contractor(s) other than the Signalling and Telecommunication Contractor.

(xxxvii) "Outline Quality Plan" means the quality plan setting out in summary form, the Contractor's proposed means of complying with his obligations in relation to quality assurance as prescribed in the Employer's Requirements.

(xxxviii) "Outline Safety Plan" means the safety plan setting out in summary form, the Contractor's proposed means of complying with his obligations in relation to construction/Installation safety as prescribed in the Employer's Requirements.

(xxxix) "Operating Hours" means operating hours for Train Operation in HORC shall be 24 Hours all days.

(xl) "Particular Specifications" means the Specifications prepared for the purpose as enclosed in PS (Signalling) and PS (Telecommunication).

(xli) "Permanent Work" means the permanent works to be designed and executed by the Contractor under the Scope of Work covered in this Contract.

(xlii) "Preliminary Design" means the submission of Contractor's Documents which comprise the initial stage of the design phase. It is basically a concept scheme design.

(xliii) "Preliminary Drawings" means the drawings prepared by the Contractor that are built on the Reference Drawings and accompany the Contractor's Preliminary Design submissions.

(xliv) "Pull-down Menu" means a list of items displayed by clicking mouse, arranged in

the downward direction.

(xlv) "Pull-up Menu" means a list of items displayed by clicking mouse, arranged in the upward direction.

(xlvi) "Possession" means taking a section of the line out of service for engineering purposes.

(xlvii) "Railway" means Railway or any portion of a Railway for public carriage of passengers and goods including dedicated freight corridors.

(xlviii) "Railway Envelope" means the zone or zones which contain the track, platforms and equipment necessary for the operation of the Railway by the HRIDC.

(xlix) "Reference Drawings" means the drawings prepared by the Employer and included in the bidding document.

(l) "Reliability" The probability that an item/equipment/system can perform a required function under given conditions for a given time interval. The measure of reliability is MTBF.

(li) "Reliability growth" condition characterised by a progressive improvement of a reliability performance measure of an item with time.

(lii) "Right of Way" means the width/area of the land acquired/being acquired for the operation of the HORC Project.

(liii) "Safety" freedom from unacceptable risk of harm.

(liv) "Safety Integrity Level" One of a number of defined discrete levels for specifying the safety integrity requirements of the safety functions to be allocated to the safety related systems. Safety Integrity Level with the highest figure has the highest level of safety integrity.

(lv) "Safety-Critical" means failure of the system, sub-system or equipment that directly leads to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss.

(lvi) "Site" means the area where the Permanent Works are executed in the Right of Way or adjoining the Right of Way.

(lvii) "Sub-system" Each system comprises of sub systems. Signalling System comprise sub systems of Electronic Interlocking System, Train Detection System, Point Operation System, Absolute Block Working with BPAC, Power Supply System, RDPM etc. Telecommunication System comprises of sub systems of Optical Fiber Communication System including, IP-MPLS system, Quad cable system, Telephone System, Emergency Communication System, VHF Communication System, Master Clock System, Public address System and Power supply System etc.

(lviii) "Stations" means Junction Stations, Crossing Stations of HORC and connected IR stations .

(lix) "System Acceptance Tests" means those tests that demonstrate the performance of the installation/equipment to the specified requirements as detailed in the Particular

Specifications.

(lx) "Particular Specifications" means the combined specifications prepared by the Contractor in a format which combines the Technical Specifications and those parts of the Contractor's Technical Proposals which specify standards for design, procurement, manufacture, construction/Installation, testing and commissioning which are developed during the Design Phase and fully comply with the Employer's requirements.

(lxi) "Temporary works" means all Temporary Works of every kind (other than Contractor's Equipment) required on Site for the execution and completion of the Permanent Works and the remedying of any defects.

(lxii) "Train Operator/Driver" means the person on the train responsible for its operation.

(lxiii) "Validation" confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled.

(lxiv) "Works" means the work, both permanent and temporary or services to be carried out, survey and investigation, designed, manufactured, fabricated, delivered to Site, erected, installed, completed, tested, commissioned, (including Integrated Testing and Commissioning) or supplied in accordance with the Contract and include Plant, Equipment and Material and their accessories.

(lxv) "Work Station" means the collection of processors, screens and input devices necessary to provide one controller or maintenance personnel with necessary system displays and commands.

(lxvi) "Working Drawings" comprise the Construction reference drawings such as construction/Installation drawings, manufacturing drawings and testing and commissioning documents, as are necessary to amplify the Good for construction/Installation Drawings for construction/Installation etc. purposes and endorsed, as required by the Engineer.

1.2 Patent, Copyright or Other Intellectual Property Rights

1.2.1 The patent, copyright or other intellectual property rights in any plant, design data, plans, calculations, drawings, documents, material, know-how and information relating to the works shall be vested in the Contractor. The Contractor shall grant to the Employer, his successors and assignees, a royalty-free, nonexclusive and irrevocable license to use and reproduce any of the works, designs or inventions incorporated and referred to in such plant, documents or material and any such know-how and information for all purposes relating to the works, including without limitation, the design, manufacture, installation, reconstruction, testing, commissioning, completion, reinstatement, extension, repair and operation of the Works.

1.2.2 Infringement of Patent Rights: The Employer shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components in the design and development of the Signalling system and any other factor not mentioned herein which may cause a dispute. The entire responsibility to settle any such disputes / matters shall lie with the Contractor

1.3 Classification of Equipment Environment

1.3.1 Table below gives the different classifications of equipment environment to be encountered. The locations at which equipment may be installed have been divided into five environmental classes as mentioned below.

CLASS	LOCATION of EQUIPMENT
A	Air Conditioned Center/Offices and Equipment Rooms. Air-conditioning failure of less than 2 hours duration at a time is permissible.
B1	Equipment Rooms with air-conditioning with possibility of failure of air-conditioning for a duration of 2 hours or more at a time.
B2	Equipment Rooms without air-conditioning where adequate ventilationmay or may not be available.
C	Buried underground or installed in manholes.
D	Outdoors — Location boxes, Cabinets or Containers, DP's protected from direct sunlight withoutany ventilation.

1.3.2 All equipment shall be designed and tested in accordance with the given figures allowing a margin of at least 10% greater and 2°C less than the limits recorded. All designs for equipment shall work within the enclosures proposed with the specified environment outside the enclosure. The following are the minimum design requirements for equipment to be installed in each class of environment. Where any class does not have a value for a parameter the most extreme value quoted for the lesser class environments should be used. For any equipment that is proposed to be installed in more than one environmental clause, the design shall take into account the most severe environmental class conditions.

Requirements for Class A	
Minimum Temperature	5°C
Ambient Temperature	29°C
Maximum Temperature	35°C
Relative Humidity	Minimum 0%, Nominal 65%, Maximum 95%(Non Condensing)

Requirements for Class B	
Minimum Temperature	-2.5°C (B1) and (B2)
Ambient Temperature	30°C (B1) and 50°C (B2)
Maximum Temperature	45°C (B1) and 55°C (B2)
Relative Humidity	Nominal 70%, Maximum 100% (Noncondensing)
Air Quality	Polluted and dusty - SOz:80-120mg/m3 Suspended Particulate Matter: 360-540mg/m3
Electrical Noise	Impulse 1kV, 1.2/50 rise/decay, SOOZ sourceimpedance, 0.5J source energy.
Radio & High Frequency	as Class A.
Requirements for Class C	
Minimum Temperature	-2.5°C
Ambient Temperature	46°C
Maximum Temperature	60°C
Relative Humidity	Nominal 70%, Maximum 100% (Noncondensing)
Electrical Noise	Impulse 5kV, otherwise as Class B
Requirements for Class D	
Guaranteed Temperature Range	0°C to 55°C
Operational Temperature Range	-5°C to 60°C

(End of Chapter-1)

CHAPTER 2 — PROJECT PROGRAMME REQUIREMENT

2.1 General Requirements

2.1.1 The Contractor shall develop in detail, a logical method of executing the Works taking into account their complex nature and different phases and shall provide programmes which reflect the detailed planning undertaken.

2.1.2 The programmes shall start with the Commencement Date of the Works as day one, are to be realistic, achievable and shall be accompanied by the detailed supporting Management Plans.

2.1.3 The Program activities shall be discrete items of work, which when combined and produces the definable elements, components, Milestones, Stages and Sections of the Works and clearly identify the completion obligations of the Contractor.

2.1.4 Milestones shall be an integral part of all programmes and all activities. Sequencing and interrelationships required to achieve each completion obligation shall be shown. Milestones shall not impose constraints that in a way affect the programme logic. Milestones shall not be introduced into any programme as constrained dates.

2.1.5 The critical path shall be clearly identified in the programme and fully described in the accompanying programme narrative.

2.1.6 Activity descriptions shall clearly convey the nature and scope of the Works. Programmes shall take into account the activities of Precursor, concurrent, adjacent and follow on project contractors and any other activity that may affect the progress of the Works.

2.1.7 The Contractor shall also incorporate the Engineers requirement for additional activities, to further explain or subdivide complex or long duration tasks, without affecting completion dates.

2.1.8 The Contractor shall monitor its and its subcontractor's performance against programmes to ensure its compliance with its obligations under the Contract. Monitoring of the Works shall include direct, daily monitoring of the progress of the Works and the preparation of return and computerised reports to be submitted to the Engineer. The reports shall include all necessary supporting data to apprise the Engineer of the status of the completion of the Works as described below.

2.2 The Execution Phases

The execution activity will include various phases of the implementation as under.

(1) Design Phase,

(2) Manufacturing/Supply Phase,

(3) Construction/Installation Phase,

(4) Testing & Commissioning Phase and

(5) Operation & Maintenance Phase;

2.2.1 Design Phase

The contractor shall deploy a qualified team of the Design Engineers and Experts as approved by the Employer, evidencing the experience of the design in relevant field

and technology with the approval of the Engineer, before commencement of Design Phase. The Design Phase shall have 4 stages as detailed below:

(a) Preliminary Design

(b) Detailed Design

(c) Construction / Installation Design

(d) As Built Documents

2.2.2 Manufacturing /SuppIy Phase

The manufacturing /suppIy will constitute the following:

(a) Manufacturing/Procurement;

(b) Factory Acceptance Tests (FAT);

(c) Delivery to the contractor's stores at site; and

(d) Storage at the site Stores, including establishing the Material Procurement tracking,receipt and issue procedures.

2.2.3 Construction/ Installation Phase

Construction/ Installation Phase will constitute of the following:

(a) Site Management including access/ ROW preparation;

(b) Availability of Construction reference Drawings;

(c) Installation preparatory works like Foundations, first fix, site safety and quality assurance procedures etc.;

(d) Equipment installation; and

(e) Training of Employer's Personnel

2.2.4 Testing and **Commissioning** Phase

Testing and commissioning phase will constitute of the following:

(a) Testing and Commissioning of all subsystems;

(b) Quality assurance;

(c) Integrated Testing & commissioning;

(d) Trial run including service trials; and

(e) Submission of verified and As Built Documents

2.2.5 Operation and Maintenance Phase

Operation and Maintenance Phase will constitute of the following

(a) Operation and Maintenance activity

(b) Defect rectification

(c) Workshop Repair Services

(d) Support and Call Out Services

(e) RAMS demonstration

(f) Supply of O & M Manuals, Maintenance schedules

2.3 Works Programme

2.3.1 The Works Programme to be submitted under the contract shall be developed from theOutline Works Programme submitted and developed during the tender period according to Key Dates given in the bid documents.

2.3.2 Within 30 days of the Commencement Date of the Works the Contractor shall submit for review by the Engineer, his proposed initial version of the Works Programme which shall provide full programme details for the first six months of the contract and shall provide outline details for the remaining period of the contract.

2.3.3 Within 60 days of the Commencement Date of the Works, the Contractor shall submit for review by the Engineer the proposed full version of the Works Programme.

2.3.4 The Works Programme shall demonstrate by reference to its Sub Programmes, Supplementary Programmes and associated Management Plans, the sequence and duration of the activities and any restraints there to that the Contractor shall adopt to achieve Milestones and to fulfill all Contract obligations. The Works Programme shall become the basis of administration of the time-related aspects of the Contract.

2.3.5 The Contractor shall provide the Engineer with substantiation for each constraint whether target start, target finish or mandatory constraint entered by the Contractor into the Works Programme. The number of constraints shall be kept to an absolute minimum.

2.3.6 The Works Programme shall include activities for all the phases and stages of the Works, clearly showing all logical interdependencies and stages in the development of the Contractors design, procurement, installation, commissioning and setting to work. As a minimum, it shall include'

(1) All works comprising the permanent works;

(2) Preparation, submission and review of Design Documents showing all items where review by the Engineer is required.

(3) Procurement of all major materials and items of Contractor's Equipment for the Works, including the dates orders are to be placed, manufacture period and the expected delivery date to the Site for each item.

(4) Any software development requirements and Validation time frames.

(5) All manufacture or prefabrication of materials of components.

(6) All design and installation of major Temporary Works.

(7) All activities associated with securing necessary permits and other statutory approvals for the works.

(8) Access and availability dates for all Project Contractors.

(9) All interfaces related to the project that may affect the progress of the Works.

(10) Testing and commissioning activities requirements.

(11) Training.

2.3.7 The Works Programme shall be divided into Sub-Programmes of manageable size addressing in more specific detail, the content of the Management Plans. The Sub- Programme shall be as follows:

(1) Design Submission Programme

(2) Procurement and Manufacturing Programme;

(3) Installation Programme

(4) Testing and Commissioning Programme; and

(5) Training Programme

2.3.8 The submission of the full version of the Works Programme shall include the Design Programme, Procurement and Manufacturing Programme and a preliminary version of the Installation Programme and the Testing and Commissioning Programme identifying all major installation, testing activities and associated interfaces.

2.3.9 The Sub-Programmes shall be further substantiated by the supplementary programmes as required by the Engineer.

2.3.10 The Contractor's Works Programme shall comply with the following;

(1) All programmes submitted in both hard copy and electronic data format.

(2) All programmes shall be prepared using the latest version of CPM scheduling software Primavera Project Planner or similar.

(3) A standard Gregorian calendar shall be used for planning and execution of the Works. All programme submissions shall include details of the Contractor's allowance for Public Holidays and known-work periods. If a Milestone falls on a public holiday or nonwork day it shall be effective the next working day.

(4) The planning unit for the duration of all programme activities shall be the day. Any activity having a duration of more than thirty (30) days shall be divided into sub activities that shall not exceed thirty days.

(5) CPM programmes shall reflect status using remaining duration and percent complete.

(6) All programmes shall be fully resource loaded as appropriate or required by the engineer covering all stages and aspects of the Contract and shall include, but not be limited to:

(a) Major manpower for both design and installation.

(b) Number of items of Contractor's Equipment.

(c) Number of drawings and other design deliverables.

(d) Principal quantities of components or parts.

(e) Principle quantities of bulk materials inclusive of cabling, pipe, ductwork andequipment item etc.

2.3.11 All programmes constituting the Works Programme shall be organised in a logical work breakdown structure including work stages or phases. Each activity shall be coded to indicate, as a minimum, the work group or entity responsible for the activity, the area, facility or location and the Cost Centre in which the activity is included, from information provided in the pricing schedules. Milestones shall be coded so as to be separately identifiable. The Contactor may be required to assign additional activity codes as required by the Engineer.

2.4 Design Submission Programme

2.4.1 The Contractor shall, within 30 days of the Commencement Date of the Works submit a Design Submission Programme covering all proposed submissions to the Engineer. The Design Submission Programme shall be broken down into a submission programme for each of the Management Plans of which shall define the dates for individual submissions and shall confirm to the base line dates shown in the Works Programme.

2.4.2 The Submission Programme shall include the requirements of the Design Submission including the procurement activities of all sub-contractors and suppliers.

2.4.3 The Submission Programme shall include each submission for every item listed in the Specification as being required to be submitted.

2.4.4 The Submission Programme shall ensure that all submissions are properly co-ordinated with the Contractor's overall Works Programme, particularly in respect of the following:-

(1) Progress of design, manufacture, installation and testing work;

(2) Co-ordination with other Contractors; and

(3) Including due allowance for the Engineer review process to be undertaken, including the time needed for any re-submissions.

2.4.5 The Design Submission Programme shall specifically include a date of submission by the Contractor of the Final Design on completion of the Preliminary Design stage. The Final Design shall include at least but not limited to; details showing all of the proposed equipment, interconnections, physical layout, installation locations and interfaces to other suppliers.

2.5 Procurement and Manufacturing Programme

2.5.1 Within 60 days of the Commencement Date of the Works, the Contractor shall submit for review by the Engineer a procurement and manufacturing programme that shall be an integrated part of the overall Works programme.

2.5.2 The Procurement and Manufacturing Programme shall show the interdependencies between Engineering disciplines as well as between the contractor and its subcontractors and suppliers. This programme shall demonstrate compliance with the requirements of the Submissions Programme.

2.5.3 The Procurement and Manufacturing Programme shall include a separate breakdown, supported by Material Controlled Schedule, which shall be a complete amplification of the Contractor's Programme and equipment list, including those items which are subject to long lead time or component parts which are manufactured from countries outside the country of assembly and testing.

2.5.4 The Material Controlled Schedule shall be automated, and shall detail the following information

for each permanent major and minor material and significant component. The format such a schedule shall include:

(1) Name, description, supplier/sub-supplier details.

(2) Drawing information (where appropriate), title, drawing status, submission dates, shop drawings/fabrication drawing preparation etc.

(3) The manufacturing process, manufacturing of test pieces, trial production, Engineer inspection, monthly production of components and monthly supply of components.

(4) The assembly process, erection and assembly sequences (particularly for the first pieces) prior to shipment, test assemblies, monthly assembly requirement, engineers inspection, testing of assemblies and

(5) Transportation process, quality release from factory, factory storage to dock and shipment.

2.5.5 The Contractor shall continuously maintain this schedule and report upon the status of each item as part of the contractors regular progress reporting. From this based data, the Contractor shall prepare an exception report detailing all components that are in delay. This report shall be annotated with the reason for the delay and indicate what action the contractor is taking to recover the lost time.

2.5.6 The Contractor shall submit, as part of the Procurement and Manufacturing Programme, a Factory Testing Programme that shall support all aspects of the Factory Testing Plan.

2.5.7 The Factory Testing Programme shall be fully detailed, with the activities individually identifying all tests for which a certificate will be issued, and shall include activities for preparation, submittal and review of the test procedures.

2.5.8 The Factory Testing Programme shall demonstrate the logical dependencies between the individual tests of the works, and shall also show the interfaces and dependencies with the contractors delivery programme.

2.5.9 The Factory Testing Programme shall include details of inspection, testing and witnessing of the contractor's and sub-contractor's procurement and manufacturing activities. As a minimum, it shall include:

(1) First article inspection;

(2) Quality Hold Points;

(3) Quality Control Points;

(4) Type Tests; and

(5) Routine Tests.

2.6 Installation Program

2.6.1 The Installation Programme shall be submitted as stated in the PS or as directed by the Engineer. The Installation Programme shall comply with the requirements of clause 2.3.10 above.

2.6.2 The Installation Programme shall include detailed activities describing all aspects of the installation of the works, to meet all Milestones given in the contract. It shall be clearly linked to the Design Program, Procurement and Manufacturing Programme and Testing and Commissioning Programme to form an integrated part of the Works Programme.

2.6.3 The Installation Programme shall be fully supported by the Construction and Installation Management Plan.

2.6.4 The Installation Programme shall indicate the physical areas to which the contractors requires access, access dates, duration required and the required degree of completion for civil or architectural finishes prior to the access date.

2.6.5 The Installation Programme shall take into account the requirements for arrival at port, delivery, storage, preservation and positioning of large items of the contractors equipment and permanent works and shall set out the contractors proposed delivery route for such items to the site.

2.6.6 Installation tests shall be clearly shown in the Installation Programme and shall include those interface tests required to be carried out by others to establish a time table for these tests.

2.6.7 Activities that may be expedited by the use of overtime, additional shifts or by any other means shall be identified and explained.

2.6.8 In preparing the Installation Programme, the contractor should note that the following conditions shall apply:

(1) The Contractor shall not have exclusive access to any part of the site except by the specific consent of Engineer.

(2) The Contractor shall take note that concurrent time allocations for certain areas may be given to more than one contractor. The contractor shall coordinate his works in such areas with that of project contractors through the Engineer.

(3) The absence of a programme date or installation period for the contractor in a specific area shall not prejudice the right of the Engineer to establish a reasonable programme date or installation period for that area.

(4) The Contractor shall comply with the identified Milestone Dates identified in the contract.

2.7 Testing and Commissioning Programme

2.7.1 The Testing and Commissioning Programme shall be submitted as stated in the PS or as directed by the Engineer and shall comply with the requirements of the clause 2.3.10 above.

2.7.2 The Contractor shall submit the Testing and Commissioning Programme that shall fulfill all the on-site testing and commissioning requirements. The Testing and Commissioning Programme shall clearly demonstrate the logic and highlight topics listed in the On-Site Testing and Commissioning Plan.

2.7.3 The Testing and Commissioning Programme shall be fully detailed, with activities individually identifying all tests for which a certificate will be issued, and shall include activities for

preparation, submittal and review of the test procedures.

2.7.4 The Testing and Commissioning Programme shall demonstrate the logical dependencies between the individual tests of the Works, and shall also show the interfaces and dependencies with all of the Project Contractor's tests required to commission the Works and support the Commissioning Plan.

2.8 Training Programme

2.8.1 The Contractor shall, within 120 days of the Commencement Date of the Works, submit for review by the Engineer, a Training Programme covering all proposed formal training courses, delivery of training equipment and accesses by the Employer's personnel.

2.8.2 The Training Programme shall be developed to the Training Plan as required.

2.8.3 The Training Programme shall be sufficiently detailed that the Employer can ensure the availability of staff for all the courses.

2.8.4 The Training Programme shall include the requirements of the Training activities of all sub-contractors and suppliers given in PS/Signalling and PS/Telecommunications.

(End of Chapter-2)

CHAPTER 3 — MANAGEMENT PLANS AND SUBMISSIONS

The contractor shall submit the Management Plans as per Appendix------ for the approval of the Engineer.

(End of Chapter-3)

CHAPTER - 4 DESIGN REQUIREMENTS

4.1 General

4.1.1 The Works shall be executed in four phases viz. the Design Phase, the Manufacturing/Supply Phase, Construction/ Installation Phase and Testing & Commissioning Phase. The various phases of the project will overlap with each other.

4.1.2 The Design Phase shall have 4 stages — Preliminary Design Stage, Detailed Design Stage, Construction/Installation Design Stage and As Built Documents Stage, overlapping with the various phases of project execution.

4.1.3 The Contractor shall ensure that his design is accurate and in compliance with Employer's Requirements and the Specifications which are deemed to be part of the contract as defined in Conditions of Contract. The Contractor shall be responsible to ensure that when the Works are completed, the same shall be fit for the intended purpose as specified in the Contract.

4.2 Design Management

4.2.1 The Contractor shall establish an office for his dedicated design team and referred to as Design Team. The Design Team shall function from this office and all meetings and discussions relating to design shall be held in this office or in the office of Engineer/Employer and/or as instructed by the Engineer. In addition to the requirements detailed herein, the Contractor shall, whenever the Engineer so requests, provide information and participate in discussions that relate to design matters.

4.2.2 The members of the Design Team shall have the requisite experience and qualification appropriate to the type and magnitude of the design involved. Full details regarding their qualifications and experience shall be submitted to the Engineer for his consent

4.2.3 The Contractor shall sub-divide all the design into Design submissions which shall be identified in the Design and Certification Submission Program. The Design submissions should relate to the significant and clearly identifiable parts of the Design and shall address the design requirements as described herein. The Design submissions shall facilitate the review and understanding of the design as a whole and shall be produced and submitted in an orderly, sequential and progressive manner to suit the manufacture/supply, installation, testing and commissioning sequence and the Works Program.

4.2.4 Separate Design Submissions may be prepared for those major elements to be procured through sub-contract. Where such work is to be procured by the Contractor on the basis of outline design, design briefs and performance specifications, the contractor shall submit such documents as part of Detailed Design Submissions.

4.3 General Design Criteria

4.3.1 Design for individual equipment, system and works shall be as per Employer's Requirements, given in PS (Signalling works) and PS (Telecommunication works).

4.3.2 The design shall be reliable, energy and cost efficient with due considerations to the local climate

conditions, safety, ease of installation, operation, maintenance and future replacements.

4.3.3 Durability and Maintenance

(1) The Permanent Works shall be designed and constructed such that they shall endure in a serviceable condition throughout their minimum design lives as described in the particular specifications to minimize the cost of operation and maintenance whilst not compromising safety or the performance characteristics of the railway.

(2) Equipment, where supplied, shall be of a quality and durability to fully meet the performance and operational requirements described in the Particular Specifications.

4.3.4 Operational Requirements

(1) The Permanent Works shall be designed to permit the HORC to operate satisfactorily at a maximum permissible speed for trains in accordance with Particular Specifications.

(2) The system offered shall be safe and reliable as safety remains a primary concern for the railways. The methodology adopted for the design and installation of the facility shall be such as to ensure a smooth and accident free operation.

(3) As the railway systems are expected to live through potentially long life the system offered and installed shall be such as to be compatible with future expansion and technological upgrades without hassles.

(4) Since the time period for the completion of the project is limited, the system may be designed with a modular approach so that prefabricated and pre tested modules are easily installed at site.

(5) It is a requirement that the Indian Railway (IR) remains operational during the construction/Installation phase covered in this Package.

4.3.5 Aesthetics: The Permanent Works shall be designed to achieve an aesthetic character and provide a feeling of design commonality throughout the project.

4.3.6 Human Factors: The Contractor is required to observe the guidance contained within ISO/TR 16982:2002 and the ergonomic design of systems supplied shall be subject to acceptance by the Engineer.

4.3.7 Safety, Health and Environment Considerations: The design of the Permanent Works shall be according to Indian laws and regulations related to Safety, Health & Environment Requirements. Safety, Health & Environment aspects shall be kept in mind during the Design, Manufacturing/Supply, Construction/ Installation and Testing & Commissioning phases, requirement for which has been specified at appropriate places in the Bidding Document.

4.3.8 Quality Control: Quality control aspects shall be kept in mind during the Design, Manufacturing/Supply, Construction/ Installation and testing & commissioning phases, requirement for which has been specified at appropriate places in the Bidding Document. It shall be the overall responsibility of the Contractor to ensure deliverables of quality products at all times conforming to the provisions mentioned in this bidding document.

4.4 Design Stages

4.4.1 The design of this project is divided into various stages as under:

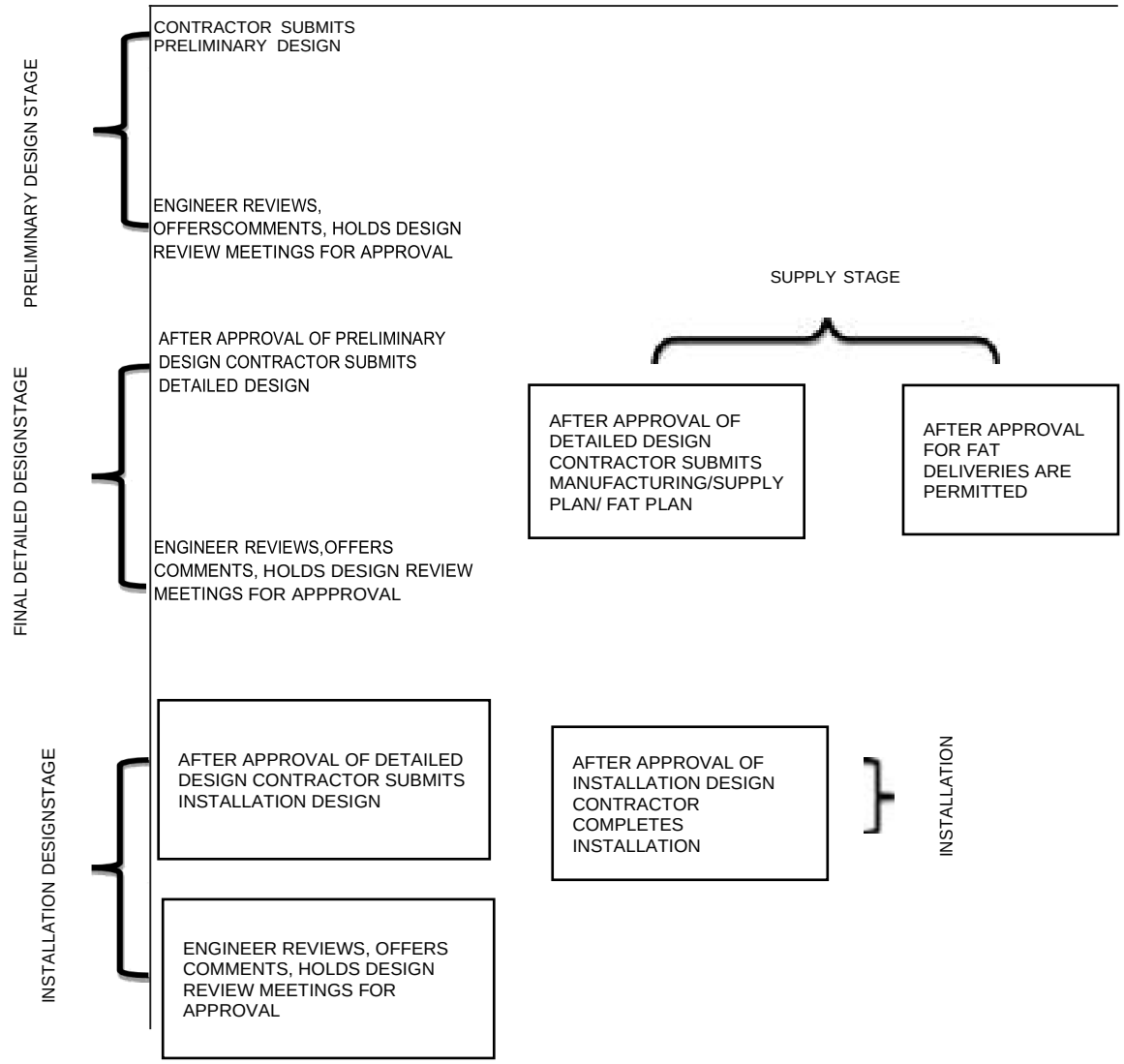
(1) Preliminary Design

(2) Detailed Design

(3) Construction/ Installation Design

(4) As Built Documents

4.4.2 The Procedure for Design Submission is laid down as under



4.5 Preliminary Design & Documents

4.5.1 Based on the Employer's Requirement, the Contractor shall prepare a System Requirement Specifications (SRS) which includes, as a minimum operational, functional, performance and design requirements of the proposed system.

4.5.2 The System Requirement Specifications, serving as a means of system requirement management and the Contractor's top level design document, shall state all the requirements completely and unambiguously and how each requirement can be verified and validated.

4.5.3 The System Requirement Specifications (SRS) shall include a compliance matrix that includes cross-references to the requirements stated in the Particular Specifications, the System Requirement Specifications and the Design Verification Table (DVT).

4.5.4 The Preliminary design stage, as a minimum, shall identify the function of each system, sub-system, equipment or other element within the overall SRS and specify the relationships and interfaces between each element of the system including the systems of the interfacing elements of other Contractors. Equipment and interconnection specifications, with supporting calculations, shall be developed at this stage. Submissions shall clarify and confirm as necessary technical aspects of all interfaces with other elements of contractor's overall design and of any interfaces with systems of other contractors.

4.5.5 Ergonomic design, mock-ups/prototypes shall be developed during this stage.

4.5.6 The Contractor, during this phase, shall submit the Preliminary Design. Subsequent to the study conducted, the contractor shall develop his basic designs of the system and the sub- systems. The Safety of the entire Railway Network including the work to be done by other Contractor(s) for earthing and bonding shall be an important document to be prepared for approval by the Engineer. The Basic and detailed Design Report submission shall also provide details.

4.5.7 The Contractor shall review the indicative General Arrangement and other Drawings, wherever applicable and suggest modification(s) and improvements based on site conditions and as a result of the simulation exercise conducted by him and approved by the Engineer.

4.5.8 The Preliminary design and documents for Signalling works shall include following but not limited to:

(1) Signalling architecture proposed at a Station.

(2) Design manual.

(3) System requirement specification

(4) Specifications of systems/ subsystems/equipment

(5) Identification of design codes and standards

(6) Design Templates for Signal Interlocking Plan, Route Control Table/Selection table/VDU diagram/Interface circuit/Logic circuit, DetailedDesign sheets etc.

(7) Preliminary System design

(8) Block diagrams showing information flow from various Signalling sub system with in a station and station to station bringing out clearly the

redundancies provided

(9) Signal Interlocking Plan (SIP) of any one station

(10) Equipment proposal for Station

(11) Equipment sizing for Station

(12) Equipment layout Plan for Station

(13) Typical Power Supply diagram for Station

(14) Preliminary Power supply load calculation, for Junction Station and Crossing Station

(15) Preliminary climate management calculations. (Station)

(16) Survey Reports

(17) Earthing, Lightning & Surge protection plan/ arrangement for Indoor Signalling equipment, Location boxes, Signals, MSDAC DP, S&T Building etc.

(18) Typical Axle counter location plans with resetting arrangement

(19) Typical Signalling Cable Core plan for Station

(20) Typical Cable termination details for track side devices such as DC track circuit, digital axle counters, BPAC, points, signals, etc.

(21) Location Foundation drawings

(22) Signal Foundation drawings

(23) Architecture lay out for RDPM system.

(24) Bridge crossing drawing for Major, minor and all other bridges

(25) Track crossing etc.

4.5.9 The Preliminary design and documents for Telecommunication works shall include following but not limited to:

(1) Telecom architecture proposed

(2) System requirement specification

(3) Specifications of equipment

(4) Survey reports

(5) Preliminary climate management calculations. (Station)

(6) OFC channeling plan

(7) Quad cable allocation plan

(8) Equipment proposal for Station

(9) Equipment sizing for Station

(10) Block diagrams showing information flow from various Telecom sub system with in

a station and station to station bringing out clearly the redundancies

(11) Earthing, Lightning & Surge protection plan/ arrangement for Indoor Telecom equipment,

(12) Typical drawings for Power Supply diagram for a Station

(13) Bridge crossing drawing for Major, minor and other bridges,

(14) Road crossing, track crossing etc.

4.6 Calculations

4.6.1 Unless otherwise required by the Engineer, calculations shall be submitted together with the Preliminary Design Package submission.

4.6.2 A comprehensive set of calculations for the whole of the Preliminary Design, commencing from the input and output data to the Simulation Program (in the form acceptable to the Engineer) shall be submitted by the Contractor to the Engineer for consent as part of the relevant submittals.

4.6.3 Should the design of the Works be revised thereafter and such revision(s) render the submitted calculations superseded, then the Contractor shall prepare and submit revised calculations and the revised design simultaneously.

4.6.4 The Engineer/Employer shall require the Contractor to submit and install one copy each of all the applicable software as used by the Contractor for the Design, including the Simulation Computer Program duly licensed in the name of Employer and also in-house Software Program/ Worksheets developed by the Contractor, computer input and program logic prior to the acceptance of any computer output. The Contractor shall submit the same to the Engineer without any additional cost.

4.6.5 The Contractor shall submit all calculations necessary to support proposals relating to the construction/Installation methods.

4.7 Detailed Design & Documents

4.7.1 During the preparation of the Detailed Design, the Contractor shall in particular ensure that:

- All standards and regulations have been identified and applied;
- Calculation and analysis are complete;
- All main and other significant elements are delineated;
- All protocol of tests and trials, all selection of material and equipment are complete;
- Full account of the effect on the Project Works of the proposed methods of Installation, Testing & Commissioning and of the Temporary Works has been taken into account; and
- Complete the validation of all the data provided by the Employer including all the additional surveys, investigations and testing as considered necessary by the Contractor to develop the Detailed Design of the Works in accordance with the Contract.

4.7.2 The Detailed Design shall be based on the Preliminary Design developed to the stage at which all sub systems of the Works are fully designed and specified.

4.7.3 The Designs shall be submitted within the specified period as per the Design Submission Program consented by the Engineer.

4.7.4 The Detailed Design shall include the Technical Drawings, the Works Specifications, the Detailed Design Report and all other contents of the Detailed Design Submittals.

4.7.5 The Temporary Works, if any, shall also be identified as a separate Works Segment and the design of those shall be proposed by the Contractor early enough to have sufficient discussions on engineering and procedural issues with the Engineer so as to meet the intent of the Employer's Requirements. The Contractor shall submit the agreed design of the Temporary works as part of the Detailed Design to the Engineer for consent.

4.7.6 The Contractor shall demonstrate, to the satisfaction of the Engineer, the adequacy of the ratings of the equipment and conductors and their suitability entailing all load, permanent and temporary, and also its effects on other Contracts.

4.7.7 Upon completion of Internal Authorization Process , the Contractor shall submit the Detailed Design as described herein, Requirements for Design, to the Engineer for consent and issue of a "Notice of No Objection".

4.7.8 The detailed design and document for Signalling works shall include following but not limited to:

(1) Signal Interlocking Plans

(2) Route Control tables/Selection table.

(3) VDU diagram.

(4) Interface circuit.

(5) Logic circuits

(6) System configuration showing EI connectivity.

(7) Equipment Layout Plans — Signal Equipment Room, Power Supply room, Location/Junction Boxes, SM office, MSDAC room, Battery Room etc..

(8) Cable Core Allocation

(9) Cable Route Plan

(10) Power supply Load Calculation for a station as well as for signals, points and Distant/Inner distant signals.

(11) Circuit Diagrams/Wiring diagrams.

(12) Application Logic of Stations.

(13) Equipment Rack details.

(14) Cable Termination Rack Diagrams.

(15) Fuse Details.

(16) Relay Contact analysis.

(17) Configuration data, parameters and settings.

(18) Interconnection details for all equipment in SER.

(19) Track devices termination details.

(20) Cable termination details of locations/Junction boxes.

(21) Station Working Rule and Station working rule Diagrams.

(22) Detailed Signalling Power supply distribution arrangement at Station.

(23) Combined drawings for all RDPM and dataloggers equipment of the complete project

4.7.9 The detailed design and document for Telecommunication works shall include following but not limited to:

(1) System architecture diagram for OFC system,

(2) System architecture diagram for IP Ready EPABX system and attendant console,

(3) System architecture diagram for Control Telephone system,

(4) System architecture diagram for Master & Slave clock system,

(5) System architecture diagram for VHF communication system,

(6) System architecture diagram for Telecommunication power supply system,

(7) System architecture for Public Announcement system

(8) Network diagram for whole project

(9) Fiber bandwidth calculation

4.7.10 System assurance submissions

(1) System Assurance Plan including

(a) System RAM Plan and

(b) System Safety Plan

(2) Safety policy

(3) Hazard Analysis and Hazard Log

(4) Design/System Safety Studies and Report

(5) RAM Analysis and Prediction Report

(6) FMECA

(7) RAM Demonstration plan.

(8) Engineering Safety Validation Report

(9) Operational Safety case

4.8 Construction/Installation Design

4.8.1 Upon the issue of a Notice of "No Objection" in respect of a Detailed Design Submission, the Contractor shall produce the respective Construction/Installation Design Submission which shall include, but not limited to,

(1) The Technical Drawings,

(2) The updated Works Specifications including Method Statements/ work procedures/ construction/Installation sequences,

(a) The Construction Sequence Statement: The document illustrates the sequence of one cycle of particular construction implementation in which such sequenceis critical to maintain the quality, safety and/or any other important factors of the construction implementation.

(b) The Safety Risk Assessment: The analysis describes and evaluates the risks associated with the construction implementation anticipated in the course of the construction.

(3) The Working Drawings:

(a) The Site Drawings: these are supplementary detail drawings which expand and explain the information shown on the Construction Technical Drawings based on the site conditions and dimensions existing there.;

(b) The Fabrication Drawings: These are supplementary drawings of specific elements of the works such as for the switchyards, portal structures shown on the Construction Technical Drawings for the purpose of manufacture or fabrication of those element and erection.

(c) All other drawings as deemed necessary by the contractor for the accurate and safe construction of the Works in accordance with the Contract.

4.8.2 Technical Drawings, updated Works Specifications/ Method Statements etc. shall be derived directly from the Detailed Design as approved by the Engineer including changes that may be necessary to resolve the comments of the Engineer attached to the Notice of No Objection.

4.8.3 The Working Drawings and the Construction/Installation Practicing Documents shall be prepared to facilitate construction/Installation to meet the required workmanship as well as technical requirements. The Works Management Plans shall be prepared to check and monitor the Works in terms of SHE requirements described in this bidding document.

4.8.4 Upon receipt of the "Notice of No Objection" or "Notice of No Objection with Comments", the Contractor shall endorse the original paper drawings in respect of the Working Drawings as "Good For Construction/Installation" as per the Internal Authorization Process as defined in the Design Quality Assurance Plan detailed in this bidding document. If the Engineer so requires, the said endorsed original paper drawings shall be re-submitted to the Engineer, who shall, if he has no objection to the contents of the re-submission, further endorse the original paper drawings by stating that he has no objection to the proposed Working Drawings. On endorsement by the Engineer, the original drawings will forthwith be returned to the Contractor as Working Drawings to be issued to the Site.

4.8.5 Technical Drawings and the Working Drawings shall be used for construction/Installation purposes and only those drawings and documents that have been endorsed and certified through the procedure and have received "Notice of No Objection" as above or those that the Engineer has expressly stated as not requiring his endorsement shall be issued to the Site.

4.8.6 The Construction/Installation of the Works shall be strictly in accordance with the Construction/Installation Design Submission for which "Notice of No Objection" has been issued by the Engineer and "Good For Construction/Installation" drawings has been issued as per the authorization process detailed as above.

4.8.7 The Construction/Installation Design may be divided into multiple submissions for different Work Segments, in such a case,

(1) Construction/Installation Design and Drawings in respect of each subsystem in a Work Segment shall be submitted for the entire subsystem

(2) Submittals which are commonly applicable to the subsequent submissions shall be submitted in the initial submission and each submission shall include correlated and interdependent submittals.

4.8.8 The Contractor shall submit the Construction/Installation Design and Drawings for a particular work to the Engineer at least 2 months but not more than 4 months prior to the planned / scheduled date of commencement of that particular work.

4.8.9 The Construction/Installation Design submission shall be a coherent and complete set of documents in line with the Detailed Design which has received "Notice of No Objection" from the Engineer and shall fully describe the proposed Construction/ Installation Design.

4.8.10 The Good for construction drawings for Signalling works shall include but not limited to:

(1) Equipment Layout Plans for Signal Equipment Room, Power Supply room, Location/Junction Boxes, SM office etc.

(2) Circuit Diagrams/Wiring diagrams for indoor and outdoor Signalling gears

(3) Equipment Rack details

(4) Cable Termination Rack Diagrams

(5) Fuse Details

(6) Relay Contact analysis

(7) Interconnection details for all equipment in SER

(8) Termination details for Track devices

(9) Cable termination details of locations/Junction boxes.

(10) RDPM and Datalogger and its equipment diagrams for all stations.

(11) BPAC equipment wiring diagram.

(12) Fuse auto change over wiring diagram.

(13) Drawings for crossing all bridges by the Signalling cable

(14) Axle counter location drawings with resetting arrangement

(15) Earthing and Surge protection drawings for Indoor & Outdoor Telecommunication system

(16) Model and Make of equipment

4.8.11 The Good for construction drawings for Telecommunication works shall include but not limited to:

(1) Telecommunication Cabe route plan,

(2) Drawings for crossing all bridges by the Telecommunication cable

(3) Equipment layout diagram for all Telecommunication system

(4) Earthing and Surge protection drawings for Indoor & Outdoor Telecommunication system

(5) Wiring diagram for OFC system,

(6) Wiring diagram for IP Ready EPABX system and attendant console,

(7) Wiring diagram for Control Telephone system,

(8) Wiring diagram for Master &Slave clock system,

(9) Wiring diagram for VHF communication system,

(10) Wiring diagram for Telecommunication power supply system,

(11) Wiring diagram for Public Announcement system,

(12) Installation drawing for VHF Antenna and Mast

(13) Model and Make of equipment

4.9 As-Built Documents

4.9.1 The Contractor shall maintain all records necessary for the preparation of As-Built Documents. Within seven days of commissioning of any Sub-System, the Contractor shall submit 6 sets of verified design documents. Prior to the issue of the Taking-Over Certificate in accordance with the Conditions of Contract, the Contractor shall prepare the As-Built Drawings and Records which, subject to the Engineer's agreement, shall become the contents of the As-Built Documents.

4.9.2 The As-Built Drawings shall be a full set of the latest revisions of the Preliminary/ Final Detailed/Construction/Installation Designs and Drawings (updated to incorporate all Design Change Notices and Field Change Notices) and as many Working Drawings as necessary to convey a full and true record of the as-built condition of the Works. The As-Built Drawings shall show all changes from the Preliminary/ Final Detailed/ Installation Design and all other features relevant to the future maintenance and management of the HRIDC and its facilities. The As-Built Drawings shall be endorsed by the Contractor as true records of the construction/Installation of the Works.

4.9.3 Configuration data tables shall be prepared for each individual sub-system on item by item basis as well as on location basis.

4.9.4 The As-Built Documents shall also incorporate the changes to dimension and details from the Construction Drawings and changes due to variation orders.

4.9.5 Following shall also be part of the all As-Built Documents :

(1) Official letters regarding the design change acceptance;

(2) Certificates of acceptance between the Contractor and the Engineer;

(3) Design Certificate.

(1) Station Working Rule and Station working rule Diagrams.

(2) Document and drawings for NI

(3) Operational Safety case

(4) CRS sanction supporting documents, including Station Working Rules (SWR) etc.

(5) Operation & Maintenance manuals for whole Signalling and Telecommunication system/ subsystems

4.9.6 As part of the As Built Documents, the Contractor shall maintain all records necessary for the financial completion and commissioning of the project. These records shall consist of as a minimum, but not limited to the following:

(1) The implemented work according to activities, places and price

(2) Used Material — type, name of manufacturers along with batch number, place and price etc.

(3) Any other record as required by the Engineer.

4.9.7 The O&M Manuals for Signalling and Telecommunication systems/subsystems shall be considered part of the As Built drawings and documents.

4.9.8 The As-Built Documents shall be submitted to the Engineer for consent and issue of a "Notice of No Objection" at no extra cost to the Employer.

4.10 Contractor's Coordination with others

4.10.1 The Contractor shall fully coordinate the design of the Works with the design of other contractors and shall follow the interfacing requirements as stipulated in Appendix-5---,Interface Requirement.

4.10.2 Those Works, which are required to be executed by the other contractors, shall be fully coordinated and integrated throughout the Detailed Design development and the results shall be recorded and summarized in the Combined Service Drawings (CSD) and the Interface Report on other contractors as part of the Detailed Design and the Construction/Installation Design.

4.10.3 Coordination with External Related Parties: The Contractor shall fully coordinate the design of the works with all relevant bodies and entities, in particular government authorities, departments and regulatory bodies, public utility companies, Power Supply Authorities adjacent Indian Railway Authorities and the consultants and contractors of adjacent projects whether ongoing or planned, as advised by the Engineer. The Contractor shall identify all such related parties in his Interface Management Plan (IMP) and other relevant requirements as detailed in Appendix---5----- Interface Requirement.

4.10.4 Co-ordination with Indian Railways:

1) For some S&T Works proposed by Contractor and having implication over working

of Indian Railways and its Systems, approval from Indian Railways through the Employer shall be required, in addition to the consent by the Engineer. The Contractor shall be required to submit three additional copies of such Preliminary Design & Detailed Design to the Engineer for onward submission to Indian Railways.

2) The Contractor shall co-ordinate in seeking the approval from Indian Railways, however, the Employer shall facilitate the Contractor in seeking the approval from Indian Railways including, but not limited to, providing clarifications / additional data, attending meetings etc. as required.

3) It will be the Contractor's responsibility to take approval of Indian Railways on the designs, however the Employer will extend all assistance in seeking these approvals.

4.11 Contractor's Warranty of Design

4.11.1 The Contractor shall give warranty that the design produced by them (in accordance with the Conditions of Contract) meets the Employer's Requirements and Specifications provided by the Employer and is fit for the purpose thereof. In accordance with S&T Design Certificates as this bidding document. Where, there is any inadequacy, insufficiency, impracticality or unsuitability from the Employer's Requirements and Specifications or any part thereof, the Contractor's design shall take into account, address or rectify such inadequacy, insufficiency, impracticality or unsuitability at Contractor's own cost.

4.11.2 The Contractor shall indemnify the Employer against any damage, expense, liability, loss or claim, which the Employer might incur, sustain or be subject to arising from any breach of the Contractor's design responsibility and/or warranty set out in this clause.

4.11.3 The Contractor shall further specify and shall deemed to have checked and accepted full responsibility for the Contractor's part of the design (in accordance with Conditions of Contract) notwithstanding.

1) That such design may be or have been prepared, developed or issued by the Employer which has been checked by the Contractor, any of Contractor's consultants, his sub contractor's and/or his qualified personnel/persons or cause to be prepared, developed or issued by others.

2) Any warranties, guaranties and/or indemnities that may be or may have been submitted by any other person.

3) That the same have been accepted by the Engineer.

4.11.4 The Contractor shall conform to the provision of any statute relating to the Works and regulation and bye-laws of any local authority and of any water and lighting agencies or undertakings with whose system the work is proposed to be connected and shall before making any variation from the drawings or the specifications that may be necessitated by so confirming give to the Engineer notice specifying the variation proposed to be made and the reason for making the variation and shall not carry out such variation until he has received instructions from the Engineer in respect thereof. The Contractor shall be bound to give all notices required by statute, regulations or bye-laws as aforesaid and shall pay all fees and taxes payable to any authority in respect thereof. Nothing shall be payable by the Employer in this regard.

4.11.5 The Contractor shall ensure compliance of provision of all laws of land in force and enacted from time to time and:

- Ensure compliance of the regulations or bye-laws of any local body and utilities.
- The Contractor shall arrange necessary clearances and approvals before the work is taken up. Nothing extra will be paid by Employer on this account.
- Ignorance of rules, regulations and bye-laws shall not constitute a basis for any claim at any stage of work.

4.11.6 The Design Warranty shall be submitted by the Contractor as per the S&T Design Certificate. Design life has been described in Particular specification of Signalling & Telecommunication system.

4.11.7 The Contractor shall ensure supply of the spares during the Design life of the Signalling/Telecom System.

4.12 Design Changes

4.12.1 If there is a requirement to change the design after the Construction Design has been submitted and consented by the issue of Notice of No Objection during the Construction Phase, the Contractor shall propose, the design change through either a Field Change Notice (FCN) or a Design Change Notice (DCN).

4.12.2 These design changes shall go through the full process of the Design Review Procedure as described in the Appendix---11----- Quality Assurance.

(End of Chapter-4)

CHAPTER 5 - SUPPLY, INSTALLATION, TESTING AND COMMISSIONING

5.1 General

5.1.1 The Contractor shall establish procedures and controls that govern the procurement/manufacturing off-site of material/equipment/ components required for the work and supply them for construction/installation assembling and wiring in the Permanent Works.

5.1.2 The Contractor shall establish Comprehensive Test and Inspection instructions for procurement/manufacturing, packaging, marking, shipping, handling, storage and preservation, to protect the quality of the material/equipment/components and to prevent damage, loss, deterioration, degradation or substitution thereof.

5.2 Procurement/Manufacturing

5.2.1 The Contractor shall ensure that all the material required for the work is manufactured/procured, inspected, tested and delivered as per the specifications and guidelines specified in the Employer's requirements.

5.2.2 In order to ensure quality in procurement/manufacturing, the Contractor shall

(1) Make a Procurement Management Plan, comprising of the details on Procurement, Manufacturing and Delivery in respect of all items and goods;

(2) Detailed Method statements for various activities such as Purchasing, Manufacturing, Inspection etc.

(3) Prepare a Material Delivery Plan;

(4) Develop and maintain a Material Control Schedule;

5.2.3 Manufacturing inspection and test provisions

(1) All the material procured/manufactured shall be inspected and tested.

(2) The Contractor shall propose a structured set of inspection hold points. The hold points shall be structured such that a formal hold point is allowed for each significant element of the manufacturing process.

(3) At each hold point, the Engineer shall hold a formal inspection or advise that the inspection has been waived.

(4) In order to facilitate such an inspection, the detailed production/manufacturing plan shall be provided by the Contractor to the participants of the inspection, at least three weeks in advance of the commencement of the manufacturing process along with the description of mandatory specifications and tests proposed during the manufacturing process and the tests intended to be conducted on the finished product along with codal permitted tolerances.

(5) Once the inspection and any required remedial actions are completed to the satisfaction of the Engineer, the Engineer may give a notice of no objection to the results of Inspection as jointly witnessed. The Engineer will not withhold his notice of no objection for shipping unreasonably, provided all pre-delivery assembly and testing has

been successfully completed.

5.2.4 The material delivered at the Site and offered for Inspection shall be manufactured normally not earlier than one (1) year and their Warantee period shall at least cover the Defects Notification Period.

5.2.5 The Signalling and Telecom equipmets/material shall be inspected by RDSO/RITES as the case may be. And the inspection charges for the same shall be borne by the Contractor. Material which are inspected by Consignee if required to be tested in the authorized Test labs as per the instruction of the Engineer, then such testing charges shall also be borne by Contractor.

5.3 Packaging, Shipping, Storage and Delivery

5.3.1 Packaging and Shipping

(1) The packaging and shipping of the equipment shall be designed and implemented to minimise damage whilst in transit.

(2) Each case, crate or package shall be of robust construction and suitable for the intended purpose. Packaging material that are likely to suffer deterioration in quality as a result of exposure to environmental conditions likely to be met during transit from the factory of origin to the Site shall not be used.

(3) The contents of each case, crate or package shall be protected against the harmful effects of ingress of moisture / water/electro static charge by enclosing within a heavy duty waterproof membrane/electro static shield.

(4) Each case, crate or package shall be legibly and indelibly marked in large letters with the address, Contract number, 'right way up', opening points and other markings like "fragile", "keep dry", "handle with care" etc. along with visual display of internationally accepted symbols as necessary to permit material to be readily identified and handled during transit and when received at Site.

(5) Each case, crate or package shall contain a comprehensive packing list showing the number, mark, size, weight and contents together with any relevant drawings. Second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each case, crate or package. Distribution of additional copies of each packing list shall be in accordance with the requirements of the Engineer.

(6) All items shall be marked on the outside of the case to show the gross and net weights, the points for slinging and where the weight is bearing.

(7) Care shall be taken to prevent movement of equipment within containers by the provision of bracing, straps and securing bolts as necessary.

(8) Bags of loose items shall be packed in cases and shall be clearly identified by well-secured metal labels on which the quantity and name of the part and its index or catalogue number have been stamped.

(9) Details of cases, crates, packages, containers, etc., intended to hold important or delicate items of equipment or material shall be submitted to the Engineer for acceptance.

(10) Sub-Assemblies: All components shall be packed together and properly labeled and numbered. Diagrams to ensure that they are properly assembled at site in the required

order of components shall also accompany the packaging.

(11) Spare parts shall be suitably packed for storage over an indefinite period without deterioration and shall be clearly identified showing full name and part number without any need to unwrap packaging. Electrical/electronic and other delicate items or equipment shall be cocooned.

(12) Cable ends, cable entry points into equipment and other similar terminations and openings shall be sealed or blanked off to prevent the ingress of dirt, vermin or moisture.

(13) Tube ends and other similar openings shall be thoroughly cleaned and then blanked- off to prevent ingress of dirt or moisture.

(14) Flanged ends shall be protected by adhesive tape or jointing material covered by a properly secured wooden blank not smaller than the flange itself.

(15) Particular care shall be taken to prevent damage to or corrosion of shafts and journals, where they rest on timber or other supports that may contain moisture.

(16) At such points wrappings impregnated with anti-rusting compositions shall be used, of sufficient strength to resist chafing under the pressures and movements likely to occur in transit.

(17) Care shall be taken to minimize risk of damage to ball and roller bearings and any fragile material in transit.

(18) The Contractor shall ensure satisfactory completion of manufacturing and testing check prior to shipment.

(19) All shipments shall be adequately protected to preclude damage during shipment. The Contractor's quality control personnel shall verify the inspection and preparation for shipment.

(20) The Handling procedures shall include the use of special crates, boxes, containers, transportation vehicles, equipment and facilities for material handling.

5.3.2 Cable Drums

(1) Immediately after the tests at the place of manufacturing, both ends of every length of cables shall be sealed by enclosing them with approved caps, tight fitting and adequately secured to prevent ingress of moisture.

(2) The ends of the factory lengths of cable shall be marked "A" and "Z", "A" being the end at which the sequence of core numbers is clockwise and "Z" the end at which the sequence is anti-clockwise.

(3) The end which is left projecting from the drum shall be consistently "A" or "Z" and shall be protected against damage in such a manner that the enclosure cannot be easily removed during handling while in transit.

(4) Cables shall be supplied on drums in the longest possible lengths and within practical limits.

(5) The maximum allowable diameter of cable drum shall be 2000 mm. The use of cable drums with diameter in excess of 2000 mm shall be subjected to the review of the

Engineer.

(6) The drums shall also be designed for use in conjunction with any special cable-laying equipment and accessories complete with spindles and cable drum braking gear, which shall be used to install the cables on Site.

(7) Each drum shall bear a distinguishing number and label "HORC", either printed or neatly chiseled on the outside of a flange.

(8) Particulars of the cable, i.e. voltage, length, conductor size, number of cores, section and length, gross and net weights, shall be clearly shown on one flange of the drum. In addition the words "Running End 'A"' or "Running End 'Z"' as appropriate shall be marked on the flange and the direction for rolling shall be indicated by an arrow.

(9) An arrow showing direction of rolling shall be shown. Both ends of the cables shall have heat shrinkable caps. The caps shall incorporate sealants which melt on heating at temperatures well above outdoor ambient expected in HORC area.

5.3.3 Storage and Delivery

(1) Unless otherwise consented by the Engineer, the Contractor shall provide adequate storage facilities by way of covered areas at his own cost for storing in a safe and secure manner all the plant & equipment and manufactured items to be supplied and erected as part of the Contract.

(2) The Contractor shall make its own arrangement of space for storage facility. However, if the spare land is available with the Employer, the same will be handed over to the Contractor free of cost, for the purpose of establishing temporary construction depot(s) with the condition that whenever the Employer requires this portion of land back, the same shall be handed over by the contractor at a month's notice and no extra cost/compensation to the Contractor.

(3) Means shall be provided by the Contractor for protection against deterioration or damage to equipment in storage. Where shelf-life of the equipment / material is limited, this shall be clearly stated on the shipment. Secure compound and storage for the high value items shall be integral part of the safe storage. Spares to be supplied, shall also be kept safe and secure until handed over to the Employer at the time of Commissioning.

5.4 Warranty Certificates from OEM:

1) All Original Warranty Certificates of OEMs of all Signalling & Telecommunication sub system or equipment including contract spare, Commissioning spare, DLP spares and Special tools & Test and Measuing Equipments shall be valid for three years or as specified in RDSO Specification of the equipment whichever is later and registered in the name of Employer. These warranty certificates received from the OEMs should be passed on to Employer before final Taking over

2) Validity of period of Warranty Certificates shall start from date of Commissioning.

3) Original invoice shall also be submitted with the OEM warranty certificates in a booklet form before Commissioning.

4) Warranty period support shall start from the date of Commissioning.

5.5 Construction/ Installation

(1) The Installation shall be carried out by competent and skilled staff. The Contractor shall ensure that his staff are competent and possess all the necessary skills to carry out the installation in a proper and safe manner.

(2) The Installation shall be carried out with necessary and sufficient resources such as tools, test instruments, spares, equipment, manpower and communication facilities.

(3) During installation, every precaution shall be taken to protect the existing equipment and facilities on Site from damage, and shall make good any damage caused. Care shall also be taken not to interfere with the operation of existing equipment.

(4) All the Installation works shall be supervised to ensure that and technical, safety and quality matters adhere to the Design as reviewed by the Engineer.

(5) The Installation shall be done in accordance with the approved Installation Plan and Method Statements. All installation activities shall commence only after the method statement and related submissions have been reviewed without objection by the Engineer.

(6) The Installation Method Statements shall include the details on the methods and procedures of installation, site arrangement, manpower resources, equipment and tools required. Drawings shall be included to illustrate the proposed installation details.

(7) Prior to proceeding with installation, the Contractor shall submit, for the Engineer's consent, six copies of drawings showing all installations including dimensions, supports, hardware, installation methods and documents confirming the availability and location of special installation tools and equipment and all other pertinent data.

(8) During installation, care may be taken to ensure that the manufacturer's erection instructions are correctly followed.

(9) The installation for major items such as important components and vital equipment of Signalling & Telecommunication Equipment shall be undertaken preferably in the presence of the manufacturer's field service representative.

(10) The Contractor shall make certain that the installation of all supports, gaskets, hardware, etc., are accomplished so as to assure safe, accurate and trouble-free installation.

(11) Upon noticing or being advised of any inconsistencies between the installation drawings and documentation and the installed equipment, the Contractor shall notify his acknowledgement to the Engineer and correct such errors within two weeks.

(12) Equipment that is improperly installed shall be removed, checked / tested and reinstalled. Any damage caused due to improper installation and removal shall be rectified before reinstallation at no extra cost to the Employer.

5.6 Asset Identification

5.6.1 The Contractor shall submit an asset database for review by the Engineer. The database shall contain the complete asset listing for all aspects of the contract works.

5.6.2 The database shall provide the following information, but not limited to:

1) Asset Details;
   - Date Manufactured
   - Date Installed; and
   - Date(s) Tested.
   - Failure History

2) All equipment and software shall have a unique identification number that can be identified electronically and manually.

5.7 Testing and Commissioning

5.7.1 General

1) The Contractor shall provide and perform all forms of testing procedures applicable to the Works relating to plant & equipment and manufactured items and various components and the interfacing of the Works relating to plant & equipment and manufactured items with the other contractor(s) and shall conduct all necessary factory, site and acceptance tests.

2) The commissioning activity shall include a period of the Integrated System testing followed by a period of Trial Run.

3) Within 6 months from the date of Commencement of the Work, the Contractor shall submit a comprehensive Testing Program defining the personnel, procedure and format of testing.

4) All testing procedures shall be submitted at least twenty eight (28) days prior to conducting any Test. The testing procedures shall show unambiguously the extent of testing covered by each submission, the method of testing, the acceptance criteria, the relevant drawing (or modification) status and the location.

5) The testing procedures shall be submitted by the Contractor and amended subsequently, if required, by the Contractor during the duration of the contract to reflect changes in design of works, interface systems or the identification of additional testing requirements, if needed.

6) The contractor shall facilitate the Employer's Personnel to monitor all tests and have access to all testing records.

7) Sufficient time shall be allowed within the Testing Programs for necessary alterations to equipment, sub-systems and designs to be undertaken, together with re-testing prior to final commissioning.

8) The Contractor shall keep in mind that at some point of time, the electric Traction System shall be energized and the additional precautions for the safety and co- ordination of the activities prior to and after 'power-on' shall be anticipated in his co- ordination with other contractors and installation, testing and commissioning Programs of all the contractors and all associated with the Traction Power Energisation Program.

9) All costs associated with the testing shall be borne by the Contractor. This shall include the Inspection/Testing Charges to be paid to RDSO/RITES/Test Laboratories. The Contractor shall also bear any expense incurred due to resetting/retesting caused by defects or failure of equipment to meet the requirements of the Contract in the first instance.

10) The cost incurred by Engineer against hotel and travel expenses for witnessing of testing shall not be borne by Contractor.

11) In the event of any test being performed in the countries other than India, the Contractor shall give at least 56 days' notice to the Engineer for witnessing the test. The Contractor shall not be required to bear the cost of the Enginner's visit i.e. travel expenses, boarding/lodging etc.

12) Unless agreed to in writing by the Engineer, the personnel engaged on testing shall be independent of those directly engaged in the design or installation of the same equipment.

13) All testing equipment shall carry an appropriate and valid calibration label. They shall be periodically checked for calibration accuracy.

14) All reports of the tests shall be signed by the Contractor's Representative.

5.7.2 Testing Philosophy

1) Testing of various items shall be carried out as per the Testing procedures approved by the Engineer. An appropriate format for Test Schedule(s) and Procedure(s) including the details of testing equipment shall be submitted to the Engineer for approval.

2) Unless otherwise agreed, all Tests shall be witnessed and signed by the authorized representative of the Engineer & recorded. Attendance on Tests, including that by Engineer / Employer, and the Contractor shall be as laid down in the Quality Assurance procedures detailed in this bidding document.

3) All tools & instruments for carrying out the tests shall be arranged by the Contractor to the satisfaction of the Engineer.

4) Prior to shipment of equipment, the Employer's Personnel reserves the right to witness the testing of the equipment at the manufacturers' works.

5.7.3 Sequence of Tests

The sequence of tests shall generally comprise of the following:

1) Type Tests, as and when required;

2) Factory Acceptance Tests (FAT);

3) Installation Tests;

4) System / Sub-system Acceptance Tests (SAT);

5) Integrated Testing & Commissioning; and

6) Trial Run.

The details on each type of tests have been covered in the respective PS (Signalling works) and PS (Telecommunications works).

5.7.4 Samples for Testing

a. Samples that have been tested may be utilized in the Works provided that:

1) The sample complies with the specified requirements;

2) The sample is not damaged;

3) The sample is not required to be retained under any other provision of the Contract; and

4) Consent of the Engineer has been obtained, in writing.

b. Additional samples shall be provided for testing, if in the opinion of the Engineer:

1) Material previously tested no longer complies with the specified requirements; or

2) Material has been handled or stored in such a manner that it may not comply with the specified requirements.

5.7.5 Test Certificates and Reports

1) The Contractor shall submit manufacturer's type and routine test certificates and reports for each equipment and device. Complete test results are to be submitted in clearly identified and organized booklet, indicating item of equipment, make, model, type, date of tests, type of tests, descriptions and procedures. Test reports shall also include the Quality Assurance Certification, the standards to which the equipment comply, and the standards to which the equipment was tested.

2) The Contractor shall submit to the Engineer for review, not less than six (6) months before testing and commissioning activities commence, his proposed format for the testing and commissioning records. The records shall be appropriately sub-divided to make provision for the various parts of the Permanent Works covered by the Contract.

3) The format of the records shall cover all tests, including tests to be conducted after modification of the design/installation based on DCN/FCN.

4) The Contractor shall, during the execution of the Works, prepare such reports and record of design, manufacture, installation and testing, as may be required, in order that a license can be issued or statutory requirements can be met or approval given. Such reports or records shall be adequate to enable each part of the Permanent Works to be commissioned and to meet the requirements of the licensing authority or any standing statutory regulations and shall be reviewed by the Engineer.

5) The Contractor shall prepare two copies of an inspection or test report immediately after the completion of each inspection or test whether or not witnessed by the Engineer. If the Engineer has witnessed the inspection or test, he may countersign the inspection or test

report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) contained therein). If the Engineer has not witnessed the inspection or test (i.e. if a waiver has been granted), or the Engineer has not witnessed the inspection or test for some other reason in accordance with the Contract), the Contractor shall forward two copies of the inspection or test report without delay to the Engineer. The Engineer will countersign the report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) and return one copy to the Contractor. Where the results of the inspection or test do not meet the requirements of the Specification, the Engineer may call for a re-inspection or re-test.

6) At the end of each inspection/test or group of tests, the Contractor shall obtain report which shows the result of all the inspections and/or tests carried out. If required by the Engineer, a manuscript copy of the test record shall be made at the time of the test and shall be given to the Engineer at the earliest opportunity if the test has not been witnessed.

7) The contractor shall carry out an analysis of the results and certify that the work has been inspected and/or tested in accordance with the requirements of the Contract and that the work complies with the requirements of the Contract. Summaries of Inspection and/or Test shall be submitted to the Engineer.

8) The Authorized representative of the Contractor, who has been assigned the required authority under the relevant quality plan, shall sign each report of inspection and/or test.

9) In addition to any other requirements, the report shall contain but not limited to, the following details:

   3) Material or part of the Works tested;
   4) Location of the batch from which the samples were taken or location of the part of the Works;
   5) Place of testing;
   6) Date and time of tests;
   7) Weather conditions in the case of in-situ tests;
   8) Technical personnel supervising or carrying out the tests or inspection;
   9) Size and description of samples and specimens;
   10) Method of sampling;
   11) Number and types of tests which are required to be done.
   12) Specified acceptance criteria;
   13) Tests actually carried out.

c. Method of testing or inspection;

   1) Properties tested or inspected;
   2) Test results, including any calculations and graphs;
   3) Results actually achieved

4) Confirmation of pass/failure accompanied with, if necessary, a schedule of further tests or actions to be carried out by the Contractor to achieve compliance with the Specification and the approved design.

5) All relevant checklists and work sheets used during the inspection and/or test , including readings and measurements taken during the tests; and

6) Other details stated in the Contract.

d. After Commissioning of a part of the Works, the Contractor shall complete each commissioning record in the agreed format and shall forward copies of the record to the Engineer for review

(End of Chapter-5)

CHAPTER 6 - QUALITY ASSURANCE

The contractor shall comply the Quality Assurance as per Appendix--11---- for the approval of the Engineer.

(End of Chapter-6)

CHAPTER 7 - RELIABILITY, AVAILABILITY, MAINTAINABILITY & SAFETY (RAMS)

7.1 General

7.1.1 The Reliability, Availability, Maintainability, & Safety activities shall be undertaken throughout the whole course of the project as an Integral part of System Assurance in order to demonstrate in a logical, progressive and traceable manner that:

(1) The objectives and requirements of the project have been satisfied.

(2) All systems and components of the works are defined appropriately with verifiable performance benchmarks.

(3) Proper designs, Calculations and Simulation tools have been used.

(4) The work has been executed by suitably competent people.

(5) The designs have been verified by the competent authorities.

(6) Any manufacturing, construction, installation, testing and commissioning works associated with the project have been validated.

(7) Safety related aspects of the systems have been identified, analysed and risks mitigated such that residual risks have been demonstrated to be as low as reasonably practicable for all project stages.

(8) RAMS requirements of the Systems have been identified, apportioned to various subsystems and elements of the works and the associated designs for these have been demonstrated to be capable of meeting their allocated performance targets.

7.1.2 The activities shall apply to software design as well as hardware and hardware application designs.

7.1.3 The Contractor shall co-ordinate results of analysis with each engineering discipline, particularly as the results affect engineering and hardware development.

7.1.4 The Contractor shall make recommendations for reengineering or modifications necessary to assure compliance with specified requirements including redundancy, utilisation of high reliability components, built-in self-diagnostics and "self-healing"; utilisation of in-service status displays to enhance fault isolation and test; easy accessibility and quick disconnect connectors; and, the use of mechanical keying to reduce errors during installation and repair.

7.1.5 The Contractor shall document instances where evaluations or analyses indicate an unresolved problem area and formulate appropriate recommendations as well as maintain records, which show that follow-up action has been taken to resolve the problem.

7.2 Reliability-Availability-Maintainability-Safety (RAMS) Plan

7.2.1 The RAMS Plan shall be maintained as a live document and updated as necessary throughout the duration of the Project.

7.2.2 The RAMS Plan shall define the Contractor's approach on systematic compliance to relevant System Requirement Specifications, procedures and schedules for conducting the Reliability, Availability, Maintainability and Safety Engineering.

7.2.3 RAMS Plan shall describe the organization, resources and procedures that will be established to manage system assurance activities. It shall clearly defining the responsibilities of personnel directly associated with system assurance activities and implementation of the program.

7.2.4 The RAMS Plan will describe the RAM and Safety Assurance activities throughout the project lifecycle, comprising Design, Manufacturing & Production, Construction & Installation, Testing & Commissioning and Operation.

7.2.5 The RAMS Plan shall describing the procedures to perform the specific RAMS tasks necessary to meet Reliability, Availability, Maintainability and Safety requirements.

7.2.6 The RAMS Plan shall include application of the relevant standards, norms, regulations, instructions and the Employer's Requirements/Specifications.

7.2.7 The Contractor shall liaise with the Employer/Engineer to establish a comprehensive program of work that will encompass all the requirements of this plan in a time scale that enables the construction, installation, testing, commissioning, putting to work and warranty monitoring to be undertaken in good time to meet the overall time scales of the project.

7.2.8 The Contractor shall submit a Compliance Matrix in the RAMS Plan with all phases mentioned above and tasks to be performed and the deliverables to be submitted for demonstration of compliance with RAMS requirements. These requirements shall also be applied to sub-contractors.

7.3 Compliance management

7.3.1 A compliance management process shall be established and maintained for the duration of the Project to:

(1) Import all RAMS requirements from the Project documents and ensure compliance to Technical Specifications and System Requirements Specifications.

(2) Import design requirements and specifications from each stage of design as they are developed and assess the impact of any changes in these.

(3) Provide traceability to demonstrate that high level and low level design requirements and specifications have been verified that they satisfy the RAMS requirements.

(4) Provide traceability of review comments made and the associated responses and follow up actions.

(5) Provide traceability of non-conformances and follow up actions required to address them.

(6) Provide traceability of validation of testing and commissioning results against RAMS requirements or design requirements and specifications.

(7) Provide summary reports on key status items including, but not limited to requirements not yet satisfied and incomplete or missing verifications or validations.

7.4 Verification & Validation

7.4.1 Verification and Validation activities shall be undertaken to show in a logical, progressive and traceable manner that the:

(1) The designs satisfy the RAMS requirements

(2) The completed works that have been subjected to testing and commissioning indeed demonstrate that they meet the RAMS requirements.

7.4.2 Verification & Validation shall be carried out preferably by an engineering team who are independent from those carrying out the design.

7.4.3 All the equipment & components/Products used in the Contract shall be approved only when the Engineer has been satisfied as to their strength, reliability and suitability. To assist the Engineer in this respect, the Contractor shall furnish on request, performance data, references to completed works and any other relevant information together with samples of materials for approval.

7.4.4 Verification methods shall include one or more of the following:

(1) Analysis of design

(2) RAM studies

(3) Design safety studies

(4) Simulations

(5) Calculations

(6) Benchmarking against international best practice where appropriate, and

(7) other methods as appropriate.

7.4.5 Records of all verification and validation activities shall be kept and shall be traceable through the Compliance Management Process.

7.5 RAMS Organization

7.5.1 The RAMS Organization of the contractor shall have dedicated RAM and Safety Managers who shall have implemented the RAMS strategy for the relevant system in at least one Metro/railway project environment.

7.5.2 Alternately, the Contractor shall retain the services of a RAMS consultant to manage the entire scope of the RAMS work.

7.6 System RAM Management

7.6.1 RAM Management activities shall be undertaken in order to demonstrate in a logical, progressive and traceable manner that the works satisfy the requirements of the project pertaining to RAM.

7.6.2 RAM Activities

(1) Design Phase - The RAM activities will include:

(2) Develop detailed RAM allocations for subsystems, assemblies, and equipment.

(3) Perform Reliability, Maintainability and Availability analyses at the Preliminary Design phase.

(4) Perform detailed Reliability, Maintainability and Availability analyses and Prediction at the Final Design phase.

(5) Perform failure mode, effects and criticality analysis (FMECA)

(6) Integrate RAM design and analysis results into test planning, maintenance planning, maintenance manuals, and operating manuals.

(7) Establish failure reporting, analysis, and corrective action system (FRACAS)

(8) Construction and Installation Phase - The RAM activities will include:

(9) Updating of Reliability, Maintainability and Availability analyses and Prediction

(10) Updating FMECA

(11) Preparation of Reliability, Maintainability and Availability Demonstration Plans

(12) Testing, Trials and Warranty Phase - The RAM activities will include:

(13) Perform RAM Demonstration.

(14) Execute a Failure Reporting and Corrective Action System (FRACAS).

(15) Provide all necessary reports and documentation for tracking by the V&V process.

Details of the above-mentioned RAM activities are enumerated in succeeding sections.

7.6.3 RAM Analysis and Prediction

(1) Contractor will undertake a RAM Analysis and Prediction of the system. The RAM Analysis will provide an initial and broad assessment of all known service failure and service interruption modes for top level events such as minor, major, and immobilizing service interruptions.

(2) The purpose of the RAM Analysis is to ensure that the potential service failure modes, causes, and mitigations are well understood by all parties as the design, integration, fabrication, testing, and acceptance activities move forward.

(3) Reliability will be assessed in terms of the MTBF/MTBSAF. The assessment will have a bottom up approach commencing from the LRU level and proceeding up to the sub-system and system level. MTBF/MTBSAF is the predicted elapsed time between inherent failures/service affecting failures of a system during operation.

(4) The RAM Analysis will also be used to identify and select service failures for in-depth assessment in the Fault Tree Analysis (FTA).

(5) The Contractor will provide a first iteration of the Reliability Prediction Report for employer's approval. Reliability Prediction Report will be periodically updated until the task is concluded.

(6) Reliability Predictions will be conducted at the appropriate level of detail to ensure adequate reliability and fulfilment of the specifications and RAM requirements. This may entail conducting an analysis at the subsystem, assembly, lowest replaceable unit (LRU), block, element, or component level, and may require combining differing analyses from different levels for a single subsystem.

(7) Reliability Predictions will be based on existing performance records, reliability test data, warranty and operating data, and reliability prediction analyses from previous similar projects. For equipment with incomplete or inconclusive operating, failure, and/or reliability demonstration data, the equipment supplier will develop a reliability prediction using other information sources, such as, MILE HDBKE 217F Notice 2, Non electronic Parts Reliability Data (NPRD), Manufacturer test data, or any other well established industrial reliability prediction databases.

(8) The reliability predictions will be subject to confirmation during the Reliability Demonstration Test.

7.6.4 Failure Mode, Effects, and Criticality Analysis (FMECA)

(1) FMECA is a systematic procedure for the analysis of a system to identify the probability of occurrence and severity of the potential failure modes, their respective causes and immediate and final effects on systems performance (performance of the immediate

assembly and their entire system) and to provide an input to mitigating measures to reduce risk. FMECA will be performed and updated at different project stages until the task is concluded. The FMECA will be intended to:

(a) Undertake decomposition of the System, Sub-systems from the highest level till the LRU level.

(b) Provide the lowest level analysis of failures and failure effects on the system and its subsystems and equipment.

(c) Identify weaknesses in system hardware and software design and analyse failure modes and effects, particularly for when these details are not established by historical records of equipment operation.

(d) Use inductive logic in a "bottom up" system analysis. This approach begins at the lowest level which is the Lowest Replaceable Unit (LRU) of the equipment under analysis and traces consequences up to the system level to determine the end effects on sub-system and system performance.

(e) Identification of single failure points critical to proper system performance.

(f) Provide early visibility into potential system interface problems.

(2) Perform Criticality Analysis (CA) of the list of possible failure modes by ranking them in accordance to their risk which is dependent on the probability of occurrence and severity of the failure. The CA will allow prioritization of mitigation measures. The purpose of FMECA will be to identify:

(a) Those failures which have unwanted effects on safety

(b) Those failures which have unwanted effects on system operation

(c) Those failures which have unwanted effects on overall reliability

(d) To allow improvements of the systems safety

(e) To allow improvements of the systems reliability

(f) To allow improvement of the systems maintainability

(g) To allow improvements in the systems availability

7.6.5 Reliability Critical Item List (RCIL)

(1) The contractor will perform Reliability Analysis to identify Reliability Critical Items List (RCIL). Reliability critical items are those items that have a significant impact on product reliability, performance, safety, availability or life cycle cost. Identifying and controlling critical items is imperative since these parts are often the parts that drive unreliability.

(2) A critical item output report will be submitted to ensure that reliability critical components were identified and controlled; reliability predictions and an FMECA were performed. Critical items will be identified via the failure rates noted in the prediction and by the single failure point analysis performed in the FMECA.

7.6.6 Maintainability Analysis and Predictions

(1) The contractor will perform analytical maintainability analysis and prediction to assure compliance with the specific maintainability requirements and to ensure system performance.

(2) Maintainability will be assessed in terms of MTTR. The MTTR shall include the diagnostic time, active repair / replacement time and adjustment / testing time, including

software re-boot, up to the point the system is restored to full functionality.

(3) The MTTR does not include the time taken for designated personnel to arrive on site (access time) to begin local diagnostic activities or the time taken for the replacement parts to be delivered at site.

(4) In all availability calculations the following access times shall be assumed:

(a) 1 hour for signalling equipment

(b) 2 hours for telecommunication equipment

(5) In the maintainability analysis, the contractor will lay special emphasis on features such as Built-in-Test (BIT) and fault isolation, acknowledging the criticality of these features to the effectiveness of system testability and maintainability. Built-in-Testing goals should be established that provide the attainment of highest fault coverage detection and isolation to the Lowest Replaceable Units (LRUs).

(6) The contractor will perform Maintainability Analysis to identify Maintainability Critical Items List (MCIL). The maintainability critical items are those items that have a significant impact on product maintainability, performance, availability or life cycle cost. Identifying and controlling critical items is imperative since these parts are often the parts that drive system downtime.

7.7 System Safety Management

7.7.1 Principle of Safety Management

(1) System Safety Management activities shall be undertaken to demonstrate in a logical, progressive and traceable manner that the works satisfy the safety requirements of the Project.

(2) The basic principle of safety management shall be that all reasonably foreseeable hazards are identified and action then taken for each hazard as follows:

(3) Risks arising from the hazard shall be assessed.

(4) If the risk is broadly acceptable no further action shall be required, otherwise measures shall be taken to reduce or eliminate the risk.

(5) Each of these measures shall become a ‘safety requirement' and all safety requirements shall be subject to verification and validation processes to show that they have been met by design and later by practical tests.

(6) The mitigation, verification and validation status of all hazards shall be recorded in the Hazard Log.

7.7.2 System Safety Plan

The System Safety Plan shall be developed in accordance with EN 50126 and shall include but not be limited to the following subjects:

(1) Safety policy;

(2) Risk acceptance criteria;

(3) Risk management and Principles;

(4) Hazard Analysis and Hazard Log

(5) Design safety studies;

(6) Management of safety during integrated testing, trials, and commercial operation.

7.7.3 Safety Policy

The proposed approach and commitment to safety shall be specified in a statement of safety policy endorsed by the submitter's senior management and this statement shall be included in the System Safety Plan.

7.7.4 Hazard Analysis

(1) Hazard analysis shall be carried out to:

a. Identify and record all reasonably foreseeable hazards associated with all phases of the Works;

b. Assess the risk that each hazard represents to this operation; and

c. Re-assess the risk after application of the proposed mitigation.

(2) Where it is not reasonably practical (based on good practice or application of the ALARP principle) to eliminate hazards at the design stage, risk assessments shall be carried out to ensure that the risks associated with residual hazards are in order of precedence:

a. Minimized through mitigation measures at the design stage;

b. Mitigated through special construction, installation and testing and commissioning processes; and

c. Mitigated through operations and maintenance procedures.

d. Additional mitigation measures shall be proposed as required until such time as the residual risk is assessed to be 'as low as reasonably practicable'.

e. The results of the hazard analysis shall be recorded in a Hazard Log in a form that can be used to track progress in the implementation of mitigating actions and provide an easily accessible reference for the future Operator of all actions taken with respect to any hazard.

7.7.5 Primary hazards for Preliminary Hazard Analysis (PHA)

(1) The PHA shall take into account, but not be limited to, the following primary hazards:

a. fire including:
   i. smoke asphyxiation;
   ii. hot works; and
   iii. explosion;

b. impact including:
   i. collision;
   ii. derailment;
   iii. falling objects;
   iv. flying objects;
   v. sharp objects;
   vi. slipping, tripping and falling;

c. electrocution;

d. other hazards including:
   i. environmental;
   ii. flooding;

iii. noxious fumes;

iv. suffocation;

v. entrapment; and

vi. burns.

(2) The PHA shall take into account the various types of operating mode (i.e. normal, degraded and emergency) and the operating scenarios during which all types of hazards might exist including, but not limited to:

i. freight service;

ii. evacuation; and

iii. maintenance.

(3) The PHA shall take into account how each type of hazard might arise including, but not limited to:

i. inappropriate design or specification;

ii. equipment failure;

iii. installation error;

iv. improper action (accidental or deliberate);

v. inaction (unintentional or intentional); and

vi. external influence.

(4) The PHA will be followed by detailed hazard analysis:-

i. Sub System Hazard Analysis (SSHA)

ii. Interface Hazard Analysis (IHA)

iii. Operating and Support Hazard Analysis (O&SHA)

(5) The hazard analysis will be supported by following assessment methods:

i. Failure Mode, Effects and Criticality Analysis (FMECA)

ii. Fault Tree Analysis (FTA) of top level hazard scenarios.

7.7.6 Design Safety Studies and Report

(1) The hazard analysis process shall identify the need for Design Safety Studies and the Hazard Log shall record the results of each of these Design Safety Studies.

(2) Design Safety Studies shall be undertaken for system and subsystem elements that are considered to be safety critical and that require hazard analysis to a greater level of detail than that applied at an overall system wide level.

(3) Design Safety Studies shall specifically refer to hazards arising from:

a. normal operations including maintenance;

b. degraded modes of operation;

c. emergency situations; and

d. the effectiveness of mitigation proposed for natural catastrophes.

(4) The Design Safety Studies shall take account of:

a. methods of operation;

b. RAM considerations;

c. anticipated likely maintenance regimes and their sustainability in Commercial Operation;

d. anticipated competence levels of personnel in Commercial Operation;

e. software security (disabling of unauthorized access to operating systems, protection against intrusive attacks, loss of password integrity, etc.); and

f. other human factors including but not limited to those identified in ergonomic studies.

(5) Design/Systems Safety Studies and the Report shall demonstrate, as a minimum, the following requirements:-

a. That the overall risk criteria for the Works have been addressed satisfactorily at the Detailed Design stage and that the Detailed Design proposals are mutually compatible with such risk criteria.

b. That all Safety Critical systems have been identified at the Detailed Design stage and the apportionment of risk factors between the major systems and sub-systems support the overall safety criteria approved in the "System Safety Plan".

c. That the results of the Design Safety Studies have been incorporated into the design, and shall be carried forward into the Final Design, manufacturing and installation processes.

d. That where management by operating and/or maintenance procedure or other management control measures have been identified during the "Design Safety Studies", auditable methods by which such measures shall be introduced into operating/maintenance provisions have been established.

e. That robust processes have been implemented to validate the Safety Critical aspects of software design.

f. That processes for assessing the potential safety impact of design changes exist.

g. A Design Safety Studies and Report shall be submitted at the completion of the design stage to confirm that all safety related aspects of design have been properly addressed and comprehensively verified.

7.8 RAM Demonstration

7.8.1 Reliability Demonstration

1) The Contractor will perform a Reliability Demonstration to verify that the system meets the required reliability performance requirements when:

a) Scheduled maintenance is performed in accordance with approved Maintenance Plan and Maintenance Manuals, and

b) Systems are operated within the environmental limits described in the Design documents.

2) The demonstration of the system will continue for a period of 24 months. If at the end of the 24 month test period the equipment has not met the reliability requirements, the System Supplier will implement design changes or modifications, as needed, to meet the reliability requirements. The test duration will be extended to ensure that the changes made result in achieving the requirements.

3) The Contractor will submit a RAM Demonstration Test Plan before the Final Design Review. The

plan will address the following to illustrate compliance with the reliability requirements:

a) Plan schedule and period

b) Identification of necessary facility, resources, support equipment, and staff for the demonstration

c) RDT procedures and forms for recording and submitting data

d) Success failure criteria for measuring reliability values for individual equipment items and subsystems

e) Failure analysis of reported failures to identify the cause and need for corrective

f) action

g) Establish a Failure Review Board (FRB) to meet with Employer, as required, to determine the need and depth of failure analyses

h) Change control procedures for implementing design changes

i) Format and location of test records, test logs, and data records

j) Final conclusion and report for the demonstration.

4) The Employer will approve the RAM Demonstration Plan and procedures before the trial commences.

5) The RAM Demonstration Procedures will include all information necessary to ensure the successful, accurate and safe performance of the demonstration testing. The RAM Demonstration Procedures will include, as required:

a) Safety Precautions

b) Identification of the reliability performance parameters that are verified by the test

c) Scope of test

d) Test equipment requirement if any

e) Personnel required

f) Any special conditions required, including condition of the equipment under test

g) Reference drawings or documents

h) Clear pass/fail criteria

i) Data sheets to record test results

j) Raw data correlation procedure

6) RAM demonstration procedure will address the following:

a) Each equipment failure reported during the RAM Demonstration will be classified as relevant or non-relevant failures by the Failure Review Board (FRB). The assessment will include all failures, whether occurring in or out of revenue service.

b) A proposed procedure for corrective action will be developed and included. The procedure will include proposed changes and appropriate supporting data. The procedure will identify a specific method for verifying the effectiveness of change(s).

c) Preventive maintenance procedures specified for the equipment during the RAM Demonstration phase will be performed by the maintainer in accordance with applicable Contract Terms and Conditions.

d) System suppliers will maintain records which contain all the information necessary to calculate reliability performance for the system and major subsystems, and to

verify satisfactory reliability requirements. System suppliers will provide failure records to employer in hard copy and in an approved electronic format.

7) A chargeable failure in the RAM Demonstration is defined as any relevant failure that requires repair or replacement of any subsystem or vehicle component. Chargeable failures also include intermittent failures, unverified failures, and software failures.

8) Non-chargeable failures in the RAM Demonstration are:

a) Consumable items, except for those which are not achieving their specified life

b) A failure occurrence in equipment of another subsystem, due to the primary failure

c) A failure of the operator/maintainer to perform recommended preventive maintenance actions

d) Vandalism or physical mistreatment at a human interface

e) Failures due to an accident.

9) The Contractor will provide Weekly Failure Reports during the RAM Demonstration phase. The Contractor will submit the format and structure of the report to employer for review and approval at least three months before system commissioning begins.

10) The Contractor will submit Monthly Demonstration Test Reports to employer documenting the current and cumulative failure totals for the system equipment, comparing the totals to the reliability requirements.

7.8.2 Availability Demonstration

1) The Contractor shall demonstrate the specified Availability during Service Trials and during the DLP. The Availability Demonstration Testing (ADT) shall be conducted on all Systems, subsystems and their interfaces.

2) In the event that the availability target is not achieved, the determination of availability achievement in the preceding six month period shall be continued at monthly intervals until the target is achieved.

3) In the event that the availability target is not achieved, the Contractor shall, at his own expense, take whatever action as deemed necessary to meet the availability requirement.

4) The contractor will submit the Availability Demonstration Test Report on completion of the demonstration testing.

7.8.3 Maintainability Demonstration

1) The Contractor will conduct a Maintainability Demonstration (MD) to establish the accuracy of task time estimates for the preventive and corrective maintenance tasks described in the applicable Maintenance Plan, Maintenance Procedures, and/or Maintenance Manuals. The Contractor will perform the MD concurrent with the HORC personnel training program. The Contractor and S&T System/Sub-system Supplier(s) will demonstrate selected servicing, preventive maintenance, troubleshooting, change out of components, corrective maintenance, and use of special tools where special emphasis, instruction, or proficiency is needed. HORC will notify System Suppliers which preventive and corrective maintenance tasks have been selected for the MD.

2) Maintainability Demonstration Test Plan will be provided before the Final Design Review.

3) In the event that any maintainability target is not achieved, the Contractor shall at his own expense take action as required to meet the maintainability targets.

4) The contractor will submit a Maintainability Demonstration Test Report on completion of the demonstration testing.

7.9 Failure Reporting and Corrective Action System (FRACAS)

1) Purpose of FRACAS: The Contractor will provide a Failure Reporting and Corrective Action System (FRACAS) that supports requirements of the RAM Demonstration and Warranty Program. The contractor will submit the FRACAS for the Engineer's's approval before the Final Design Review. The Contractor will use a Failure Reporting, Analysis and Corrective Action System (FRACAS) to track and report on system failures. The FRACAS will consist of a set of data management tools for capturing and reporting on equipment incident data, and a set of procedures which use the data management tools. The FRACAS procedures:

2) Implement key project functions of reliability demonstration and warranty administration

3) Assess compliance of delivered equipment with requirements

4) Provide field and operating information to equipment and project design and analysis tasks

5) Assess the effectiveness of modifications to equipment in the field.

7.9.1 Where system failures indicate the possibility of a non-compliant design, the FRACAS process will consist of the following activities:

1) Communication of failure information from the operating authority to the S&T System Suppliers

2) Assessment of the failure conditions, impacts, and possible causes by the S&T System Supplier Quality Assurance, Electrical and Engineering departments, and by equipment suppliers

3) Where appropriate, failure analysis by the equipment supplier

4) Corrective action by the equipment supplier

5) Once corrective action has been completed through field or factory action, verification by the System Supplier that the implemented solution is adequate and acceptable.

7.9.2 FRACAS Guidelines.

1) A comprehensive FRACAS closed loop diagram is shown below:

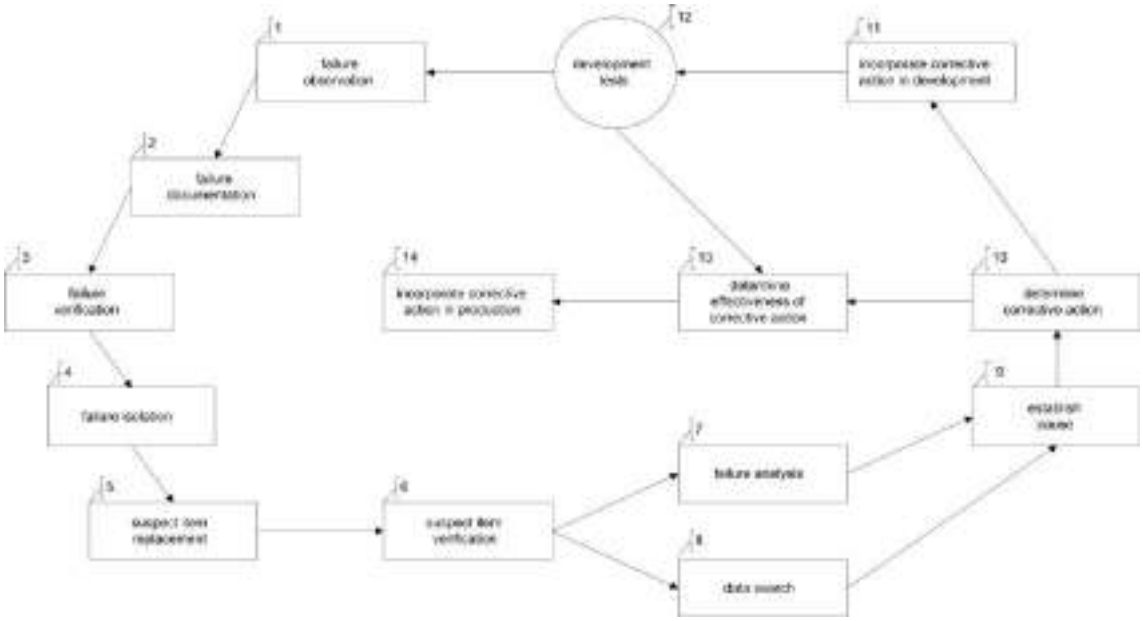


Figure 1: Generic Closed-Loop FRACAS

2) Key steps in FRACAS are as follows:

a) Observation of failure

b) Complete documentation of failure including all significant conditions whichexisted at the time of the failure

c) Failure verification, i.e. confirmation of the validity of the initial failure

2) observation

a) Failure isolation, localization to the lowest replaceable defective item within the product

b) Replacement of the suspect defective item

c) Confirmation that the suspect item is defective

d) Failure analysis of the defective item

e) Data search to uncover other similar failure occurrences and to determine theprevious history of the defective item and similar related items

f) Establishment of the root cause of the failure

g) Determination, by the design team, of the necessary corrective action,especially any applicable redesign

h) Incorporation of the recommended corrective action into developmentequipment

i) Establishment of the effectiveness of the proposed corrective action

j) Incorporation of effective corrective action into the equipment

k) The failure documentation should be augmented with the verification of failure (step c) and verification that the suspect part did indeed fail (step f).

3) Reporting of Failure

Failure Report Forms: All failures shall be recorded on a failure report form which shall

contain as a minimum the following information:

a) Identification of the equipment, including nomenclature, serial number, manufacturer's part number and location;

b) Location of failure;

c) Individual who observed failure;

d) Operating time of each system including each shut-down and its cause;

e) Date and time of each incident;

f) Failure symptom/indication, mode, cause and effect;

g) Classification of the incident (relevant independent failure or dependent failure);

h) Corrective maintenance or operational procedures required to restore the System to operation;

i) Time to restore System to operation and active repair time; and

j) Circumstances of interest such as Environmental conditions and supply voltages.

7.9.3 Failure Database

1) The key to a successful FRACAS is its database. This is particularly important in establishing the significance of a failure. For example, the failure of a capacitor in a reliability growth test becomes more significant if the database shows similar failures during incoming inspection of the part and in any environmental tests performed. For this reason all available sources of data should feed the FRACAS.

2) The Contractor shall maintain the failure database throughout the execution of the Works. The FRACAS system along with the database shall be handed over to the Engineer at the expiry of the Defects Liability Period.

7.10 Field Testing and Integrated System Testing

7.10.1 General Requirements: The On-site Testing and Integrated System Testing shall demonstrate as a minimum the following requirements:

1) That the safety management organisation to control the on-site Testing and Integrated System Testing is in place.

2) The testing procedures shall ensure that all the critical failure modes as identified during the Failure, mode, effects and criticality analysis (FMECA)/Failure, mode, effect analysis (FMEA) activity are addressed through proper test cases inclusion. A traceability matrix shall be developed such that these critical failure modes are traced back to the corresponding test cases. All failure modes shall be considered as critical failure modes unless the Contractor demonstrates by a sensitive analysis or other means that the impact of a failure mode on reliability and maintainability will be insignificant.

3) That the scope of activities to be carried out during the on-site Testing and Integrated System Testing period covers all Safety Critical functions and Safety requirements including those in the Hazard Log.

4) That the segregation of on-site Testing and Integrated System Testing activities from residual construction and installation activities shall be implemented.

5) That the procedures required to conduct on-site Testing and Integrated System Testing activities safely, including where necessary, the protection measures for any part of the Railway which may be in operation shall be implemented.

6) That the processes which are to be implemented to validate the Safety Critical aspects of

software installation and testing shall be implemented.

7) That the processes required to assess the safety implications of the results of tests and inspections carried out during the periods of on-site Testing and Integrated System Testing activities shall be implemented.

8) That the processes required to control and validate the safety implications of modifications carried out during the period of on-site Testing and Integrated System Testing activities shall be implemented.

9) That the arrangements which are to be utilised to record, report and investigate accidents and incidents together with the systems necessary to formulate and implement measures to prevent reoccurrence shall be implemented.

10) That effective controls shall be implemented in respect of the activities of all other contractors, relevant authorities and third parties.

7.11 Engineering Safety Validation Plan

1) Testing shall validate that all safety related functions have been implemented in accordance with the Detailed Design and the safety requirements identified in the Design Safety Report.

2) A program of all safety validations to be carried out shall be submitted and this program shall be updated with actual dates of validation during the on-site testing and integrated system testing phase.

3) Validation of the correct implementation of all safety design criteria shall be demonstrated by submitting details including:

a. a cross reference to the program of safety validations;

b. the purpose of each validation;

c. the method of each validation;

d. the qualifications of staff performing the validation;

e. the names of witnesses to the validation;

f. the acceptance criteria for each validation;

g. the results of each validation;

h. analysis of validation results to show that they confirm requirements have been met; and

i. the recommended procedure for the correction of deficiencies observed during the validation process and the steps required to repeat the validation.

7.12 Operational Safety Case

1) General Requirements: In order to demonstrate that the system will be managed safely, the Contractor shall produce and maintain an Operational Safety Case, in accordance with the System Assurance requirements detailed in the Contract documents.

2) The Operational Safety Case shall typically consist of but not be limited to the following:

a. Executive Summary;

b. Introduction;

c. Definition of System;

d. Quality Management Report;

e. Safety Management Report;

(i) Introduction;

(ii) Roles and Responsibilities;

(iii) Safety Lifecycle;

(iv) Safety Requirements;

(v) Safety Standards;

(vi) Safety Audit and Assessment;

(vii) Supplier Management;

(viii) Safety Controls;

(ix) Configuration Management; and

(x) Project Safety Training.

3) Technical Safety Report

(i) Introduction;

(ii) Assurance of correct functional operation;

(iii) Effects of faults;

(iv) Operation with External Influences;

(v) Safety-related application conditions;

(vi) Safety Qualification tests; and

(vii) Other Outstanding Safety Issues.

4) Conclusion:

As part of the Operational Safety Case development process, the Contractor shall ensure that plans and procedures as typically listed below will be in accordance with the Operational Safety Case requirements:

- System Management Plan;
- System Safety Plan;
- System Operating Safety Plan;
- System Operating Plan;
- System Assurance Plan;
- Emergency Preparedness and Fault Recovery Plan;
- Rules and Procedures;
- Indian Railways Rules and Procedures; and
- Health and Safety Regulations.

7.13 Proof of Safety

The "Proof of Safety" shall demonstrate that the Works are fit for the purpose of commencing Revenue Service. The "Proof of Safety" shall make traceable reference to system documentation that shall demonstrate as a minimum the following requirements have been met:

1) That the Works have been manufactured, installed and tested up to an including Integrated System Testing in a manner to ensure that the Railway can be operated and maintained within the parameters of risk as approved in the "Design/Systems Safety Report" and that there are no outstanding safety issues.

2) That the recommended safety performance criteria and safety thresholds for the safe operation

and maintenance of the Works have been met.

3) That the standards and specifications upon which the safe operation and maintenance of the Works are based have been met.

4) That the safe systems of work, rules and procedures required to operate and maintain the Works within the defined parameters of risk as approved in the "Design/Systems Safety Report" have been verified.

7.14 Trial Running

1) Activities: The period of Trial Running shall include as a minimum the following activities:

   a. Demonstration of system performance and adherence to timetables during Trial Run.

   b. Evaluation of the effectiveness of normal operating procedures including those that deal with minor disruptions and staff unavailability.

   c. Evaluation of the effectiveness of system fault reporting, fall back systems, operating procedures and maintenance responses in the event of a number of system failures and degraded operating scenarios by simulating such scenarios during simulated revenue service.

   d. Evaluation of the effectiveness of operating procedures and other incident management responses in the event of a serious incident including but not limited to fire by simulating such scenarios during simulated revenue service.

7.15 Revenue Service Running

1) General Requirements

The Contractor shall continue to implement system assurance activities during and after the transition to revenue service including, but not limited to, the following requirements.

   a. Revenue Service shall not commence until the "Proof of Safety" has received the approval of the Employer.

   b. During the Defects Notification Period, day to day monitoring of the RAM performance shall be carried out and the findings shall be used for recording of the RAM performance.

   c. In the event that a defect/failure shall arise, the Contractor shall provide full technical support in failure investigation and rectification.

   d. The Contractor shall employ suitable mechanisms and develop a suitable organization structure in conjunction with the Employer to support ongoing RAM activities.

   e. The Contractor shall provide support to the Operator to ensure that the documentation and processes defined in the Ongoing Management of Safety document have been fully assimilated into the Operator's Safety Management System and organization.

(End of Chapter-7)

S&T DESIGN CERTIFICATE

This Design Certificate refers to Submission No..... which comprises:

[*Design Package No. .... / the Detailed Design and Drawing Submission No. .... / Technical Submission No.] in respect of:

[description of the Works to which the submission refers)

The contents of this submission are scheduled in Section A below.

The documents scheduled in Section B below, for which a Notice of No Objection has been issued, are of relevance to this submission.

DESIGNER'S STATEMENT

We hereby certify that:

a) The design of the Works, as illustrated and described in the documents scheduled in Section A below, complies with the specifications requirements and [see note 1 below];

b) The outline designs, design briefs and performance specifications of those elements of the Works as illustrated and described in the documents scheduled in Section A below comply with the specifications requirements and *[see note 1 belowj,*

c) The design of the Works, as illustrated and described in the documents scheduled in Section A below, complies with the Employer's Requirements specifications requirements and. *[see note 1 belowj* except in the following respects:

(i) (to be completed by Contractor/Designer)

(ii) (etc.)

d) An in-house check has been undertaken and completed to confirm the completeness, adequacy and validity of the design of the Works as illustrated and described in the documents scheduled in Section A below;

e) All necessary and required approvals relating to the design of the Works, as illustrated and described in the documents scheduled in Section A below, have been obtained and copies of such approvals are annexed in Section C below;

AND (in the case of a submission covering a part of the Works only) :

f) All effects of the design comprising the submission on the design of adjacent or other parts of the Works have been fully taken into account in the design of those parts.

Signed by ‘Authorized

Representative’(for Designer)

Name

Position/

DesignationDate

CONTRACTOR’S CERTIFICATION

This is to certify that all design has been performed utilizing the skill and care to be expected of a professionally qualified, competent designer, experienced in work of similar nature and scope. This further certifies that all works relating to the preparation, review, checking and certification of design has been verified by us.

Signed by ‘Authorized Representative’ (for

Contractor)Name

Position/Designation

Date

Note 1

The Contractor shall insert one of the following, as applicable:

(i) the Contractor's Technical Proposals

(ii) the Contractor's Technical Proposals and Design Packages Nos. for which a Notice of No Objection has been issued.

(iii) Design Packages Nos.....for which a Notice of No Objection has been issued if such Design Packages develop and amplify the Contractor's Technical Proposals.

(iv) The Detailed Design:

Note 2

The Contractor designer/authorized representative shall take utmost care while signing the Design certificate. For repeated false compliance of specifications/Work’s requirement, Engineer may ask for suitable replacement for the position.

Section A

Submission no. . comprises the following

Drawings : *(Title, drawing number and revision)* Documents: *(Title, reference number and revision)*Others:

Section B

Documents for which a Notice of No Objection has been issued and which are of relevance to this Submission No. .....

Document:

Submitted with

[*Design Package No. ...../

Detailed Design Submission No. .../ □

Good for Construction Drawing Submission No. ..../ □

Technical Submission No...../ □

Date of Issue of Notice of No Objection

(Delete as appropriate)*

The Contractor is required to provide this information in respect of each document in Section B

Section C

[Contractor to attach copies of necessary and required approvals)

(End)

Section VII: Employer's Requirements

Section VII-9: Particular Specifications (PS) -Signalling

PARTICULAR SPECIFICATIONS (PS): SIGNALLING

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CHAPTER 1: SCOPE OF WORKS

1.1 INTRODUCTION

1.1.1. This document is arranged in the following way. Firstly, an overview of the HORC project and Signalling works is given, to allow the project requirements to be set in the correct context. This is followed by the Signalling system requirements. The requirements are then broken down into sub system requirements and finally, the implementation requirements for the project are given.

1.1.2. The Contractor shall consider the Project Objectives and Scope of works contained in Chapter-1 and then using the guidance given in the document, develop an appropriate Signalling system that meets the System requirements for design, implementation and support contained in Chapters 2 to 11.

1.2 OVER VIEW OF THE PROJECT

1.2.1. Haryana Oribital Rail Corridor (HORC) Railway project will run from New Prithila to Harsanakalan via proposed Manesar and Kharkhoda stations. Part of this HORC project covered in this Package C-2 will run from Manesar Jn. to New Patli Jn. (new double line), its connectivity (new BG single line) from proposed Manesar Junction of HORC to existing Patli Railway Station (IR) under PH-1 and its connectivity from proposed New Patli Jn. to Existing Patli (IR) and Sultanpur stations (NR) (PH-2) on IR Network.

1.2.2. This Chapter gives an overview of the Project. Information provided in this Chapter is for reference purposes only.

1.2.3. HORC consists of approx. 121 Route Km and 143.932 Track Km (including connectivity to the existing Stations on IR and WDFC) length passes through 10 no. of proposed station locations and connectivity to 5 no. of existing IR station/WDFC. The Proposed line runs parallel to KundIi-Manesar-PaIwaI (KMP) Expressway near Sohna-Manesar-Harsana Kalan Stretch for about 95 Kms. Part of this HORC project covered in this Package C-2 consists of approx. 23 Route Km and 42 Track Km (including connectivity from Manesar Station Line no. 1only to the existing station Patli (IR) under Phase 1, New Patli station to Existing Patli (IR) and New Patli station to Existing station Sultanpur (IR) length passing through 02 no. of proposed stations at Manesar Jn. and New Palti under Phase 2 on HORC.

1.2.4. Phases of commissioning: It is envisaged that there will be Two phases of commissioning as given above in Para 1.2.3.

1.2.5. The Manesar Jn. (including) to New Patli Jn. (including) section will be double line track with 02 new junction stations. There will be a single line track connecting HORC Junction stations to IR stations. The trains from/to Indian railways will enter/exit the section of HORC at the two Junction stations through these single line line tracks.

1.3 SIGNALLING OVERVIEW

1) The entire stretch from DFCCIL New Prithila (excluding) to IR Haranakalan (excluding) section will be provided with Electronic interlocking and Absolute Block system of working with BPAC. The Single line/double line tracks connecting HORC Junction stations and IR/DFCCIL stations shall be provided with Absolute block system/slot working with BPAC. Accordingly, the part of HORC covered in this Package from Proposed Manesar Jn. (including) to New Patli Jn. (including) double line section will be provided with Electronic interlocking and Absolute Block system of working with BPAC. The Single line tracks connecting HORC Junction stations and IR stations shall be provided with Absolute block system/slot system of working. Interfacing with IR stations Signalling system shall be tenderer's responsibility. Shifting of utility for carrying out Signalling/Telecom/Electrical/Civil/Track works covered in this Package/different Packages for connection between proposed station of HORC and existing IR station shall be in the scope of the contractor. Such work of removal of any unchartered utility to be done by the Contractor, this shall be treated as a Variation to the Contract and shall be dealt as per the provisions for dealing with Variations in Contract. The Contractor shall be paid as per actual work done for removal of uncharted utilities based on the Variation approved by the Engineer, on case-to-case basis. Interfacing with IR stations Signalling system will be coordinated by the Engineer.

2) The Signals, Points, Track-vacancy detection systems and other Signalling equipment at the stations and in the block sections will be controlled/monitored by Electronic Interlocking (EI) located at stations. The Electronic Interlocking architecture including their size, numbers and locations shall be determined by the contractor's design. The OFC required for communication between the various EI's is being provided under PS (Telecommunications).

3) It is a requirement that Digital Axle counter technology is used to provide primary train detection function at the Stations except at Patli station of IR where conventional DC track circuits shall be provided. The Track vacancy detection system architecture including size, numbers and locations shall be determined by the contractor's design. The OFC/Quade cable required for communication between the Evaluator and the track devices, if any, shall also be provided by the tenderer.

4) The Power supply for the Signaling system at the Stations shall be provided using Integrated Power Supply (IPS). The Power supply scheme including rating, quantity and locations of Power supply systems, shall be determined by the contractor's design.

5) A centralized Sectional Control Centre (SCC) for train operation monitoring/control for HORC sections shall be extended to Delhi Division of IR's existing Control center at State entry Road, New Delhi.

6) The Sectional control center (SCC) will house all the controllers such as Traffic Controllers, Engineering Controller, Traction Power Controllers, Train loco controller, Signal/Telecom Fault Controller etc. who will monitor and manage all train operations and associated activities, including maintenance of entire HORC. The SCC shall house the "Integrated Remote Diagnostic and Predictive Maintenance system".

7) The "Integrated Remote Diagnostic and Predictive Maintenance system" provided in SCC shall collect real time data of important Signalling functions of stations and display it in SCC. For this purpose, the OFC system required for data communication is being provided under PS (Telecommunications). The Traffic Controller(s) at the SCC shall be provided with Train control communication system and will monitor and control

train operations by selective voice command using the Telecommunications system provided under TS (Telecommunications).

8) While the Traffic controllers at SCC will manage overall train operations, the Railway control at local level will be managed by Station Masters located at the stations along the route. Station Masters will require an appropriate display and sufficient control to support their activity under both normal and abnormal railway operations. The Station Masters will receive/depart trains management through information/instructions from the Traffic Controller located at the SCC.

9) The Signalling system shall be housed in Interlocking Structures, being provided under the this/different contract packages. The size and location of building Structures at Stations being provided in this Package/different Packages shall be reviewed in accordance with the contractor's design for Signalling/Telecom System.

10) It is anticipated that Centralized Traffic Control (CTC)/TMS and TCAS/Train Protection Warning System (TPWS) may be required in the future, therefore system provided under this contract shall be demonstrable to be fully compatible for the same.

11) Contractor shall liaison with designated authorities in Indian Railway to design Signalling & Telecom Arrangement for interlocking of LC Gate serving Indian Railway at CH: 4087.148m and other location at Sultanpur station of IR. The design so finalised shall be submitted to Indian railway for approval. The contractor shall execute the so reviewed Signal and Telecom Arrangement for/at LC Gates serving Indian Railway.

1.4 SCOPE OF WORKS

The Signalling works shall meet all the requirements as defined in the Particular Specifications. However brief scope is given below: -

(1) Design, Supply, Installation, Testing, and Commissioning of the Signalling works at the following two Junction stations of HORC: Manesar Jn. and New Patli Jn. The Signalling System shall include, but not be limited to, the Sub-systems namely Distributed architecture with object controllers of EI for Signalling interlocking System, MSDAC for track vacancy detection System, IPS for Power supply System, Absolute Block System of working with Block proving with Axle counter (BPAC) and Remote Diagnostic and Predictive Maintenance (RDPM) using Data logger system for remote monitoring management.

(2) Design, Supply, Installation, Testing, and Commissioning of the Signalling works at two IR stations: Patli (NR) (Phase-1 & 2) and Sultanpur. The Signalling System at Patli shall include, but not be limited to, the Sub-systems namely alteration/modifications to existing EI for Signalling interlocking System, existing DC track circuit for track vacancy detection System, existing IPS for Power supply System and existing RDPM using Data logger system for remote monitoring management. And the Signalling System at Sultanpur shall include, but not be limited to, the Sub-systems namely Distributed architecture with object controllers of EI for Signalling interlocking System, MSDAC for track vacancy detection System, IPS for Power supply System, interlocking of LC gates and RDPM using Data logger system for remote monitoring management.

(3) Design, Supply, Installation, Testing, and Commissioning of Absolute Block system of working with Block proving with Axle counter (BPAC) on Single line connecting Manesar (HORC) & Patli station (NR), New Patli (HORC) & Patli station (NR), New Patli (HORC) & Sultanpur (NR). This also includes

alterations/modifications to existing Signalling/Telecom System at Faruqnagar (NR) and Garhi Harsuru (NR) stations to introduce Absolute Block system of working in Sultanpur (NR)- Faruqnagar (NR) and Sultanpur (NR)- Garhi Harsuru (NR) sections.

(4) Shifting of utility for carrying out Signalling/Telecom/Electrical/Civil/Track works covered in this Package/different Packages for connection between proposed station of HORC and existing Patli & Sultanpur station of IR shall be in the scope of this contract. Such work of removal of any unchartered utility to be done by the Contractor, this shall be dealt under Schedule "C"~~- Provisional Sums~~. The Contractor shall be paid as per actual work done for removal of uncharted utilities based on the approval by the Engineer, on case-to-case basis. Interfacing with IR stations Signalling/Telecom system will be coordinated by the Engineer.

(5) Maintenance of the aforesaid Signalling system for one year period after final taking over.

(6) The scope of Signalling works shall also include, but not limited to, Project Management, Interface Management, Quality Management, System Assurance Management, Safety Management, EMC Management, Design, Procurement & Manufacturing Management, Construction & Installation Management, Overall Site Supervision & Management, Completion Management, Warranty and Defect Liability including Maintenance Management, etc.

1.5 RELEVANT DOCUMENTS

1.5.1 This Particular Specification (PS) shall be read in conjunction with the Conditions of Contract, the General Specifications (S&T) called as GS(S&T) and any other document forming part of the Contract.

1.5.2 In the event of a conflict between this document and others, the following precedence shall apply:

(1) Employer's Requirements - Particular Specification (Signalling)

(2) Employer's Requirements-GS (S&T)

(3) General and Subsidiary Rules (G & SR) of NR

(4) Indian Standards referenced herein including Indian Railway signaling engineering manual (IRSEM) with latest amendment.

(5) International Standards referenced herein.

(6) Other National Standards.

(7) Other International Standards.

1.5.3 Notwithstanding the precedence specified above, the Contractor shall seek clarification from the Engineer in the event of conflict among above specifications.

(End of Chapter-1)

CHAPTER 2: SYSTEM REQUIREMENTS

2.1 Introduction

2.1.1. A new Signalling system is required for the HORC. The main components of the system shall be Electronic Interlocking, Track vacancy detection using MSDAC/HASSDAC, Line Side Signals, Point Machines, Remote diagnostic and predictive maintenance (RDPM) Including Data logger system, Absolute block working with BPAC and other signalling equipments.

2.1.2. The design life of Signalling sub system/equipment (except low maintenance/VRLA batteries) shall be as under:

SN	Signalling sub system/equipment	Design life (Years)
1	MSDAC (Axle counter)	15
2	Signalling cables	25
3	Other Signalling sub system/equipment	15

2.1.3. For reasons of operational availability, a distributed control capability is required with an interlocking used within each station area of control to ensure points, and signals do not conflict and that the train is protected from points movement during its passage.

2.1.4. It is anticipated that Centralized Traffic Control (CTC), Train management system (TMS) and Train collision avoidance system (TCAS) may be required in the future, therefore system provided under this contract shall be fully demonstrable to be fully compatible for the same.

2.1.5. The System shall be designed in such a manner that the failure of a single item of Signalling equipment shall not cause loss of overall system functionality. The use of redundancy, hot standby and cold standby shall be considered in accordance with meeting the system objectives.

2.1.6. The System shall remain fully functional with no degradation across the range of published climatic conditions found in the region. The Climatic conditions are covered under this bidding document and GS (S&T).

2.1.7. The System shall be designed to be repaired without loss of overall functionality.

2.1.8. The System shall be designed to operate correctly and safely within a 25 Kv AC Traction system environment and shall present no safety hazards to personnel working on the system.

2.1.9. The System design shall be modular and amenable to assembly and testing away from the final installation site.

2.1.10. The System shall be designed keeping energy usage as a key feature of design philosophy and making it part of the review of the system design.

2.1.11. The System shall be designed and installed in such a manner that theft and vandalism are discouraged. Track side units shall feature locks and similar deterrent features preventing plug coupled cables and modules from being removed, and larger structures shall feature anti vandalism measures to the satisfaction of the Engineer.

2.1.12. The System shall be designed to incorporate a Remote diagnostic and predictive maintenance system to be used to support railway maintenance activities.

2.1.13. The System shall be designed to interface with Signalling systems on adjacent sections of HORC and Signalling systems of connected IR stations.

2.2 Signalling System Requirements

2.2.1 General

(1) Absolute block working system with BPAC shall be provided on Main lines using Solid State Block proving by Axle Counter as per RDSO spec. described in chapter-4 with latest amendment or Block proving by Axle Counter using UFSBI with block panel as per IRS spec. in a continuous stretch from Manesar Jn. (including) to New Patli Jn. (including) with 3/4 Aspect Colour Light LED Signals (MACLS).

(2) Absolute block working system with BPAC on single line connections between HORC and IR stations shall be provided using Solid State Block proving by Axle Counter as per RDSO spec. described in chapter-4 with latest amendment or Block proving by Axle Counter using UFSBI with block panel as per IRS spec. described in chapter-4 with latest amendment. Wherever provision of Absolute Block working system with BPAC as described above is not feasible/workable provision of Slot working with all necessary safety features and counters be considered.

(3) Station area shall be designed for maximum flexibility and shall be fully signalled in accordance with current IR practices.

(4) Interlocking of Stations and Block sections shall be provided using Electronic Interlocking.

(5) Track Vacancy Detection System shall primarily use MSDAC/HASSDAC.

(6) Fuse Auto Change over system for Indoor Signalling system.

2.2.2 Signals

(1) System Requirements

(a) All Signals and Subsidiary signals should be designed and implemented in accordance with Indian railways General rules and Signal engineering Manual and other requirements of this specification.

(b) The design of the proposed Absolute block working system with BPAC shall, as far as possible avoid positioning of signals at following locations, where they can display a red 'STOP' aspect:

(i) Where trains may stop across a junction or a point of conflict with anothertrain;

(ii) Where trains may stop inside or too close to an OHE Neutral Section;

(iii) Where trains may stop at steep up/down gradient.

(iv) Where trains may stop in a position that is considered dangerous.

(c) All Main line signals shall be 2/3/4 aspect Colour light line side signals. The signals on the loop lines shall be 2/3 aspect signals.

(d) A CSL board shall be provided on the Starter signals indicating Clear Standing Length of the line.

(e) Position light type Shunt signals shall be provided below Starter and Intermediate Starter signals.

(f) Independent Position light type Shunt signals shall be provided for exit from sidings and shunt back from Advanced Starter. Sufficient number of such Shunt signals shall be provided so as to allow maximum flexibility in shunting movements in the yard.

(g) Calling-ON signal shall be provided below all Home signals and Starter/Intermediate Starter signals if required.

(h) The Main Signals leading to more than one route shall be provided with Junction type/Theatre Route indicators.

(i) All the Signals - Main and Subsidiary shall be equipped with LED signal lighting units.

(2) Technical requirements

The Colour light tubular signal posts, outside dia. 140mm, length 3.5/4.5/5.5 meters or more (as per requirement) complete with surface base, anchor bolts, ladder with platform guard rail etc. shall be provided as per spec No. IRS-S-6/81 and relevant RDSO drawings.

(a) The Main running signals shall be Multi unit Colour Light Signals as per RDSO spec. No. IRS: S26-64 and relevant RDSO drawings.

(b) All signals, main or subsidiary shall use LED Signal lighting unit as per RDSO specification No. RDSO/SPN/153/2011. LED Signal lighting unit shall work on 110V 50 Hz AC. ECRs as per RDSO specification STS/E/Relays/AC Lit LED Signal/09-2002 shall be used with LED signal lighting units.

(c) Directions type (Junction Type) route Indicators (5 lamp unit arm) using LED signal light, complete with all the fittings shall be supplied as per IRS: S- 66/1985 and relevant RDSO drawings.

(d) Installation of Signals

(i) Signals shall be installed clear of the structure gauge as per the provisions of IRSEM and SOD of IR.

(ii) The signal shall be so located that a clear view is available to the driver of an approaching train and is as close to the track as permissible. The actual visibility of signal shall be checked by a Signal sighting committee and action to improve the visibility as per recommendation of the committee shall be taken before commissioning any new signal. The Signal sighting committee shall be nominated by the Engineer.

(iii) Location of signals shall be worked out as per the requirement of IRSEM, 25 KV AC traction system of IR. The signal shall be located beyond electrical clearances. Suitable metallic protective screening shall be provided if electrical clearance are not achieved.

(iv) All mountings on signal post viz. Shunt signal, 'Calling ON' signals, 'shall be done using separate brackets of suitable size for each of them.

(v) Signals on posts shall be equipped with a ladder enabling access to the LED Signal lighting units as well as Shunt signal, Calling 'ON' signal mounted on the post.

(vi) Emergency sockets shall be installed on the Signal posts of signals in block section including Home signal as far as possible under PS (Telecommunications).

(vii) Suitable Earthing arrangements shall be provided for all signals with earth value <5Ω.

(e) Foundations for Signals

(i) The foundations of signals must be made of concrete not less than M-20 grade.

(ii) The foundations must be dimensioned sufficiently for signals on posts, and shunt signals.

(iii) The height of the foundations must be adjusted to the geographical situation (slope, etc.) and to the location of the signals. It should not be more than rail level. Depth of foundation from ground level shall not be less than 1.3m.

(iv) The height of independent Position Light Shunt signal shall not exceed a maximum limit that may infringe the SOD of IR. Depth of foundation from ground level shall not be less than 600mm.

(v) The foundation drawings of Main signal and Position Light Shunt Signals (Independent) shall be proposed by the Contractor and approved by the Engineer.

(vi) Suitable pre-fabricated assembly units of reinforced concrete may be used with the approval of the Engineer. In this case, the foundation must have one or several eyebolts for transport purposes. These must be closed after final mounting.

(vii) All signals foundations shall have SOD clearance from the track.

2.2.3 Interlocking

(1) General

The principles of interlocking as per IRSEM shall be followed while designing the Signalling system.

(2) System requirements

(a) Each Station control area including adjacent block sections shall have a high integrity electronic interlocking suited to work with a dual VDU Control terminal for Signalling control.

(b) The Electronic Interlocking shall be housed in Signal Equipment Rooms (SER) at the stations. The number of Electronic Interlocking and their locations shall be determined by the Contractor's design.

(c) Wherever interlocking equipment (Central Interlocking Unit or Object Controller) is located, a display shall be available showing the state of the railway under control by that interlocking and up to the neighboring control area on both sides. The display shall be provided in all the Station master Rooms at Stations

(d) The interlocking shall be provided with a data recording system allowing all interlocking states to be time stamped and recorded. The data recording system

shall record and retain interlocking state data for a minimum period of 7 days on a rolling 7 day basis. Interlocking data shall be available to the user for interrogation through a suitable PC interface.

(3) Technical requirements

(a) The Electronic Interlocking (EI) shall be as per RDSO specification RDSO/SPN/192/2019 or latest.

(b) Separate I/O Cards shall be used for UP & DN lines for improved functionality.

(c) It shall be capable of interfacing with CTC, TMS, TCAS and TPWS systems using serial/ Ethernet/OFC ports.

(d) The System design shall ensure that required integrity of safety related vital information is maintained during communication between EI and EI/Object Controllers. In this regard, the requirements for transmission of vital safety information, as laid down in RDSO/SPN/144/2006 and EN 50159 shall be followed.

(e) The EI Processor shall have sufficient capacity to handle, without any degradation, the load of additional I/O when added in future utilizing available spare provisions as indicated at Para 2.2.3(4)(f). Interlocking input and output circuits and associated interface cabling shall be suitable for use within 25 KV AC traction system environment and shall be suitably protected against transient and high voltage discharge interference.

(f) Interlocking input and output circuits and associated interface cabling shall be suitable for use within 25 KV AC traction system environment and shall be suitably protected against transient and high voltage discharge interference.

(g) All the Electronic Interlocking shall be connected through duplicated self-healing fail safe OFC rings for transfer of vital data among EI systems. The connection shall be such that full network protection against single fibre failure is available with seamless switchover between the redundant OFC's. The contractor shall make maximum use of shared backbone communication links for diagnostic and operational information transfer.

(h) At connecting station namely Patli of IR presently EI of Siemens make has been provided. And necessary Signal equipment EI, MSDAC, BPAC etc. required as per the scope of work shall be provided in existing Signal equipment/Relay room. If space is not available in the existing rooms separate Rooms shall be provided by the contractor.

(4) Interlocking Design

(a) The Concept Yard plans have been provided under "Section VII: Tender drawings & documents" of this Tender document. These shall be reviewed and revalidated by the contractor from Signalling & Interlocking point of view.

(b) Based on the approved ESP (Engineering Scale Plan) and Concept Yard Plans Yard plan, the contractor shall prepare the Signal Interlocking plans (SIP), the Control Tables and other documents for the Stations. The SIP, Control Tables and other documents shall be prepared in accordance with interlocking principles provided for in the IRSEM.

(c) The approved SIP, Tables of Control and other documents shall form the basis for the design of Signalling system.

(d) The interlocking including object controllers shall be designed with a hot stand by capability as per RDSO specifications of EI.

(e) EI system shall ensure the compliance of provisions of IRSEM, including the following:

(i) Route Locking after Route setting;

(ii) Route holding when train passes through the route set;

(iii) Approach locking after route cancellation when train approached the set route; and

(iv) On all legitimate routes, the conditions and the signal aspects shall be laid down in the Interlocking Table/chart.

(f) The System shall have provision for accommodating additional 20% of the I/O used as minimum spare provision, including corresponding Processor capacity for future use.

2.2.4 VDU Control system

(1) System requirements

(a) For reasons of operational availability, a distributed control capability is required at the stations on the HORC section including Sultanpur Station of IR.

(b) There shall be a two no. of VDU Control terminal in Hot Standby mode provided at every Station with the Station Master. There shall be no Control terminal in the block section. The Control terminal provided with the Station Master at the Station shall be used to control the Station yard and block section (part or complete), under control of the said Station Master. The display on the Control terminal shall however, include not only the current state of railway under control of the Station Master, but shall also include further display for the complete block sections up to the adjacent stations on both sides.

(c) The Control terminal shall have hard SM key/ smart card or login facility or to authenticate the operator for operation and transfer from one Control terminal to another.

(d) Diagnostic functions shall not be operative from the Control Terminal.

(e) Signalling control shall be available on only one Control Terminal (Main or Standby) at a time, to avoid conflicting control commands.

(f) Route Locking, route holding and all locking of signals as well as points and crossings shall not be affected if there is a transfer of control from one Control terminal to another.

(g) The SM shall have facility to put back any signal under his control to ON position.

(h) Certain operations are regarded as safety critical and shall require two stage commands, such as, latched key, simultaneous operation with more than two (02) switches or buttons, or co-operated operation by two persons or confirmation through system generated captcha. Following are some examples of safety critical operations:

(i) Route Cancellation.

(ii) Point machine Crank handle release.

(iii) Point operation under Track section failure.

(iv) Resetting of Axle Counter.

(v) Emergency points operation

The contractor shall prepare and submit list of such safety critical operations derived from an analysis of the system, along with the proposed two stage command protocol for the Engineer's review and acceptance.

(2) Technical requirements

(a) The Control terminal shall be provided with full redundancy (1+1) in hot standby mode. When changeover takes place, it should be ensured that requirement of 2.2.4(1)(e) & (f) and RDSO specification continue to be met.

(b) The Control terminal shall have a latest industrial grade embedded fan less PC with no external drive, colour VDU monitor with minimum size of 55".

(c) The Software of Control terminal shall be validated to SIL-2. All safety critical functions shall be compliant to SIL-4.

(d) The Control terminal shall be connected to EI on duplicate cables, preferably OFC laid through diverse routes.

(e) The Control terminal shall work on 230V + 10%, 50 Hz AC power supply. It shall be provided with power back up of 4 hours either through IPS of the Station Signalling system.

(f) Maintenance Terminal for event & fault logging with 42" commercial LED monitor as per latest RDSO guidelines with A-4 size colour printer, UPS & with all necessary communication arrangement. This should also include all accessories.

(g) All required relays shall be its integrated part. Laptop based work station for data input and configuration, simulation and functional testing, diagnostic and trouble shooting and commissioning of EI/SSI system shall be provided.

2.2.5 Block Proving by Axle Counter (BPAC)

Some of the important features of the BPAC system to be provided shall be as follows:

(a) The Block sections shall be provided with High Availability Single Section Digital Axle Counter as per approved RDSO spec. described in chapter-4 with latest amendment using Solid State Block proving by Axle Counter as per RDSO spec. described in chapter-4 with latest amendment or Block proving by Axle Counter using UFSBI with block panel as per IRS spec. UFSBI/ Solid state block panel as per approved RDSO/IRS spec. described in chapter-4 with latest amendment block working through EI system and shall comprise of Block Panel, Universal Fail Safe Block Interface, HASSDAC, Block Telephone, Relays etc.

(b) The BPAC shall work on Optical Fibre Cable System and quad cable with auto change over arrangements.

(c) Power Supply requirement shall be met from IPS to be provided by the Contractor for S&T systems.

(d) It shall not be possible to take the Last Stop Signal (i.e. Advance Starter) to "OFF" unless "LINE CLEAR" has been obtained from station in Advance.

(e) It shall not be possible to obtain "LINE CLEAR" unless Block section and Adequate Distance beyond the First Stop Signal (i.e. Home Signal) of station in Advance is clear of trains.

(f) The Last Stop Signal (i.e. Advance Starter) shall assume "ON" aspect automatically on entry of train into block section and when so replaced shall maintain its "ON" position till a fresh "LINE CLEAR" is obtained on Block Panel/VDU.

(g) Block section shall automatically show "TRAIN ON LINE" on panel when train enters into block section on Line Clear.

(h) Train Entry/Exit buzzer To/From block section shall be provided which shall be acknowledged by concerned ASM.

(i) Block section shall automatically close on complete arrival of train at receiving station.

(j) A control mechanism shall be provided to prevent the station in rear to take "LINE CLEAR" on its Block Panel/VDU without taking consent of receiving station.

(k) A control mechanism shall be provided to "CANCEL" the "LINE CLEAR", already taken by station in rear.

(l) It shall be possible to close the block section only if no train has entered the Block section for at least 120 seconds after application of Line Clear Cancellation with cooperation of station in rear.

(m) Separate Block Telephones shall be provided for every block section.

(n) Separate evaluators shall be provided for UP and DN lines.

2.2.6 Track Vacancy Detection System

(1) System requirements

(a) Track-vacancy detection shall be continuous, provided at the Stations, on all the lines, including berthing portions of sidings at the stations.

(b) The track vacancy detection technique shall use MSDAC technology as a means of train detection.

(c) The presence of trains and vehicles shall be positively detected, under all modes of system operation. However, Light vehicles like push trolley, dip lorry and the rail dolly etc. which are being used on Indian Railways, shall not affect the functioning of the MSDAC.

(d) The tolerance of detection accuracy for detecting the position of the vehicle/train shall be such that safety is maintained, operational requirements are fulfilled and fouling marks are not infringed, under worst-case conditions.

(e) The contractor should comprehensively detail the impact of system failure on train detection and the impact on train detection once the failure is restored.

(f) At the boundary with adjacent section of HORC, the track vacancy detection system provided shall achieve no loss of continuous detection at any point of time.

(g) DC track circuits and associated equipment/ arrangement shall be used for track

vacancy detection compatible with existing system at IR station Patli.

(2) Technical requirements

(a) The Track-vacancy detection system shall be designed to meet the requirements of SIL 4 as defined in IEC 61508.

(b) Track-vacancy detection at the stations shall be Multi Section Digital Axle Counters (MSDAC) as per RDSO specification no. RDSO/SPN/176/2013 latest version and amendments.

(c) The detection system shall be suitable for use with UIC 60 Kg/52 Kg rail.

(d) When the Signalling system starts after long duration power failure, all track sections shall show occupied until reset by the Station master(s).

(e) Track devices on crossovers /points shall be provided considering Flange Protection.

(f) Detection Points and Track sections-

(i) At the boundary with adjacent section of IR, the DP of the last track section shall be so located that the track section overlaps with the track section of the track vacancy detection system of the adjacent section. The distance between the two adjacent DPs shall be sufficient not to cause any interference between the two systems.

(ii) The detection points attached to the rail must be protected by means of deflectors against mechanical damage that can be caused by hanging parts of running trains.

(g) Evaluators

(i) The Supervisory system, where used, shall have a separate Evaluator from the Main system.

(ii) Either a standby Evaluator with complete programming and configuration shall be provided for every Evaluator at Stations or in the same evaluator all major cards like power supply card, processor/configuration card and communication module shall work in 1+1 hot standby mode with complete programming and configuration. In case if the standby Evaluator is not working in 1+1 hot standby mode then after every change over, the track sections shall go in error state and shall have to be reset as per manual resetting procedure.

(iii) Communication

(a) The transmission between Central Evaluator and Field units of UP and DN systems shall be in separate Quad cables, preferably of different kinds, say OFC and quad.

(iv) Resetting Arrangement

(a) Manual Resetting

i. A suitable resetting scheme shall be designed by the contractorfor manual resetting of axle counter track sections at stations and block sections. This shall be achieved through a mix of system design and the operating procedures.

ii. The scheme, as far as possible, shall make use of Station Master's Control terminal for resetting operations.

iii. Provision shall be made to record every operation of resetting by non-resettable counter. The counter shall count, every time the resetting is done and shall not reset back on failure of control terminal /power supply.

iv. Preparatory reset of a track section shall not disturb other tracksections in any way.

(v) Installation and Entry into Service

(a) The trackside equipment shall be installed on that side of the track, which is less dangerous for maintenance staff. It should not be installed between themain line tracks.

(b) The requirement of track maintenance machines (mechanized) shall be taken into account while installing outdoor equipment. Trackside Equipment installations shall be agreed with the Engineer prior to installation to avoid conflict with track maintenance machines.

(c) Where feasible, the trackside equipment shall be housed in sturdy lockable location boxes as an anti-theft measure. Additional anti-theft measures shall be proposed by the Contractor and approved by the Engineer at the time of installation.

2.2.7 Points and Points machine

(1) System requirements

(a) On the HORC section, modern turnouts and derailing switches are programmed to be used. The turnouts will be on 60 Kg rail, with thick web switches and weldable CMS crossings suitable for 25 tonne axle load and Speed potential of 140 Kmph on Main lines.

(b) The points laid in the various station yards of the HORC by the Track contractor under Package T-1 shall meet all the requirements set out in the IR Signal Engineering Manual for which the contractor shall interface with the Track contractor.

(c) The indicative list of items for which the contractor shall be required to maintain Interface with the Track contractor of Contract Package T-1, is given in interface management in Appendix 5.

(d) All the points shall be worked with High thrust/Normal Electric Point machines as the case may be.

(e) It shall be possible to operate trains through all points and crossings in all directions of travel. Loss of electrical power shall not cause a change of physical point status and the points shall remain locked in the last operated position.

(f) The Point machines and the ground connections supplied by the Contractor shall be compatible with turnouts and derailing switches provided by the Track contractor. The contractor shall interface with the Track contractor for the same.

(g) Point machines supplied shall be simple in operation and shall require minimum

maintenance. They shall be small compact units, readily accessible and interchangeable.

(2) Technical requirements

(a) Non trailable Electric Point machines shall be as per specification IRS S 24-2002 with latest amendments. The Point machines with 220-mm thrust to drive thick web switches and with 143-mm thrust to drive other switches shall be provided with external Clamp locking arrangement.

(b) Provision shall be made for individual manual operation of each point. Electrical Power shall get disconnected from the point drive under manual (crank handle) operation. Crank handles used for manual operation of point shall be interlocked such that removal of key for crank handle operation shall prevent setting of relevant routes. The number of keys for crank handles operation shall be minimized by suitable grouping such that the impact on operations is minimal when the key is taken out.

(c) Point detection shall be provided to detect that each switch is positioned with sufficient accuracy to ensure safe travel through the point before authorizing a train movement over the point. The limits of Obstruction Test shall be as per the requirement of IRSEM.

(d) Where the points form a crossover, independent detection shall be provided for the points at each end of the crossover. The two independent detections can however, be proved together and read into EI as a single input.

(e) The relative position between the point machine and the stock rail shall be fixed such that independent movement is prevented.

(f) The super imposed detection is not permitted.

(g) Locking detection shall be provided to detect that the point lock is in the respective locked position before authorizing a train movement over the point.

(h) Provision shall be made for emergency operation of points during track section failure. Each such operation shall be recorded by a suitable counter.

(i) All point operating equipment and point operation & detection circuits shall be totally immune from 25 KV AC traction current effects or other EMI sources.

(j) Point machine wires shall be protected to prevent short-circuiting and monitored continuously for earth leakage.

(3) Point machine Installation

(a) Point machines installed shall present a minimum hazard to people walking along the track.

(b) Point machines shall be installed beside the close switch leading to high speed movement clear of all infringements.

(c) No point machines shall be installed in between the main line tracks.

(d) The point machine cover shall be provided with secured locking mechanism.

(e) The point machine shall be installed as per RDSO/OEM checklist.

2.2.8 Relays

(1) The various types of relays used in interlocking systems shall comply with IRS

specification no. S34 and the requirements of IRS, BS or BRS specifications or any other specifications as approved by the Engineer.

(2) Time element relays electronic type conforming to IRS/BS/BRS or of the specification approved by the Engineer shall be used. When electronic time element relays are used these shall be two in number and their contacts should be proved in series with each other.

(3) The relays shall be preferably of the plug-in type. The contractor shall seek the advice of the Engineer in case other than plug-in-type relays are proposed to be used.

(4) All plug-in Relays and relay groups shall be fitted with non-interchangeable interlocking device to prevent the wrong relays/relay group being accidentally plugged in during replacements.

(5) Removal or replacement of plug-in relays/relay groups during operation shall not cause any unsafe conditions in the circuits.

(6) All relays shall, to the extent possible be housed in the Signalling Equipment room.

(7) All relays shall have minimum 10% of working contacts as spare subject to a minimum of one front and one back contact.

(8) The use of relays within the signalling sub system shall, however be minimised by design.

2.2.9 Integrated Power Supply (IPS) for Signalling system

(1) The power supply scheme for Signalling and Telecommunication System should be based on 230V 50Hz AC supply.

(2) The Contractor shall take the Power supply from Automatic changeover panel for CLS to the main AC distribution panel for Signalling system on two independent power cables laid through diverse routes.

(3) The Contractor is required to create MCB protected 230 V, 50 Hz supply for the Signalling and Telecommunication system with sufficient capacity plus an additional 30% spare capacity for future expansion to meet the system design requirements.

(4) The Power Supply for Signalling system shall be drawn from Main AC Distribution Panels/Boxes and terminated on Signalling AC Distribution Panel/Box from where it shall be distributed to all Signalling Equipment/Signalling Power Supply Equipment operating at 230 V AC.

(5) The Contractor shall carry out a detailed power supply calculation for total Signalling load (including load of battery charging in boost mode) of every Station and depending on the load requirement at each location, an Integrated Power Supply (IPS) system of appropriate capacity shall be provided.

(6) All design loadings and calculations are subject to acceptance and approval by the Engineer before installation commences.

(7) The IPS provided shall be as per specification RDSO/SPN/165/2012. The supply to different Signalling equipment say Distributed architecture with object controllers of Electronic Interlocking, Digital Axle Counter, Relays Internal, Relays External, Point Machine, Data Logger, VDU, BPAC etc. shall

be separate, provided using separate set of additional power supply equipment with minimum N+1 redundancy. The additional power supply equipment shall be in accordance with IRS/RDSO specification (if any)/ relevant international standards.

(8) The battery backup shall be provided with VRLA as per specification IRS: S 93/96(A) of suitable capacity. Battery bank shall have adequate capacity to provide a backup time of minimum 4 hours with maximum depth of discharge of the battery as 70%. The batteries shall be installed on battery racks.

(9) At connecting IR station namely Patli, necessary power supply equipment/battery system shall be provided in existing power supply equipment/IPS/Battry room. If space is not available in the existing room separate Rooms shall be provided by the contractor.

(10) NMS system is to be provided for remote monitoring of all IPS equipment provided in this Package, which shall be integrated with RDPM system.

(11) Six numbers of 2V Cells and a spare Cell charger for charging (with boost charging facility also) up to 55 cells at 10% of battery AH capacity shall be provided as spare at each power supply location with the main supply.

(12) Restoration of the primary input supply shall cause a seamless changeover from the IPS back to the primary supply.

(13) The Contractor shall sectionalize the power feeds to logical groups of equipment to allow for ease of maintenance and to enable maintenance to be carried out without disturbing the operation of other equipment groups.

(14) All Signalling equipment local supplies shall use redundancy techniques (ring circuit) to provide appropriate availability. The design of the distribution shall ensure that a technician can isolate the power feed to an item of equipment without affecting the operation of other equipment/items connected to the ring.

(15) An external bypass facility shall be incorporated in all IPS battery power supplies to cater for maintenance and failure requirements.

(16) Automatic monitoring of battery condition and charge state shall be provided.

(17) All feeding voltages shall be monitored continuously by voltage sensors. In addition, all non-earthed output supplies shall be monitored by earth leakage detectors. The said monitoring shall be possible from RDPM terminal at the stations and IMD/SCC for which necessary sensors and interfaces shall be provided.

(18) Any failure of power supply equipment shall be recorded and displayed on the Control terminal at the Station and RDPM terminal at the Station and in the IMD/SCC.

(19) Notwithstanding anything contained in this specification, the contractor shall be fully responsible for proper working of Signalling power supply system.

2.2.10 Remote diagnostic and predictive maintenance (RDPM) System

(1) System Requirements

(a) A Remote diagnostic and predictive maintenance system (FDPM) shall be provided for monitoring and supervision of health of Signalling equipment and enable carrying out condition-based maintenance of

Signalling equipment with optimum manpower and reduce the MTTR of the equipment and Datalogger as per RDSO IRS specification S 99/2006 with latest amendment shall be used for event logging.

(b) This system shall be able to anticipate, where practicable, failure of the equipment based on the deterioration of the parameters being monitored, thereby avoiding a potential future failure of Signalling system.

(c) The RDPM terminals shall be provided with the Signal Maintainer at the Stations and with the Signal Fault Controller at the SCC. Each Signal Maintainer's RDPM terminal/RDPM terminal provided at SCC shall be able to monitor health of Signalling equipment under his area of control.

(d) The RDPM system shall analyze, link and evaluate indications such as status, alarms, fault, and event indications. With the help of such analysis and the specific fault conditions, the RDPM system shall identify the displayed faults. These faults shall be stored in a data-base separate for each system. Eliminated faults shall be stored for statistical evaluation at a later stage.

(e) The system should create alarms and reports for equipment maintenance and trouble shooting. It shall also be possible to send the alarms in the form of SMS to signal technicians in the field. The Contractor shall provide the necessary hardware and software for the same.

(f) A soft copy of maintenance manuals/registers shall be available on the RD PM workstation, which the signal technicians can refer during fault diagnostics and rectification and also make records during regular maintenance.

(g) All Signalling 'As Built' drawing and documents of concerned station and adjoining block sections shall be loaded on the RDPM workstation of the station in pdf format. The RDPM Server at SCC shall house the 'As Built' drawings and documents of the entire section covered in this Package.

(h) The Signalling system shall indicate within 2 seconds, certain functions, but not limited to the following:

  (i) Identification of failure of point throwing or detection.

  (ii) Identification of signal defects.

  (iii) Signal passing at Danger (SPAD) cases.

  (iv) Failure to set points against occupied line after reception of a train by station controller.

  (v) Signal assuming green with points in the route in reverse position.

  (vi) Signal not gone to 'ON' position after first controlling track section is occupied by train.

  (vii) Power supply defects including IPS defects and earth faults.

  (viii) Untimely or out-of-sequence operation of equipment.

  (ix) Unauthorized or potentially unsafe train movement.

  (x) Failure of redundant communication channels.

(xi) Following Typical alarms (but not limited to) shall be generated by the system:

(i) Point machine:

- Point obstructed.
- Point machine drawing more than normal current.
- Operating voltage drop at point machine is high.
- Make and break of points detection during train movement due to poor ballast packing.
- Points bursting
- Points changed status without operation by station controller.
- Crank handle key released when route is locked for those points.

(ii) Axle counter:

- Evaluator operating voltage low.
- State of reset.
- failure.
- Abnormal movement.

(iii) Power supply system:

- Presence of input supply from AT 1 and AT 2 and local electricity board /DG supply on Automatic change over CLS Panel.
- Presence of output supply from ACO
- Input mains voltage beyond limits.
- Output voltage beyond limits
- Battery charger output not available
- IPS sub module failures
- Working on standby system after main system failure.

(iv) Earth Leakage Detector [ELD] for cable health monitoring:

- Different Supply leakage occurred time.
- Different Supply leakage disappeared time.
- Linking the events of supply application and withdrawal to cable conductors with ELD alarm.

(v) Signalling Equipment room monitoring

- Room door opening and closing events.
- Fire alarm detection system monitoring

(vi) Block instrument/BPAC Panel

- State of the block section relating with block instrument.
- Wrong sequencing of block operations.

(vii) Battery Monitoring Unit:

- Cell voltage beyond limits.
- Battery charging and load currents beyond limits.
- Each cell temperature beyond limits.
- State of charge of battery bank lower than the limit set.

(viii) Colour light LED Signal:

- Current drawn beyond range.
- Signal lamp lit due to faulty voltage.
- Bobbing of signal.

(2) Technical requirements

(a) Parameters of each Signalling equipment/ system shall be monitored by monitoring the voltages, currents, potential free contacts etc. using a general purpose data logger. In processor based equipment like Axle counters, Electronic Interlocking, IPS etc., the data logger shall collect the diagnostic data in soft form through a port in the equipment. Scanning interval for digital inputs shall be less than 20 milliseconds.

(b) The RDPM data network shall be established by networking all data loggers using copper quad cable or OFC channels or dark fibres as appropriate and data of all stations and block sections shall be brought to Signal Fault controller in SCC on the OFC network provided under PS (Telecommunications).

(c) The Data logger networking system at SCC shall consist of Servers, LAN Switches, Central Monitoring Units, Front End Processors, RDPM terminal etc. with redundancy provided for each equipment. The VDU for RDPM terminal at SCC shall be of minimum size 43".

(d) The Event Log should be automatically backed up by the system with a 60 day archive back up and that the active storage period is a rolling 30 days period.

(e) The RDPM terminals shall be Industrial grade PC with a low noise logging printer of the latest technology provided at all stations and at SCC.

2.2.11 Fuse auto changeover system

(1) System Requirements

(a) On the failure of a main fuse, its standby fuse should come in circuit automatically before dropping of signaling relay. The changeover time shall not be more than 20 milliseconds at rated voltage of the system.

(b) RDSO specification RDSO/SPN/209/2012 with latest amendment shall be followed.

(c) The system shall be modular by design and each module of the system shall

have capacity for monitoring either of the following

(d) TYPE-I: 32 nos. of external Non-Deteriorating Type or 'G' type fuses from 0.6 Amp to 4 Amp capacities which are in signaling circuits. System shall have 8 cards with monitoring arrangement of 4 fuses in one card.

(e) TYPE II: 24 no. of external Non-Deteriorating Type or 'G' type fuses from 4 A to 10 Amp capacities generally used for point operation circuits. Such system shall have 6 cards with monitoring of 4 fuses in one card.

(f) The system shall be capable of monitoring fuses with system voltage of fuse circuit as 12V, 24V, 60V or 110V DC/AC.

(g) GSM Modem: A GSM modem shall be supplied and with such modem connected, the system(s) shall send SMSs on GSM network to upto 5 preselected GSM mobile numbers in case of any of the fuse blowing. The mobile numbers shall be configurable.

(h) Common audio- visual alarm unit shall be hanged in ASM's room or any other convenient place and shall have following features: -

(i) Power supply OK - YELLOW Indication (5 mm LED).

(j) Common failure LED indication (RED) in case of any main fuse getting blown out at the station.

(k) Another LED indication (RED) if any of the standby fuse also is blown along with its Main fuse. Both the LEDs shall be lit in case of both Main and Standby getting blown.

(l) Piezoelectric buzzer to give audio alarm for failure conditions mentioned

(m) A Non locking type Push Button for acknowledgement of Audio Alarm.

(n) A suitable fuse shall be provided at input of the power supply inside the unit.

(o) NOTE: 5 mm RED LED with suitable holders and flashing indications to be used.

(2) Technical Requirements

(a) The changeover facility covered in this specification should be suitable for changing over of circuit operation from main fuse to spare fuse automatically when main fuse is blown off without affecting the functioning of signaling circuits and point machine circuits. At every change–over, audio/visual indication should appear.

(b) Equipment shall work either on 24V DC, 60V DC or 110 V AC as specified by the purchaser. The equipment shall be able to work in tolerance range of +20%, - 30%. The power supply used in the system shall be SMPS type. Reverse polarity protection and overload protection voltage should also be provided in the power supply circuit.

(c) The following components shall be provided on the Power Card Module of the system.

- POWER ON Indication (LED based).
- Buzzer ACKNOWLEDGE push button.
- Fuse for protection of Power card module.

- TEST push button for checking health of all indications.
- Buzzer

(d) Following components shall be provided on each monitoring card of the system:

- Standby Fuses.
- LED indications for Main and Standby Fuses monitored by the card.
- RESET push button (one for each monitoring card)

2.2.12 Automatic Fire Detection and Alarm System (AFDAS)

(1) Automatic fire detection and alarm system as per RDSO spec. RDSO/SPN/217/2021 with latest amendment shall be provided.

(2) Analogue addressable UL listed Fire Alarm Control Panel with 80-character display with battery charger and battery, backup for 24 Hours normal operation and 15 Min alarm operation addressable power supply and alphanumeric keyboard for installation for the FAS Panel and 1000 event recording facility without GSM interface module shall be provided at every station.

(3) Automatic fire detection & alarm system will be provided in all Signalling Equipment room, Telecom equipment room, Power Supply/IPS room, Battery room, SM room, Signal maintainer room Signalling Power supply equipment rooms, and DG room with facility of alarm generation at stations, the arrangement for remote monitoring of this system shall be provided, separately at SM room of every station.

(4) Portable Fire Extinguishers shall be provided in all the Signalling equipment rooms, Telecom equipment room, Power Supply/IPS room, Battery room, SM room, signal maintainer room and Power supply equipment rooms at the Stations and at TSS/SP/SSP. Portable fire extinguishers shall be compliant to NFPA 10 standard or better and suited for electrical equipment fires.

2.2.13 Earth Leakage Detector

(1) Earth leakage detection system as per RDSO spec. RDSO/SPN/256 with latest amendment shall be provided at all stations to monitor earth leakage/fault in all Outdoor/Indoor Signalling cables and all Power supplies bus bars used in Signalling system.

2.2.14 Signaling outdoor cables

(1) The Cables for carrying outdoor Signalling circuits shall be PVC insulated, PVC sheathed and armoured unscreened cable conforming to IRS specification IRS S 63/2014 with latest revision and amendment. The cable conductor shall be of annealed copper having minimum cross-sectional area of 1.5 sq. mm of 24Core, 19Core, 12 Core, and 6 Core.

2.2.15 Signaling indoor cables

(1) Indoor cable/wire used shall be single core, plain annealed high conductivity copper conductor, PVC insulated unarmoured as per IRS spec. IRS S 76/89 with latest amendment, tinned flexible single core indoor wire in different colours or suitable cable shall be used. All electronic equipment shall however, be wired as per the requirement of the relevant RDSO specification of the equipment and /or as specified by the OEM. The Q style relay wiring shall be carried out with 16/0.2mm size flexible

multicolour wire.

2.2.16 Quad cable

(1) The Quad cable used for Axle Counter circuit shall be 6 quad Telecom underground Jelly filled cable as per RDSO specification RDSO/SPN/TC/72/07 with latest amendment.

2.2.17 Optic Fibre Cable

(1) The Optic Fibre Cable for the Signalling system shall be provided as per RDSO specification TC 55/2006 with latest amendments.

2.2.17 Batteries for signalling

(1) All batteries for Indoor installation like with IPS etc. shall be VRLA batteries as per IRS Specification S 93-96 with latest amendments.

(2) All batteries for Outdoor installation like with Track circuit etc. shall be Low Maintenance batteries as per IRS Specification S 88-2004 with latest amendments.

2.2.18 Level Crossing Gates

There is 01 No 'C' class level crossing gate at Chainage no. 4087.148 m at Sultanpur of IR. There may beother LC Gate at other loclation at Sultanpur station of IR. These LC Gates will be required to be interlocked with Signals. New Gate Lodges will also be built on all the LC Gate to be interlocked. The details of these Level Crossings are given in Drawings section ESP of Sultanpur.

(End of Chapter-2)

CHAPTER 3: PERFORMANCE REQUIREMENTS

3.1 System Performance

3.1.1 The Signalling system shall be designed as per provisions of Employer's requirements, for a speed potential of 140 Kmph on the main line, keeping 10% safety margins.

3.1.2 The Contractor shall carry out to the satisfaction of the Engineer, the Simulation and other Performance tests to demonstrate the System Safety and Operational performance.

3.1.3 The Reliability, Availability, Maintainability, Safety (RAMS) activities during the apportionment of system requirements, design and implementation, manufacture, integration, system validation, system acceptance and operation and maintenance during defect liability phases shall meet or exceed the requirements of CENELEC standards EN50126, EN50128 and EN50129 with latest amendments. The system phase related tasks to be carried out by the Contractor for these phases are highlighted as under:

3.2 Reliability, Availability, Maintainability (RAM)

3.2.1 The Signalling system shall achieve all RAM requirements specified in GS (S&T) and this Particular Specifications.

3.2.2 The Employer attaches great importance to the attainment of the highest possible reliability during service of all the equipment and systems supplied and installed under this contract. The design, manufacture, installation and commissioning of the equipment and also the training of the operating and maintenance staff shall be such as to ensure near Zero Failure performance in the initial stages and that the few defects and deficiencies that may be exposed during the Service Trial are totally eliminated.

3.2.3 All the sub-systems and equipment to be used for this system shall be of proven design, in use on other similar railway projects and reliability in accordance with RAMS standards.

3.2.4 The sub-systems and equipment shall be engineered to maximize system availability during traffic hours in accordance with RAMS standards, to minimize the amount of maintenance required and to ensure that any maintenance can be easily and quickly carried out in minimum time.

3.2.5 Fault Tolerance & Graceful Degradation: The system shall be designed such that service can be maintained in the presence of faults. Subsystems and components whose failure can significantly impact on RAM performance shall be backed up by simpler sub-systems or components that permit continuous operation.

3.2.6 Recovery: Provision shall be made to recover from any credible fault while minimizing disruption to service.

3.2.7 Condition Monitoring & Diagnostics: Diagnostic systems shall be used to detect, or where practicable, anticipate faults. Such systems shall be used to reduce requirements for preventive inspection and maintenance, to reduce overall costs, and improve reliability.

3.2.8 The Contractor shall submit system Reliability, Availability and Maintainability (RAM) Plan for review and approval of the Engineer.

3.3 Reliability Modelling

3.3.1 The Contractor shall perform Reliability and Maintainability analysis of each system, up to the point of interface with other systems.

3.3.2 The Contractor shall develop an evolving Reliability model consisting of Reliability Block Diagrams (RBD) and probability of success equations. This model shall show the relationships required for system and equipment to operate successfully. The RBD shall include multiple Electronic Interlocking and Track Vacancy Detection Systems that will be implemented for this

project. The RBD shall also include all elements essential to the successful performance of the system and the interrelationships and interface of these elements. The model shall not reflect the degraded mode of operation. The Contractor shall revise the RBD model to keep current with design iterations.

3.3.3 The reliability model consisting of reliability block diagrams and probability of success equations shall be developed and submitted to the Engineer for acceptance.

3.3.4 Reliability apportionment and prediction analysis shall be in accordance with established techniques or standards, or properly documented and verifiable field failure data for identical or similar equipment. The standards used or the source of field data shall be identified.

3.3.5 The Reliability apportionment and prediction analysis shall be carried out in parallel with the design of the system. The relevant apportionment and prediction figures shall be partof the design submission documents for the individual equipment, sub-system and system.

3.4 Failure Definitions

3.4.1 The inability to perform a required function, the occurrence of unexpected action by the equipment, or the degradation of performance to below the required specifications shall constitute a failure.

3.4.2 Relevant Failure: A relevant failure of an item is an independent failure which results in aloss of function of that item caused by any of the following:

(a) A fault in an equipment or sub-system while operating within its design and environmental specification limits;

(b) Improper operation, maintenance, or testing of the item as a result of the Contractor supplied documentation.

(c) Failures of transient nature including those with post investigation status as 'No fault found', shall be considered as relevant failure if in the opinion of the Engineerthese are attributable to Signalling System.

3.4.3 Non-relevant Failure: Any failure of an item not included in the definition of relevant failure, such as the following:

(a) A failure caused by malfunction of other equipment or sub-system that are not supplied by the Contractor.

(b) A failure caused by human error, except as noted in Relevant Failure above;

(c) A failure caused by accidents not associated with the normal operation of the item.

(d) A failure caused by operating the equipment or sub-system outside of design or environmental specification limits.

3.4.4 Service Failure: Any relevant failure or combination of relevant failures during revenue service operations to determine availability for revenue service, which results in one of the following:

(1) Delay to train service;

(2) Fault preventing a train from entering service at its scheduled time.

3.4.5 Pattern Failure: The repeated occurrences of 3 or more relevant failures of the same replaceable part, item or equipment in same manner in identical or equivalent applications when they occur at a rate which is inconsistent with the predicted failure rate of the part, item or equipment will be termed as pattern failure.

3.5 Reliability Requirements

1) Reliability requirements and goals shall be developed in terms of Mean Time Between Service Affecting Failures (MTBSAF)/Mean Time Between Failure (MTBF).

2) The reliability requirement is subsidiary to the Availability and Maintainability requirements as specified in this PS. If higher figures are required to achieve the Availability requirements then these higher figures shall become the reliability requirements for Signalling system.

3) The Signalling System shall be fault tolerant such that if failure of any sub-system is likely to adversely affect the train operation, the reliability shall be enhanced by providingredundancy in the system.

4) Redundant sub-system shall change over seamlessly when active system fails. If changeover has a finite time, contractor shall show that its system shall not obstruct the train operation.

5) The System shall be designed to generally recover from power supply disturbances without manual intervention. The failed axle counter track sections would require resetting as per Para 2.2.6 (2) (i) of this specification.

6) The Contractor shall minimize the risk of common mode faults in design of the subsystems providing redundancy.

7) The MTBF/MTBSAF of Interlocking, Track vacancy detection system, Power supply, other Signalling sub-systems (including FDPM) shall be at least, as specified in the relevant RDSO specifications. Wherever failure of any sub-system/equipment is likely to adversely affect the train operation and Availability, the reliability shall be enhanced by providing redundancy in the system.

3.6 Availability

1) The Contractor shall be responsible for providing a system design, maintenance procedures, and defining the recommended spares holdings to ensure that the Availability requirements of the Signalling System are fully achieved.

2) The Contractor shall submit calculations with reliability block diagrams for each sub- system till LRU level to demonstrate the compliance with specified availability figures. The availability calculation shall take all possible failure modes (barring Non relevant failures, as per Para 3.4.3 above) into consideration that cause gap in service operation of system, subsystem, equipment or part thereof. The calculation shall be based on the Contractor's submitted equipment MTBSAF and MTTR data and the configuration of each sub-system.

3) Equipment duplication, hot-standby protection, parallel-run, path diversity, etc. shall be adopted whenever necessary and appropriate to meet the required availability.

4) Signalling System shall have Availability better than the targets specified here below:

System/Sub-System	Availability	Remarks
Electronic Interlocking System (including power supply, wiring, etc.)	99.98%	Availability per system
Track Vacancy Detection System (MSDAC/SSDAC), IPS, FDPM etc.	99.99%	Availability per system

5) Degraded performance or loss of any software or hardware dependent function of any end equipment shall be taken as unavailability.

3.7 Perturbation Analysis

1) A detailed system perturbation analysis shall be performed stating the types of failures that could cause service interruptions and the failure management actions required to mitigate the effect of these failures.

2) The service interruption analysis shall document all failure modes capable of causing service interruptions.

3) The Contractor shall design the system to reduce the perturbations to the minimum. Operational actions, System design features or maintenance strategies that can reduce the impact of potential service interruptions shall be submitted to the Engineer for review.

3.8 Maintainability

1) Maintainability requirements and goals shall be developed in terms of Mean Time to Restore (MTTR). The required MTTR shall be achieved for the whole System.

2) The system shall be designed such that the MTTR shall be less than one hour.

3) The MTTR shall include the diagnostic time, active repair / replacement time and adjustment / testing time, including software re-boot, up to the point the system is restored to full functionality. In the event that the failure cannot be rectified, the measurement shall include the time necessary to remove the failed piece of equipment from the System and replace it with a functional module.

4) The MTTR does not include the time taken for designated personnel to arrive on site (access time) to begin local diagnostic activities or the time taken for the replacement parts to be delivered at site.

5) The Contractor shall analyze each and every failure/defect of components of various equipment to determine the cause of failure and to propose preventive/corrective measures in the FMECA analysis.

6) The System shall be suitably designed to minimize the need for frequent preventive maintenance.

7) Redundancy shall be used to enable any necessary preventative maintenance to be carried out on off-line systems during Traffic Hours.

8) Built-in self-diagnostics, power-up self-test and sufficient test points shall be provided in the System to minimize the time required to locate a fault.

9) As far as the technology permit, all vital plug-in modules shall permit hot swapping so as not to affect the normal or emergency operation of the system

10) The Contractor shall provide Service Life support as specified in PS (SIgnalling).

3.9 Safety Engineering

1) Safety is defined as freedom from those conditions that can cause death, injury, occupational illness, or damage to or loss of equipment or property, or withdraw the train from service. All circumstances susceptible to cause injuries or death of a person (public, operation staff, maintenance staff), and by extension all events leading to a partial or total destruction of costly equipment are considered as a risk.

3.10 System Safety Plan

The Contractor shall develop System Safety Plan in accordance with EN 50126 and submit the same for review and approval of the Engineer.

3.10.1 Safety Principle

(1) All equipment and sub-systems, including software, affecting safety and identified as being "vital", shall be designed according to the following principles:

(a) Only components having a high reliability and predictable failure mode shallbe used.

(b) Components must be utilized in such a manner that ensures that a restrictive, rather than a permissive condition will result from hardware, software or any part of the equipment failure.

(c) Circuits shall be designed such that when a normally energized electric circuit is interrupted or de-energized, it will cause the controlled function to assume its most restrictive condition.

(d) System safety equipment design shall be such that any single independent component or subsystem failure results in a restrictive condition. Failures

(e) that are not independent, those failures which, in turn, always cause others, must be considered in combination as a single failure and must not cause a permissive condition.

(2) The Signalling system shall fully conform to the interlocking principles as specified in the Indian Railway Signal Engineering Manual.

(3) During consideration of precedence in the control of system hazards, the Contractor shall take actions to satisfy requirements in the following order of precedence:

(a) Incorporation of fail-safe on vital features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure; and,

(b) Reduction of the probability of occurrence of a failure by increased component reliability or by provision of supervised redundant components.

3.10.2 Safety Requirements

(1) The Contractor shall be fully responsible for the system safety within his domain through the application of engineering and management principles, criteria and techniques to optimize all aspects of safety throughout all phases of the System life cycle.

(2) The safety level of Electronic Interlocking (EI) and Track Vacancy Detection Systems realized with software shall satisfy the SIL4 or equivalent safety level.

(3) Component failure shall be self-detecting by way of causing a signal to display a most restrictive aspect as far as practicable. Failure of components which are not self-detecting shall not cause any unsafe failure of the equipment.

(4) The design of the equipment shall cater for detection and restoration of system toa safer state in case of following faults if these are likely to result in unsafe condition:

(a) Variation in power supply beyond its tolerance limits.

(b) Spikes in the power supply system.

(c) Insertion of PCBs in wrong card slots.

(d) Earthing of any component or wire or a combination of such earthing faults.

(e) Broken wires, damaged or dirty contacts, failure of a component to energize, loss of power supply or blown fuses etc.

(5) During each stage in the design and development process, the Contractor shall take cognizance of any hazard that arise as a result of the design or operation of the proposed equipment and take immediate steps to change the design or operation principals of the proposed equipment to mitigate the hazard.

(6) Occurrence of any failure or error of operation in the axle counter components must not lead to any hazard but should rather transit to a safe state.

(7) The Contractor shall use safety devices to reduce the magnitude of the loss or risk once a hazardous mode has been entered; and ensure that the safety device does not introduce an additional hazard or system malfunction.

(8) The Contractor shall use warning devices and systems which are audio/visual portion of a vital system in which the human is the responder. The Contractor shall recommend special equipment operating procedures to reduce the probability of a hazardous event.

(9) A Hazard Log shall be established as a basis for on-going risk management. The hazard Log shall be updated with each event identified and mitigated. Residual Risk shall be carried forward and rules and procedures proposed to the Engineer for the Management of such Residual Risk.

(10) During the Design Review process, the Contractor shall submit analysis for Engineer's review, which demonstrate compliance with these safety principles. These analyses shall address the following issues:

(a) Circuit design;

(b) Hardware design (Failure Modes, Effect and Criticality Analysis);

(c) Electrical interference;

(d) Software errors; and

(e) System failures.

(11) All metallic enclosures shall be provided with an earth terminal.

(12) The design of the System shall minimize the risk of fire.

(13) The design of the System shall minimize the build-up of static, as well as the effects of static discharge during maintenance.

(14) Components or materials containing toxic chemicals or asbestos should not be used unless absolutely necessary and where they are to be used, they should be submitted to the Engineer for agreement.

(15) The safety level of each function outlined in this specification shall be defined and demonstrated by the Contractor in accordance with the process defined in General Specifications.

3.10.3 Risk Acceptance Criteria

(1) Risk is defined as probable rate of occurrence of a hazard causing harm and the degree of severity of the harm. Risk acceptance shall be based on the principle of "As Low as Reasonably Practicable" (ALARP) based on the guidelines set out in EN 50126.

(2) The frequency of occurrence of hazardous event is categorized into different rankings:

Category	Description
Frequent	Likely to occur frequently. The hazard will be continually experienced.
Probable	Will occur several times. The hazard can be expected to occur often.
Occasional	Likely to occur several times. The hazard can be expected to occur several times.
Remote	Like to occur sometime in the system life cycle. The hazard can be reasonably expected to occur.
Improbable	Unlikely to occur but possible. It can be assumed that the hazard may exceptionally occur.
Incredible	Extremely unlikely to occur. It can be assumed that the hazard may not occur.

(3) The hazard severity is categorized into different hazard consequence levels:

Hazard Category	Consequence	Description
4	Catastrophic	Operating conditions such that personnel error, environment, designdeficiencies, subsystem or component failure or procedural deficiencies may cause death or system loss.
3	Critical	Operating conditions such that personnel error, environment, designdeficiencies, subsystem or component failure or procedural deficiencies may cause severe injury to personnel, severe occupational illness or major system damage.
2	Marginal	Operating conditions such that personnel error, environment, designdeficiencies, subsystem or component failure or procedural deficiencies may cause minor injury to personnel, minor occupational illness or minor system damage. Acceptable with adequate control and agreement o the Employer.
1	Negligible	Operating conditions such that personnel error, environment, designdeficiencies, subsystem or component failure or procedural deficiencies will not result in injury to personnel, occupational illnessor damage to the system.

(4) Risk classification of hazards:

Frequency		Consequence			
		Catastrophic (Category 4)	Critical (Category3)	Marginal (Category2)	Negligible (Category1)
Frequency	Frequent	I	I	I	II
	Probable	I	I	II	III
	Occasional	I	II	III	III
	Remote	II	III	III	IV
	Improbable	III	III	IV	IV
	Incredible	IV	IV	IV	IV

(5) The Risk Classes are defined as follows:

Risk Class	Interpretation
Intolerable	Intolerable risk. Shall be eliminated

Undesirable	Undesirable risk, and tolerable only if risk reduction is impracticable of if the costs are grossly disproportionate to the improvement gained. Shall only be accepted when risk reduction is impracticable and with the agreement of the Railway Authority or the Safety Regulatory Authority, as appropriate

Risk Class		Interpretation
Class III	Tolerable	Tolerable risk if the cost of risk reduction would exceed the improvement gained. Acceptable with adequate control and with the agreement of the Railway Authority.
	Negligible	Negligible Risk. Acceptable with/without the agreement ofthe Railway Authority

(6) Risk acceptance shall be based on the principles of "As Low as Reasonably Practicable" (ALARP) and as follows:

(a) Category 4 hazards shall be not greater than one unsafe incident in one hundred years (1:100 years).

(b) Category 3 hazards shall not be greater than one unsafe incident in one hundred years or only be accepted when the risk reduction is impractical and with the agreement of the Employer.

(c) Category 2 hazards shall only be permitted if a desired benefit is demonstrated as generally acceptable within accepted levels for the international railway industry and in agreement with the Employer.

(d) Category 1 hazards shall only be permitted if assured that the risk will remain at that level and any residual risk shall be mitigated by Operating Rules and Procedures

3.10.4 Hazard Analysis

(1) The Contractor shall, as part of the safety analysis, prepare analysis to identify Hazards and ensure their satisfactory resolution. The following analysis shall be prepared and submitted by the Contractor for the Engineer's acceptance:

(a) Preliminary Hazard Analysis (PHA)

(b) Subsystem Hazard Analysis (SSHA)

(c) Interface Hazard Analysis (IHA)

(d) Operating and Support Hazard Analysis (O&SHA)

(e) Quantitative Fault Tree Analysis (QFTA)

(f) Failure Modes, Effects and Criticality Analysis (FMECA)

(2) The Contractor shall carryout the Hazard Analysis and FMECA/FTA for key equipment / sub-systems / systems. As a result of hazard analysis, the Contractor shall:

(a) Identify and list the hazards

(b) Identify and list the Safety Requirement Specifications

(c) Identify and list the safety related functions

(d) Specify for each safety related function the safety related failures

(e) Identify and list the safety critical and non-safety critical items.

(3) The Hazard Review Procedure shall be submitted for the Engineer's approval. The final risk assessment, acceptance of mitigation and close out of hazards shall conform to the approved safety and risk acceptance criteria.

(4) The following targets/norms shall be employed for the Fault Tree Analysis. These norms are subject to review by the Engineer during the detailed design stage, and mutually agreed upon:

(a) No single point failure shall lead to fatality.

(b) No combination of undetected failure and double point failures shall result in fatality.

(c) No combination of undetected failure and single point failure shall result inmajor injury.

(5) The Hazard Log shall be substantially complete prior to commencement of Trial Running and shall be handed over to the Employer complete in all respects prior to the commencement of Revenue Service.

(6) The Contractor shall fully develop a Safety Critical Items List (SCIL) which shall be updated as required and carried forward throughout implementation until final resolution of identified hazards is achieved.

(7) Further, the information presented by the Contractor shall be supported by the history of tests conducted and by approved test certificates from accredited laboratories which attest to the engineering program characteristics and behavior.

(8) The procedures for Operation, Maintenance, Training and the Contractor Quality Assurance manuals shall incorporate resolution of hazards so identified from this Hazard Analysis. Proper cross-referencing to the hazards and resolution measures shall be provided in all these aforementioned documents.

3.10.5 Design/Systems Safety Studies and Report

(1) The Hazard analysis process shall identify the need for Design Safety Studies and the Hazard Log shall record the results of each of these Design Safety Studies.

(2) Design Safety Studies shall be undertaken for system and subsystem elements that are considered to be safety critical and that require hazard analysis to a greater level of detail than that applied at an overall system wide level.

(3) Design Safety Studies shall specifically refer to hazards arising from:

(a) normal operations including maintenance;

(b) degraded modes of operation;

(c) emergency situations; and

(d) the effectiveness of mitigation proposed for natural catastrophes.

(4) The Design Safety Studies shall take account of:

(a) methods of operation;

(b) RAM considerations;

(c) Anticipated likelymaintenance regimes and their sustainability in Commercial Operation;

(d) anticipated competence levels of personnel in Commercial Operation;

(e) software security (disabling of unauthorized access to operating systems, protection against intrusive attacks, loss of password integrity, etc.); and

(f) Other human factors including but not limited to those identified in ergonomic studies.

(5) Design/Systems Safety Studies and the Report shall demonstrate, as a minimum, the following requirements:-

(a) That the overall risk criteria for the Works have been addressed satisfactorily at the Detailed Design stage and that the Detailed Design proposals are mutually

compatible with such risk criteria.

(b) That all Safety Critical systems have been identified at the Detailed Design stage and the apportionment of risk factors between the major systems and sub-systems support the overall safety criteria approved in the "System Safety Plan".

(c) That the results of the Design Safety Studies have been incorporated into the design, and shall be carried forward into the Final Design, manufacturing and installation processes.

(d) That where management by operating and/or maintenance procedure or other management control measures have been identified during the "Design Safety Studies", auditable methods by which such measures shall be introduced into operating/maintenance provisions have been established.

(e) That robust processes have been implemented to validate the Safety Critical aspects of software design.

(f) That processes for assessing the potential safety impact of design changes exist.

(6) The Design/Systems Safety Studies and a Report shall be submitted at the completion of the Detailed Design period to confirm that all safety related aspects of design have been properly addressed and comprehensively validated.

3.10.6 Engineering Safety Validation Plan and Report

(1) The contractor shall submit Engineering Safety Validation Plan that will outline the safety related tests to be conducted during the on-site testing and integrated system testing phase. The document will include the validation of the safety requirements for the system such as output voltage of DC-DC converter or an inverter shall not exceed pre-set value. Throughout this document details test cases carried out in order to validate the system, the relationship of the effects found in these tests and the validation of the same in subsequent tests will ensure that the system comply with the safety requirements.

(2) An Engineering Safety Validation Report will be submitted after the completion of this testing.

3.10.7 Safety Case

The contractor shall submit the Safety Case which will be a documented demonstration that the product complies with the specified safety requirements. The Contractor may be required to issue updated Safety Case conforming to EN50129 after Trial Run. The Safety Case forms part of the overall documentary evidence to be submitted to the relevant safety authority in order to obtain safety approval for the system.

3.10.8 Relational Database Management System

(1) All hazard resolution by procedural control shall be cross-referenced from the safety critical and non-safety critical Items List to the appropriate manuals. The results of the Hazard Analysis shall be recorded and maintained by the Contractor in a Hazard Log in the form of a relational database that can be used to track progress in the implementation of mitigating actions and control measures, and provide an easily accessible reference for the future Operator of all actions taken with respect to any hazard of any type in an any location for any area of activity. Proper cross-referencing to the hazards and resolution measures shall be provided in all these afore mentioned documents.

(2) The fully functional soft copy of the relational database management system shall include together with all passwords, supporting software and instructions on its use and further

development during Revenue Service.

3.11 RAM Demonstration

3.11.1 RAM Demonstration Plan

(1) The Contractor shall submit RAM Demonstration Plan to the Engineer for approvalbefore the final design review to demonstrate that all RAM predictions and specifications are met.

(2) The requirements relating to Maintainability shall be demonstrated before the commencement of Trial Running and may begin as soon as the necessary systems or elements of systems have been tested and commissioned.

(3) The requirements relating to Reliability and Availability shall be demonstrated throughout Trial Running Period and the Defects Liability Period.

3.11.2 Failure Reporting and Corrective Action System (FRACAS)

(1) The Contractor shall be required to establish a computer based Failure Reporting and Corrective Action System (FRACAS) during the RAM Demonstration phase. The FRACAS proposed by the contractor shall need the approval of the Engineer.

(2) The FRACAS shall:

(a) Provide an application for reporting, classifying, analysing failures through mapping with FDPM, and planning corrective actions in response to those failures.

(b) Collect data, record and analyse system failures.

(c) Produce a history of failure and corrective actions.

3.11.3 Reliability Demonstration

(1) During the RAM demonstration phase, the Contractor shall collect and maintain data on every failure of the system provided by him along with the data indicating the probable failure. MTBSAF shall be calculated throughout the monitoring period. The Contractor shall submit monthly Reliability Demonstration Reports.

(2) In case the Contractor is not able to achieve specified/predicted reliability target, the Contractor shall take necessary corrective measures either by way of change of design and/or replacement of the relevant equipment / component, at no additional cost to the Employer.

(3) The Contractor shall analyze each and every failure/ defect of components of various equipment to determine the cause of failure and propose corrective measures, which would be reviewed by the Engineer.

3.11.4 Maintainability Demonstration

(1) The Contractor shall carry out tests on all the system provided by him to demonstrate that all maintainability predictions provided are met.

(2) The maintainability demonstration shall consist of simulated failures and repair activities, the duration of which shall be measured to determine the MTTR. As an alternative, data from actual maintenance actions for relevant independent failures occurring during the testing period may be used in lieu of simulation.

(3) A minimum of 50 maintenance actions shall be included for this demonstration.

(4) The maintenance actions shall be distributed among the equipment of each test group in proportion to their expected failure occurrence and in accordance with the MTBSAF.

(5) In the event that any maintainability target is not achieved, the Contractor shall at his own

expense take whatever action is deemed necessary to meet the maintainability targets.

(6) The Contractor shall ensure that all the required information including the related Maintenance Work Instructions (MWI) etc. are available to enable him to demonstrate the maintainability targets.

3.11.5 Availability Demonstration

(1) The Contractor shall demonstrate the specified Availability during Service Trials and during the DLP. The Availability Demonstration Testing (ADT) shall be conducted on all Systems, subsystems and their interfaces.

(2) The demonstration test measure for Availability shall consider the performance of the Contractor's installed equipment, and the effectiveness of maintenance procedures recommended by the Contractor.

(3) The availability shall be worked out on the basis of the formula given during the preceding six months. In the event that the availability target as specified is not achieved, the Contractor shall,

(a) The determination of availability achievement in the preceding six month period shall be continued at monthly intervals until the target is achieved.

(b) The contractor at his own expense, will take action deemed necessary to meet the availability requirement.

3.12 Environment

3.12.1 Details of climatic conditions generally prevalent in HORC section covered in this Package are given in GS.

3.12.2 The Signalling Equipment rooms at the stations will be built and provided with air-conditioning by 'Electrical contractors of this Package' and will have following Environment classifications:

(1) Signalling Equipment Room(s) at Station: Class B1

3.12.3 The Signalling Power supply Equipment rooms at the Stations, being built by 'Other contractors' shall normally have following Environment classifications:

(1) Power Supply Equipment Rooms at Stations: Class B2

3.13 EMC/EMI Requirements

3.13.1 The Signalling system provided should be electromagnetically compatible with other systems viz. Electrification, Telecommunication and Rolling Stock as per relevant national and international standards specified at Para 4.1.2 of this specification.

3.13.2 The Contractor shall conduct the EMI Hazard analysis at the preliminary design stage to identify sources of EMI likely to affect the Signalling system, its consequences and EMC protective measures, all of which should be detailed in the EMI Hazard analysis report. The EMI Hazard analysis report shall be submitted to the Engineer for review and acceptance.

3.13.3 EMC Control Plan

(1) The contractor shall prepare an EMC control plan and submit it to Engineer forreview and acceptance.

(2) The plan shall analyse EMI/EMC impacts on the design of the Signalling Systemincluding trackside equipment as well as the general environment.

(3) The Plan shall specify measures to increase immunity of the Signalling system.

(4) The Plan shall include measures to reduce conducted, induced and radiated emissions to acceptable levels as specified by the relevant national and international standards.

(5) The plan shall specify basic protective measures proposed for all electrical and electronic subsystems and components and specific measures to be adopted for the selected subsystems and components.

3.13.4 Intra system EMI

The Contractor shall ensure that any intra system EMI is mitigated through proper designand other special measures. All major subsystems shall be tested for emissions and immunities in accordance with the appropriate international standards for equipment operating in Railway or similar industrial environment as listed under Para 4.1.2 of this specification

3.13.5 Inter system EMI

(1) The Contractor shall ensure that all the Signalling System is designed and manufactured in accordance with the latest issues or versions of internationally recognized EMC standards, including but not limited to EN50081, EN50082, EN50121, EN50123, IEC571, EN50155, and IEC61000 to ensure proper functioning.

(2) The contractor shall identify all likely sources of EMI that are prevalent in the environment. Adequate measures may be taken to ensure correct operation of theSignalling system in its intended operating environment.

3.13.6 EMC Tests

(1) The contractor shall not be required to conduct EMC tests if it can be demonstrated that the same have been done at the design stage of his equipment.However, if EMC tests were not done or if no test reports are submitted, the tests have to be conducted in accordance with, but not limited to satisfying following standards for overall compliance:

(a) EN50121-1

(b) EN50121-2

(c) EN50121-4

(d) EN50121-5

(2) In all cases where tests are not conducted, waiver for the same may be applied along with justification for approval of the Engineer.

(3) For any standard off-the-shelf products, their EMC test certificates shall be submitted to the Engineer for review.

3.13.7 Safety related Systems Interference (Hardware/Software interfaces & protocols)

(1) Special attention shall be given to the interference with safety related operations and equipment such as communication systems. Adequate safety margins must be ensured between the immunity levels of these safety related systems and emission levels of the Signalling and Control System specified by prevailing international standards.

(2) If considered necessary, following measures shall be taken to improve the immunity of the Signalling system. These measures shall include, but not limitedto the following actions:

(a) Proper grounding to reduce ground-loop coupling.

(b) Proper cable shielding to reduce common-mode coupling.

(c) Proper use of twisted-pair cable to reduce differential mode coupling.

(d) Proper magnetic shield to reduce low-frequency magnetic field interference from the traction system.

(e) Use steel cable supports (trunkings, trays, etc.) instead of aluminium.

(f) All cable supports shall be grounded.

(g) Correct choice of operating frequency.

(h) Use of filter to reject out-of-band noise.

(i) Proper use of surge arrestor.

(j) Use of high-level modulation technique to improve the immunity of the system.

(k) Use of redundancy codes/check sum etc. to improve the immunity of the system.

(l) Use of parallel-check technique to improve the immunity of the Signalling system.

(m) The probabilities of various conditions which could lead to an unsafe operation shall be determined and action to resolve the same shall be taken.

(n) An appropriate technical construction file suitable for safety audit shall be submitted or if not available developed to demonstrate EMC compliance.

3.13.8 Installation mitigation guidelines for Cabling

(1) The cables used in the Signalling system shall be adequately protected against external interference.

(2) Additional protective measures, including but not limited to the use of metallic conduit, armour, ferrite choke and EMI filters shall be used to reduce such external interference wherever required. Covered conduit is preferred.

(3) The cables shall also be installed at a safe separation from potential interfering sources, including power cables etc.

(4) A cable routing plan shall be designed so that there is least likelihood of coupling between the Signalling cables and the extraneous potential sources. For example, long parallel run of Signalling cable and power cable shall be avoided unless they are enclosed within separate conduits/covered troughs.

(5) The Contractor should refer to guidelines recommended by IEC61000-5-2, wherever possible for signal trunking /conduit separation.

(6) For protection against electrostatic capacitance coupling, direct electrical connection between ducts of power cables and signal cables shall be avoided.

3.13.9 The latest versions of IEC61000-5 and other relevant standards shall be complied with wherever applicable.

(End of Chapter-3)

CHAPTER 4: GENERAL REQUIREMENTS

4.1 Project Design Standards

4.1.1 High Level Standards

(1) The project requires contractors to work within the framework of the international standard for Quality Management ISO 9000.

(2) Working within IEC61508, Functional Safety of Electrical/Electronic/ Programmable Electronic Safety-related System, the suppliers/contractor should demonstrate how compliance will be achieved for this project.

(3) Where systems and products have been designed and are approved against Design standards as specified at Para 4.1.2 below, full details of approval shall be given. Where systems and products have been approved within other markets, for example against US FRA standards, then a gap analysis between the design and approving standard and the appropriate design standard specified at Para 4.1.2 below shall be required before products are approved for use on the project. The contractor will be required to give detail of how the gap analysis will be conducted.

4.1.2 Design Standards

(1) The generic standards or other equivalent standards which are specified as under shall be applied for Signalling system.

(a) RDSO: Research, Design and Standards Organization, Ministry of Railways, India.

(b) IEC: International Electro-technical Commission.

(c) EN: European Standards Organizations CEN, CENELEC or ETSI.

(d) ISO: International Standards Organization

(2) Research Design and Standards Organization (RDSO), an organization of the Ministry of Railways, Government of India has standardized the technical specifications for various components of railway systems in India as Indian Railway Standard (IRS) Specifications. These are generally based on International Specifications and adopted to Indian conditions. The list of IRS/RDSO Specifications issued by RDSO is available at the website of RDSO (www.rdso.gov.in). The IRS/RDSO specifications can be purchased from RDSO. The contractor shall submit the specification at the time of seeking approval of the equipment specification before procurement.

(3) For the Signalling system, the following specified standards (with latest versions and amendments) shall be followed. This list is indicative, contractor shall refer the latest approved specification.

SPECIFICATION NO.	DESCRIPTION
IRS SPECIFICATIONS	
S-6/81 along with drawings	Tubular Steel Signal Poles with Siganl base and Anchor bolts

S 23 - 88	Electrical and Electronic based Signalling and inter-locking equipment. Part 1: Technology & General requirements. Part 2: General requirements for Electrical Signalling & inter-locking equipment.
S 24 - 2002	Non-trailable electric point machine
S 26 - 64	Colour light signal, multi-unit type/Shunt Signal position light type
S 34 - 68	Testing Railway Signalling relays (General)
S 42 - 85	Axle counting equipment
S 63 - 2007	PVC insulated underground unscreened cables for Railway Signalling
S 66 - 84	Route indicator, direction type 5 lamp unit arm (1 to 6 way)
S71 - 87	Tag block
S 76 -89	PVC insulated indoor cables for Railway Signalling
S 93 - 96	Valve Regulated Lead Acid Stationary Battery &Charger for Railway S&T Installations
S 88-2004	Low Mainteneance battery for S&T Installation
S 101 - 90	Railway Signalling symbols
S105/2012	Block Proving by Axle Counter using UFSBI
IRS: S: 99/ 2006 Amendment 3	Datalogger system
TC-30/2005	Four / Six Quad Underground Jelly Filled Cables
TC-55-2006	24 Fibre Optic Fibre armoured cable
RDSO SPECIFICATIONS	
RDSO/SPN/144/2006	Safety & Reliability requirement of Electronic Signalling Equipment
RDSO/SPN/153/2011	LED Signal lighting unit
RDSO/SPN/165/2012 Ver -3	Integrated Power supply system (IPS)

RDSO/SPN/175/2005	Solid State Block Proving by Axle Counter (Digital)
RDSO/SPN/176/2013 Ver -3	Multi Section Digital Axle Counter
RDSO/SPN/177/2012 (Ver.3)	High Availability Single Section Digital Axle Counter
RDSO/SPN/189/2004	Terminal Blocks, Fuse terminal blocks and Miniature fuse links of international standard for Railway Signalling
RDSO/SPN/192/2019 Ver 2.0	Electronic interlocking
RDSO/SPN/199/2010	LED SignalL Lamps For Main Colour Light Signals (INTEGRATED) For Railway Signalling
RDSO/SPN/197/2008	Code Practice for Earthing and Bonding system for Signalling equipment
RDSO/SPN/204/2011	Double Walled Corrugated HDPE ducts for signalling cables
RDSO/SPN/209/2012 Rev.1.0 Ver. 2.0	Fuse Auto Change Over System
BRS 941A STS/E/Relays/AC Lit LED Signal/09-2002	Universal Plug-in type, tractive armature AC Lamp proving relay (metal to carbon) for 110V AC LED Signal Lamp
RDSO/SPN/217/2016 Ver. 1.0	Automatic fire detection and alarm system
RDSO/SPN/256	Earth leakage detector
EUROPEAN STANDARDS	
EN 50121 1,2,3,4	Railway applications - Electromagnetic compatibility
EN 50124 - 1	Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepagedistances for all electronic equipment
EN 50124 - 2	Railway applications - Insulation coordination - Part 2: Over-voltages and related protection

EN 50125 - 3	Railway applications - Environmental conditions for equipment - Part 3: Equipment for signalling and communications
EN 50126	Railway applications - The specification and demonstration of Reliability, Availability, Maintainabilityand Safety (RAMS)
EN 50128	Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems
EN 50129	Railway applications - Communication, signalling and processing systems - Safety related electronic systemsfor Signalling
EN 50159 - 1	Railway applications - Communication, signalling and processing systems - Part 1: Safety related Communication in closed transmission systems
EN 50159 - 2	Railway applications - Communication, signalling and processing systems Part 1: Safety related Communication in open transmission systems.
EN 60529	Specification for degrees of protection provided by enclosures (IP Code)
EN 50081 - 2	Electromagnetic compatibility - Generic Emission Standards - Part 2: Industrial Environment
EN 50123	Railway Application-Fixed installations .D.C. Switchgear. General
EN 50082 - 2	Electromagnetic compatibility. Generic immunity standard. Industrial environment.
EN 60364	Lightning and Surge protection
EN 61643	Lightning and Surge protection

EN 62305	Lightning and Surge protection
EN 60204 - 1	Safety of machinery. Electrical equipment of machines. General requirements

IEC 61000.4.2	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test and basic EMC
IEC 61000.4.4	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic fast transient/burst immunity test and basic EMC publication
IEC 61000.4.5	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Surge and immunity test
IEC 62278	Railway Applications- Specifications and demonstration of Reliability, Availability, Maintainability & Safety.
IEC 62279	Railway Applications-Communications, Signalling and processing systems-software for Railway Control and Protection Systems.
IEC 62425	Railway Applications-Communications, Signalling and processing systems- Safety Related Electronics Systems for Signalling.
IEC 62427	Railway Applications- Compatibility between Rolling Stock and Train Detection Systems
IEC 62280-1	Railway Applications-Communications, Signalling and processing systems — Safety related communication in closed transmission systems.
IEC 62280-2	Railway Applications-Communications, Signalling and processing systems - Safety related communication inopen transmission systems.
IEC 62236	Railway Applications — Electromagnetic compatibility (EMC)
IEC 60571	Electronic Equipment Used on Rail Vehicles
IEC 61373	Railway Applications — Rolling stock equipment — Shock and vibration tests
IEC 62305	Protection against Lightning
IEC 61992	Railway applications — Surge arresters and low-voltage limiters for specific use in. D.C. systems
IEC 60364	Electrical Installations for Buildings

IEC 62505	Railway applications — Fixed installations — Particular requirements for A.C. switchgear
ISO/TR 16982:2002	Ergonomics of human-system interaction Usability methods supporting human-centred design

ISO 11064 Parts 1-7	Ergonomics Design of Control Centres

4.1.3 Following manuals and schedules shall also be referenced during the design:

(1) Indian Railways Signal Engineering Manual (IRSEM).

(2) General Rules (GR) of IR.

(3) Subsidiary Rules (SR) of NR

(4) AC Traction Manual (ACTM) of IR.

(5) Indian Railways Permanent Way Manual (IRPWM).

(6) Schedule of Dimensions (SOD) of IR.

4.1.4 Following Indicative Typical arrangement drawings which are available in Appendix 17 of this document (NR Policy circular 02/2016 circulated vide their Letter No. 256-Sig/O/SG/Pt-XV Dated 22-08-2016) shall also be referenced during the design :

S.N.	Description	Drawing No.	Annexure of NR Circular
1.	TYPICAL MAIN CABLE DISTRIBUTION PLAN FOR DOUBLE LINE (4 LINES) PI STATION	SDO/CABLE LAYING/001	Annexure 1
2.	POSITION OF TRENCHES FOR CABLE LAYING	SDO/CABLE LAYING/002	Annexure 2
3.	CABLE TRENCH	SDO/CABLE LAYING/003	Annexure 3
4.	LAYING OF SIGNALLING CABLE & TELECOM/ POWER CABLE IN SAME TRENCH	SDO/CABLE LAYING/004	Annexure 4
5.	RCC DUCT 300 MM	NR/SIG/CABLE/001	Annexure 5
6.	RCC DUCT 500 MM	NR/SIG/CABLE/002	Annexure 6

7.	RCC DUCT 500 MM	NR/SIG/CABLE/003	Annexure 7
8.	LAYING OF CABLES IN ROCKY AREA	NR/SIG/CABLE/004	Annexure 8
9.	TRACK CROSSINGS	NR/SIG/CABLE/005	Annexure 9
10.	ROAD CROSSINGS	NR/SIG/CABLE/006	Annexure 10
11.	CABLE LAYING ON CULVERTS WITH LOW FLOOD LEVEL	SDO/CABLE LAYING/011	Annexure11
12.	CABLE LAYING ON CULVERTS WITH HIGH FLOOD LEVEL	NR/SIG/CABLE/007	Annexure12
13.	CABLE LAYING ON METALLIC BRIDGES	SDO/CABLE LAYING/013	Annexure13
14.	CABLE TROUGH FOR METALLIC BRIDGES	SDO/CABLE LAYING/014	Annexure14
15.	CABLE LAYING ON ARCH BRIDGES	NR/SIG/CABLE/008	Annexure15
16.	BRICK MASONRY CHANNEL FOR ARCH BRIDGE	SDO/CABLE LAYING/016	Annexure16
17.	ARRANGEMENT OF JUMPER CABLE	SDO/CABLE LAYING/017	Annexure17
18.	CI CABLE MARKER & CONCRETING	SDO/CABLE LAYING/018	Annexure18
19.	CI CABLE MARKER	SDO/CABLE LAYING/019	Annexure19
20.	CONCRETE CABLE MARKER	SDO/CABLE LAYING/020	Annexure20
21.	METHOD OF UNROLLING CABLE	SDO/CABLE LAYING/021	Annexure21
22.	RULE MADE OF PIPE FOR MEASURING TRENCH DEPTH	SDO/CABLE LAYING/022	Annexure22

4.1.5 Following Typical arrangement drawings shall be submitted by the contractor for approval of engineer:

(1) All the drawings/arrangement for the items mentioned in Para 4.1.4.

(2) Typical Earthing and Bonding arrangement for Indoor Signalling equipment.

(3) Typical Earthing, Bonding and Surge Protection arrangement for Location boxhaving Electronic equipment.

(4) Signalling System Architecture

(5) Foundation of Signals, Apparatus cases

(6) Installation drawing of signals

(7) Foundation of MSDAC DP

(8) Installation drawing of MSDAC DP

(9) Installation drawing of HASSDAC

(10) Installation drawing of Point machines

(11) Installation drawing of MSDAC evaluator, IPS, Battery, EI, VDU, Relay rack, CTR, MSDAC Reset box, BPAC etc.

4.2 Procurement

4.2.1 The contractor may procure items/equipment either locally (from India) or from the international market.

4.2.2 RDSO maintains an approved list of suppliers/vendors for various equipment/items/ components to be used on railway systems in India. The list of suppliers/vendors approved for various items are available at the website of RDSO (www.rdso.gov.in).

4.2.3 The list of applicable RDSO specifications is given in Para 4.1.2 of this document. If procured locally items shall be procured from RDSO's "Approved list of firms for manufacture and supply" and as per relevant specification. Before procurement model of equipment and vendor name shall be submitted by the contractor to the engineer for approval.

(End of Chapter-4)

CHAPTER 5: CONSTRUCTION REQUIREMENTS

5.1 General

5.1.1 The construction requirements establish the overall procedures for the Contractor to follow for the Works that is related to the components manufactured off-site and supplied for installation, assembling and wiring of the Permanent Works. These requirements relate to their Manufacturing, Supply and installation in the system and associated activities. The requirement given here are specific requirements to be read in conjunction with the general requirements given in this bidding document and GS (S&T).

5.1.2 The requirement of Construction/Installation Plan, Method Statement, Manufacturing/Procurement, Delivery, Storage and Installation at site are covered in detail in GS (S&T). The requirement given here are specific requirements to be read in conjunction with the general requirements given in this bidding document and GS (S&T).

5.1.3 The Contractor shall be required to demonstrate that the construction/installation system/procedure he has adopted would enable installation of equipment in the minimum time available commensurate with the project aims. The contractor shall identify and undertake the construction activities that are possible to be carried out away from the site and include them in his Construction/Installation Plan and Programme.

5.2 Installation

5.2.1 All the important Signalling equipment viz. Distributed architecture with object controllers of EI, MSDAC/HASSDAC, LED signals, IPS, Data loggers, Points Machines, BPAC, RDPM etc. shall be installed in accordance with RDSO/OEM's installation checklist. A certificate shall also be required to be issued by the OEM that the installation has been done in accordance with the Installation checklist and earthing and surge protection arrangements are adequate for satisfactory performance of the equipment. As far as possible the equipment's shall be commissioned after such a certificate has been issued by the OEM.

5.2.2 Indoor Installation

(1) All items of Signalling system comprising active electrical and electronic components shall, as far as possible be located in the Signalling equipment rooms.

(2) All wall-mounted equipment shall be installed at appropriate height to avoid any hazards to the person passing by. The Contractor shall ensure the fixture is of sufficient strength to hold the wall-mounted equipment in a secure and safe manner. Sufficient space shall be provided to allow for front maintenance access of the wall mounted equipment.

(3) All floor mounted equipment cabinets in the equipment room shall be securely bolted to ground, properly aligned and levelled. Racks/cabinets shall be suitably protected against entry of rodents, lizards etc. and also from effects of vibrations generated from train movements. All cable entries shall be sealed using suitable cable sealing system. The floor mounted equipment cabinets shall be arranged in a way to allow sufficient space at the front and rear side of the cabinets for maintenance access.

(4) The equipment layout within the equipment room shall be designed to:

(a) Allow sufficient clearance for escape out of the equipment rooms in case of emergency.

(b) Allow sufficient space at the front and at the back of the equipment for the

maintainer to attend to the equipment freely without obstruction.

(c) Allow required space around the equipment as mandated by the OEM/RDSO specification.

(5) The Contractor shall submit the following to the Engineer for review at least three months before the commencement of the installation inside the equipment room:

(a) Drawings showing the equipment layouts and positions of the racks,cabinets and enclosures.

(b) Racks, cabinets, layout drawings showing the arrangement of individual module.

(c) Specifications, sample of all the mounting brackets and accessories.

(d) Equipment mounting and installation methods.

(e) Schematic diagrams and wiring diagrams of the System.

(f) Electrical distribution schematics within the room including the earthing details and

(g) Cable route diagrams for cables within the room.

(h) Installation work inside the room shall be carried only after these submissions have been reviewed without objection by the Engineer.

5.2.3 Signalling Structures

(1) For housing the Signalling Indoor equipment, at least the following structures shall be provided at each location.

(a) Signalling equipment rooms (SERs) for housing Signalling equipment.

(b) Signalling Power Supply Equipment room for housing Signalling Power supply equipment.

(2) The installation layout of SERs shall be planned in such a way that number of indoor equipment units, their size and installation as per contractor's design for better utilization of space and same got approved by the Engineer. The layout of the SERs shall be determined keeping provision of a 19" rack for future provision for TMS/TCAS and further space for a 19" rack for any future expansion/modification requirement.

(3) The Signalling Equipment roomss and Signalling Power supply equipment rooms for housing the Central Interlocking Unit at Stations are being built under this package/other Package C1 as part of Station building. The Contractor shall coordinate with building contractor for construction of cable pit/duct for entry/exit of cable. The Station Building Plans are given along with the Drawings of Civil Works of this Document. The air-conditioning of SERs at Stations are being provided under this Package and for which too, the contractor should do the required coordination. The additional hut/structure if any, required for housing object controller/EI of distributed interlocking at the Station as per contractor design, shall be built by the Contractor.

(4) Opening/closure of Signalling Equipment rooms at the station shall be indicated on the SM's Control Terminal and Signalling maintainer's RDPM workstation at the Station.

(5) Arrangement for remote monitoring of the air-conditioning system, temperature- regulator equipment and air-circulation equipment of Signalling Equipment Rooms, Telecom Equipment Rooms and Signalling and Telecom Power supply Equipment rooms shall be provided, as part of RDPM system

(6) Portable Fire Extinguishers shall be provided in all the Signalling Equipment rooms,

Telecom equipment room, Battery room, SM room, Signal maintainer room and Power supply equipment rooms at the Stations. Portable fire extinguishers shall be compliant to NFPA 10 standard or better and suited for electrical equipment fires.

(7) Automatic fire detection & alarm system will be provided in all Signalling Equipment rooms, Telecom equipment room, Battery room, SM room, Signal maintainer rooms and Power supply equipment rooms at the Stations and all TSS/SP/SSP's, the arrangement for remote monitoring of this system shall be provided, as part of RDPM system.

5.2.4 Outdoor Installation

(1) All the ducts/ troughs/pipes for laying cables will be provided by the contractor.

(2) All the ducts/ troughs/pipes for laying cables will be provided by the contractor.

(3) All the mounting brackets and accessories shall be corrosion resistant, aesthetically designed to match with all architectural finishes and of sufficient strength to mount the equipment securely.

(4) If the equipment is installed at locations exposed to direct sunlight, the equipment, mounting brackets, cables and accessories shall be made of materials which are resistant to ultra violet rays.

(5) All trackside equipment and the mounting method shall be designed in a way to minimize frequency of preventive maintenance and theft and vandalism.

(6) The Contractor shall submit the following to the Engineer for review at least three months before the commencement of the outdoor installation activities:

(a) Specifications, sample of all the mounting brackets and accessories.

(b) Equipment mounting and installation methods and

(c) Schematic diagrams and wiring diagrams of the System.

5.3 Signalling Cable Laying, Termination and Testing

5.3.1 Signalling Cables

(a) The Cables for carrying outdoor Signalling circuits shall be PVC insulated, PVC sheathed and armoured unscreened cable conforming to IRS specification. The cable conductor shall be of annealed copper having minimum cross sectional area of 1.5 sq. mm.

(b) The Cables for carrying Signalling power supplies outdoor shall be copper conductor, minimum conductor size 16 sq. mm, PVC insulated armoured, unscreened, underground power cable as per IRS specification IRS: S-63/2007 & IS: 1554 (Part-2). The size of conductor shall be so selected as to suit the electrical load.

(c) The Quad cable used for Axle Counter circuit shall be 4/6 quad Telecom underground Jelly filled cable as per IRS specification.

(d) The Optic Fibre Cable for the Signalling system shall be provided as per IRS/RDSO Specification. The Signalling system shall interface with the Telecommunication system for the same.

(e) Indoor cable/wire used shall be single/multi core, plain annealed high conductivity copper conductor, PVC insulated unarmoured as per IRS S-76/89. All electronic equipment shall however, be wired as per the requirement of the relevant RDSO

specification of the equipment and /or as specified by the OEM. The Q style relays shall be wired with 16/0.2 mm multistrand wire. The contractor shall take prior approval of Engineer if indoor cable/wire other than RDSO approved are proposed to be used.

(f) All cables shall be adequately rated for their current carrying capacity. All power cables shall be able to withstand full load current for peak operation. The Contractor shall comply with the latest edition of IEE Wiring Regulations.

(g) A labelling scheme shall be applied for all cables installed. Each cable shall be uniquely identified. Labels shall be tied at both ends, at entry and exit points of cable trays, ducts and trenches and at other appropriate locations where necessary. Type of labels to be used shall be got approved from the Engineer.

(h) The DWC-HDPE pipe/duct used for protection of Signalling cables below the track, on the slope of embankment for crossing bridges or any other place shall be supplied as per RDSO specification.

(i) GI Pipe shall be provided on the top level of major OWG bridges. On embankment if cable protection with concrete cover is not possible then GI pipe with suitable support shall be provided.

(j) Signalling cables shall be protected with RCC duct with cover in Station area from Home to Home Signals of the station area as given in Appendix 17 Annexure 8.

(k) Outside station area i.e. beyond Home Signals, the signalling cable shall be protected with bricks of good quality.

(l) Signalling and Telecom cable shall be laid in separate trenches to the extent possible. If not possible a brick separation shall be provided. Telecom cables shall be laid on both sides of the track

5.3.2 Cable core allocation

(a) A cable core distribution plan shall be prepared for each installation.

(b) Preferably 6/12/19/24 core out door signalling cables shall only be used to keep low the inventory requirement.

(c) Adequate spare conductors to a minimum of 20% of the total conductors used shall be provided for in each main cable. All branch/tail cables shall have at least 10% spare cores or 2 cores, whichever is more. The spare conductors shall be provided in the outermost layer. All spare cores shall be made through up to the end points and terminated.

(d) Where a number of cables have been used, the circuits shall be so distributed that the cables can be disconnected for maintenance purpose with the least possible dislocation to traffic. Line wise and if necessary, function wise cables shall be provided.

(e) A separate cable shall be used for operation of each point/crossover. Operation and detection circuit shall work on different cables.

(f) UP and DN track vacancy detection systems shall be in different cables.

(g) The quad cable used for signalling functions and emergency communication shall also have 20% (of the total conductors used) spare conductors.

5.3.3 Cable Route Plan

(a) After deciding the size and the number of conductors in the different types of cables to be used on a route, a foot survey along the track shall be done to determine the best route for the cable.

(b) While planning the cable route, any future yard modification etc. shall also be kept in view.

(c) As far as possible low-lying areas, platform copings, drainages, hutments, rocky terrains, points and crossings, shall be avoided.

(d) The cable route plan shall show the actual alignment of track, giving offsets from permanent way or permanent structures at regular intervals. The diagram shall indicate the various road and track crossings, crossing with electric power cables, water and sewage lines and other items of importance.

(e) All cable routes shall be carefully coordinated with all the interfacing parties. The cable trenching work shall be taken in hand only when the cable route plan has been approved by the Engineer.

(f) The cable shall be laid in the HORC/IR land only.

5.3.4 Storing & transportation of cable

(a) Cable drums shall not be stacked on flat side. Suitable stoppers shall be placed for stability.

(b) Cable drums shall have easy access for lifting and moving.

(c) When rolling the cable drum either for unloading or transportation, the drum shall always be rotated in the direction of the 'arrow' which is marked on the drum.

(d) The drums shall not be rolled over objects that could cause damage to the protective battens of the cable.

(e) When unloading is carried out from the vehicle the drum shall not be dropped on the ground directly to avoid damage due to impact. Fork lifter or ramp shall be used.

(f) During all stages of storage, it is essential that the ends of the cable are effectively sealed by end cap or in any other approved manner to avoid water entry into the cable.

(g) It is desirable that cable drums are stored in covered shed to protect against direct exposure to sun/rains.

5.3.5 Paying out the cable

(a) For paying out cables, the cable drums shall be mounted on cable wheels. It shall be ensured that no kink is formed while paying out the cable.

(b) Cable drum shall never be kept on its side and cable uncoiled since this can result in twisting of cable conductors resulting in damage to them.

(c) The drum on the wheel shall be brought to one end of the trench and the end of the cable freed and the cable shall be laid along the trench.

(d) The cable drum shall be brought as close to the cable trench if possible. The cable drum shall clear the ground by 5 to 10 cm.

(e) The wooden battens on the drums shall be carefully removed shortly prior to laying and before the drum is mounted on the jack.

(f) A party of labourers shall move along the trench carrying cable at suitable intervals so that cable is not damaged due to dragging along the ground or bent unduly.

(g) The in-charge of cable laying shall ensure proper synchronization of all labourers for smooth laying.

(h) In cases where the wheels are not available, the drum shall be mounted on an axle at one end of the trench and cable paid out and carried by labourers.

(i) In no case, shall the drum be rolled off on to the road for laying the cable and the cable dragged on the ground for laying purposes.

(j) Whenever mechanized equipment is used, the work shall be carried out by a trained operator under the supervision of the Engineer or its authorized representative.

(k) Where the cable drum is in damaged condition the cable may be placed on a horizontal revolving platform and the cable paid out in the same manner as given in paras above.

(l) Paying out of cable shall be done by rotating the cable drum and not by pulling the cable with excessive force.

(m) Wherever flaking of cable is required, it shall be done by making a succession of loops in the form of Figure '8', these loops being disposed on top of each other to avoid tangling of cable. Figure of '8' flaking shall only be carried out under the direct supervision of an experienced official.

5.3.6 Excavation and backfilling of the trenches

(a) Manual trenching is recommended for laying of Signalling cables in the station yards from Home-to-Home signal and mechanized trenching is recommended from Home signal and beyond.

(b) Digging of trench between IR track and HORC track shall be manual or mechanized as proposed by the contractor as per site survey/feasibility and approved by the Engineer for every Station & Block section separately.

(c) Excavation of cable trench shall be made in all kinds of soils including clearing roots of trees, rocks, etc. During excavation, the earth of the trenches shall not be thrown on the ballast. The earth shall be thrown by the side of the trenches away from track.

(d) Trenches shall be straight as far as possible and steep angles shall be avoided.

(e) The width of manually made cable trenches shall be commensurate with number of cables. The minimum width shall be kept as 0.3 metres.

(f) It is desirable that the excavation of the trenches is not done in long lengths and does not remain uncovered for long period. It is preferable that cables are laid and refilling done on the same day.

(g) Before commencement of the laying, inspection of the trench and inspection of protection works shall be carried out by the Engineer so as to ensure their conformity with the specification.

(h) After cable has been laid and until the whole of the cables to be laid in the trench have been covered with their protective covers, no sharp metal tool such as spades, crowbar or fencing pins shall be used in the trench or placed in such a position that they may fall into the trench.

(i) For road/platforms/railway track crossing, trenchless horizontal directional drilling (HDD) technique shall be adopted under the supervision of competent staff for laying of RCC/GI/DWC-HDPE pipe. Both ends of RCC/GI/DWC-HDPE pipes shall be closed properly using accessories and the pits shall be properly backfilled. There shall be no damage to the road/platform/tracks or any such structures etc. enrooted during or after the HDD

operations.

(j) Backfilling of the trenches shall be done properly. The earth excavated shall be put back on the trench rammed and consolidated.

5.3.7 Cable Laying underground

(a) The cables may be laid underground, either in the trench, in ducts, in cement troughs, in pipes or in any other approved manner.

(b) Cable laying in ducts-RCC ducts be used for laying the cable from Home-to-Home Signal in Station yard. The ducts shall have suitable covers and shall rest on walls of duct as per Appendix 17 Annexure 10 of this document.

(c) The cables shall generally be laid keeping in view all the relevant provisions of Signal Engineering Manual of IR and the Joint Procedure order for undertaking digging work in the vicinity of S&T underground cables (Appendix 17 Annexure 1 and Appendix 18 of the document).

(d) Before commencing work on any part of the site, the Contractor shall ascertain that the Engineer and also, where applicable, the local and statutory authorities or other bodies/persons concerned have reviewed the cable route. The Contractor shall further ensure that all necessary permits in such cases have been obtained and notices served.

(e) Every precaution shall be taken to ensure that cables and equipment are not installed in a manner or under conditions likely to cause electrolytic or other corrosive action or damage to, or be detrimental to, the performance of the cables and equipment during operation.

(f) Signalling cables shall not run with cables carrying high voltages or heavy currents and shall conform to the requirements specified in BS 7671.

(g) Signalling tail cables shall be mechanically protected by DWC pipe to avoid being damaged from track side maintenance activities and shall be immune to any malfunction from electromagnetic interference.

(h) All cables shall be laid along the track preferably one metre inside the HORC/IR boundary. If it is necessary to lay the cable outside the HORC boundary it shall be laid on the berm with interface with civil contractor under this Package as well as Package C 1 with the approval of the Engineer. After back filling Compaction of the formation shall be done properly.

(i) The cable laid parallel to the track shall be buried at a depth of minimum 1.0 metre (top most cable) from ground level However, in case of rocky soil, the depth may be reduced suitably with pre cast cement concrete slab of minimum 10 cms. thickness provided for protection of cables. When it concerns the laying of tail cables which serve the track apparatus etc., the depth shall not be less than 0.50 metres.

(j) No sharp object like stone chips, iron pieces etc. shall ever come in contact with laid cables irrespective of the method of laying the same. The bottom of the cable trench shall be levelled and got rid of any sharp materials. In the soft ground, the cable shall be laid at the bottom of the trench previously levelled. In both the above cases, the cable shall be covered with a layer of sand or sifted earth of 0.10 metre thickness and thereafter a protective cover of trough or a layer of bricks shall be placed in block section and half split DWC pipe in station area shall be placed.

(k) At each end of the main cable an extra loop length of 4 to 5 metre shall be kept.

(l) Before starting cabling work, location boxes shall first be erected so that cable after laying

is directly taken inside location box and its multiple handling/damage by re-digging and taking inside location box/Signal equipment Room is eliminated.

(m) Signalling and Telecom cable shall be laid in separate trenches to the extent possible, however if laid in same trench a brick separation shall be provided. Telecom cable shall be laid on both side of the Railway track.

5.3.8 Cable Laying in Electrified area

(a) The cable shall be laid at not less than one meter from the nearest edge of the mast foundations supporting the catenary or any other live conductor, provided the depth of the cable does not exceed 0.5 meters with suitable cable protection measures provided. When the cable is laid at a depth greater than 0.5 metres, a minimum distance of 3 metres between the cable and the nearest edge of the O.H.E. structure shall be maintained. If it is difficult to maintain these distances, the cable shall be laid in concrete/heavy duty HDPE/Ducts or any other approved means for a distance of 3 metres on either side of the Mast. When so laid, the distance between the cable and mast may be reduced to 0.5 meters. The precautions are necessary to avoid damage to the cable in the event of the failure of an overhead insulator.

(b) In the vicinity of traction sub stations and feeding posts, the cable shall be laid at least one metre away from any metallic part of the O.H.E. and other equipment at substation, which is fixed on the ground, and at least five metre away from the substation earthing. In addition, the cable shall be laid in RCC pipes/or other approved means for a length of 300 metres on either side of the feeding point. As far as possible, the cable shall be laid on the side of the track opposite to the feeding post.

(c) In the vicinity of the SP/SSP, the cable shall be laid at least one metre away from any metallic body of the station, which is fixed in the ground, and at least 5 metres away from the station earthing. The distance of 5 metres can be reduced to one metre provided the cables are laid in RCC/GI/DWC/HDPE pipes or any other approved means.

(d) Where an independent Earth is provided for an OHE structure, i.e. where the mast is connected to a separate Earth instead of being connected to the rail, the cables shall be laid at least one metre away from the Earth.

(e) Where there are O.H.E. structures along the cable route, the cable trenches shall as far as possible, be dug not less than 5.5 metres away from the centre of the Track.

5.3.9 Laying of different type of cable in same trench

(a) The OFC cable shall be laid/blown in lubricated HDPE pipe as per Telecom manual. The cables other than OFC may be laid directly in the same trench (both Signalling & Telecom cables).

(b) Where several cables of different categories have to be laid in the same trench, they shall be placed as far as possible in the following order starting from the main track side, so that in the event of failures, the maintenance staff may easily recognize the damaged cables: -

(i) Telecommunication cable

(ii) Signalling cable

(iii) Power cable of S & T

(c) A distance of approximately 10 cm must be maintained between Telecommunication cable and Signalling cables. The Signalling cables must be separated from power cables/Telecom cables by a row of bricks placed between them as per sketch shown in Annexure 7 of Appendix 17 of this document.

5.3.10 Cable laying in ducts

(a) When cables are laid in rocky area, it is desirable to protect them with split RCC ducts/Cocrete cover of suitable design.

(b) Cables for longer distances shall be laid on bottom layer. Duct shall be filled with sand after cable is laid to avoid entry of rodents.

(c) The ducts shall be of such design as to prevent collecting the water in the duct.

(d) Cables in any conduits, trunkings or ducts shall not occupy cross-sectional space in excess of 50%.

(e) When cables are laid in trunking/RCC duct, care shall be taken to see that no ballast or stones have been dropped inside the trunking/RCC duct. The trunking/RCC duct shall be cleared of all ballast and stones before the cover are secured. When the ends of covers are joined together with cement plaster, a piece of paper or wood shall be placed under the joint to prevent the cement plaster from falling on the cable.

(f) After placing the trunking/RCC duct in the trench the ducts have to be aligned using 8 mm rod. For this purpose, a hole is left in the trunking/RCC duct for insertion of rods. Wherever there is a diversion proper care shall be taken to cover the cables, either by smoothly forming a curve with duct or a masonry structure can be constructed to protect the cables. After laying of cables the ducts shall be covered with RCC slab and shall be continuously plastered at the end with trunking/RCC duct.

(g) Where it is necessary to take the cables between the tracks, it shall be carried in trunking/RCC duct kept sufficiently below the ballast level.

(h) In station area the S & T cables shall be laid in RCC duct as per sketch given in Annexure 9 of Appendix 17 of this document.

5.3.11 Cable Laying in Solid & Rocky soil

(a) In case of rocky soil, the depth may be reduced suitably.

(b) Sharp edges on the sides must be smoothened out and bottom of the chase shall be levelled. In the rocky ground the cable shall be laid normally on layer of sifted earth of 50 mm thickness previously deposited at the bottom of the trench. Cable shall be covered with the layer of sand or sifted earth of 100 mm thickness.

(c) In case sharp edge of rocky ground cannot be protected with sifted earth, concrete/ RCC/GI/DWC-HDPE pipe shall be used if numbers of cables are small. If number of cables is large, RCC duct shall be used. In isolated cases, it can be given smooth surface by using either masonry bricks or cement concrete.

(d) A row of bricks shall then be placed lengthwise on the top and jointed with cement mortar and a layer of concrete with cement plaster shall be provided on the top of the same.

(e) A sketch showing laying of cables in rocky area is placed at Annexure-11 of Appendix 17 of this document.

5.3.12 Laying in special soil condition

Cable shall not be run through abnormally high acidic or alkaline soil or through sewages. If this is unavoidable special measures shall be taken to prevent corrosion. Cable may be laid in the concrete/ RCC/GI/DWC-HDPE pipes properly jointed to prevent ingress of moisture.

5.3.13 Cable laying in residential area

When laying the cable in residential area, the cable shall be specially protected on both sides up to a distance of about 50-100 metres beyond the building line subjected to approval of Engineer. In such cases, the cable shall be protected by means of concreting of 50 mm as proposed for rocky soil/ in concrete/ RCC/GI/DWC-HDPE pipes. This is better than using bricks as in a residential area bricks are usually found while digging and its special significance of cable protection may be overlooked.

5.3.14 Track crossing

(1) As far as possible, the cable shall be crossed from one side of the yard to theother, at minimum number of locations.

(2) Track crossing shall be through trenchless method. The following precaution shallbe taken:

(a) The cable crosses the track at right angles.

(b) The cable does not cross the track under points and crossings.

(c) The cable is laid in concrete/RCC/GI/DWC-HDPE pipes or suitable ductsor in any other approved manner while crossing the track.

(d) Cable laid across the track must be 1.0 metre (minimum) below the groundlevel.

(e) No digging shall be done below the sleepers.

(f) A sketch showing track crossing is placed at Annexure-12 of Appendix 17 of this document.

5.3.15 Road crossing

(1) Road crossing shall be done through trenchless method. The cable shall be laid in concrete/ RCC pipes or in any other approved manner while crossing the road at the depth of 1 metre from the ground level. It shall extend 1 metre (minimum) on each side of the road keeping in view the future increase of width of the road.

(2) When crossing roads, it is necessary to lay the cables in such a manner as to avoid the necessity of bending the cable sharply and minimize the excavation of road surface as far as possible.

(3) The crossing of main roads often involves difficulties, especially if traffic is heavy. Precautions to avoid accidents to workmen, pedestrians and vehicles shall be taken. On minor roads, which can be temporarily closed to traffic it is possible to open up across the entire width of the road, pipes shall be installed quickly in the cutting, which is then filled in there by reducing to a minimum the time for which the road is closed.

(4) Some roads, which are broad, may be opened for half their width allowing the other half for use of traffic, pipes are laid, trench filled in the first half and the other half opened up after the first half is opened half is linked with those laid in the first half.

(5) Whenever a cable is laid across an important road, particularly one with a special surface, space for future expansion may be provided. Either of the following methods may be adopted:-

(a) The size of the pipe shall be so chosen that provision for laying of additional cables in future is kept. Pipes having diameters ranging from 100 to 200 mm are suggested, or

(b) A spare pipe may be laid, through which a cable can be drawn when required. It will be advantageous to leave a lead wire of G.I wire in the pipe for drawing the cable in future.

(1) A separate pipe of suitable diameter shall be used for telecommunication cable.

(2) A sketch showing track crossing is placed at Annexure 12 of Appendix 17 of the document.

5.3.16 Cable laying on bridges/culverts

(1) Wherever practicable, the cable may be taken underground across the drain bed at a suitable depth for crossing small culverts with low flood level. A sketch No. showing cable laying on culverts with low flood level is placed at Annexure-14 of Appendix 17 of this document. Wherever cable may not be taken underground across the drain bed, cable shall be taken on the approach slopes of culvert through GI pipe of suitable sizes with concrete cover and blocks. A sketch No. showing cable laying on culverts with high flood level is placed at Annexure-15 of Appendix 17 of this document. The Civil contractor of this Package/Package C 1 shall provide ducts on the concrete bridges and culverts on both sides. The same may be used by the contractor for laying of S&T cables. The cables in these ducts shall be laid in HDPE/DWC pipes.

(2) When cables have to cross a metallic bridge, they shall be placed inside a metallic through which may be filled, as an anti-theft measure, with sealing compound. The cable shall be supported across the bridge in a manner which would involve minimum vibrations to the cable and which will facilitate maintenance work. Adequate cable length to the extent 5 to 6 meters shall be made available at the approaches of bridge. A sketches showing cable laying on metallic bridges are placed at Annexure-16 & 17 of Appendix 17 of this document.

(3) In case of arch bridges, cable shall be taken through GI pipes on top of the arch adjoining the parapet wall. The pipe shall be covered with ballast. Cement Concreting of 50 mm shall be done throughout from entry/exit end of cable up to diversion point including slope on either side. The entry and exit ends of the cable from the pipe to the diversion point of the cable shall be concreted for 1 metre (minimum). A sketches showing cable laying on arch bridges are placed at Annexure-18 & 19 of Appendix 17 of this document.

(4) On minor RCC box Bridges , 300mmx300mm conctrete duct on the both side of Railway Tracks will be provided by Civil Structure Contractor of Package C 1 and of this Package for laying of cables. All Outdoor Signalling cables and Telecommunication Cables (OFC cable,Telecom Quad Cable & PIJF Telephone Cables etc.) on these Concrete Bridges & Culverts shall be laid inside DWC Pipes. OFC cable shall be laid inside the HDPE duct. Entry/Exit of the Cables to/from Bridges & Culverts shall be suitably protected by concrete cover. The Contractor shall carry out necessary co-ordination with Civil, Structure (C 1 and this Package) & Track Contractor (T 1) in this matter. Cable shall be laid in Double Wall Corrugated Pipes in the slope to climb from ground to top level of bridges. It shall be so laid to maintain a continuous depth of 1 meter (top of DWC Pipe) from the nearest ground level. The slope of track formation shall be restored to its original condition after laying of cables. On Major OWG bridges, GI pipe shall be laid on the top level of the bridges.

(5) As the laying involves movement of a large number of staff over the bridge the line shall be blocked and flagman posted on other side. On a double line only the line near which cable is being laid shall be blocked but care shall be taken to see that staff is aware of this and measures taken to prevent staff from straying on to the unblocked line.

(6) Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation, pier of bridge to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

(7) In order to prevent theft and miscreant activities on approach of cable to bridge/culvert where it is not possible to ensure adequate depth, concrete protection is proposed.

(8) To cross the bridges full DWC pipe shall be provided on the slope at the distance of about 500mm from the retaining wall. On top of the bridge with concrete duct DWC pipe shall be provided to protect the signaling/ Telecom cable.

5.3.17 Cable Laying in monsoon season

(1) Cable laying in monsoon when the precipitation is heavy shall be avoided. The trenches will be inundated and visual inspection of the bedding of the trench will be rendered difficult. Threading the cable in pipes will also be more difficult.

(2) When cable laying is necessary during the rainy season, the cable ends shall be inserted in a pipe sealed at one end and the pipe buried. Termination work shall be started only when there is likelihood of a clear weather for three to four days.

5.3.18 Laying of cable above ground

(1) Signalling cables for outdoor circuits shall not normally be laid above ground. In exceptional cases where it becomes unavoidable, the following precautions shall be taken:

(a) The cable shall be suspended in wooden cleats, from cable hangers or in any other approved manner so that no mechanical damage occurs to the cable even under exposed condition.

(b) The cable supports shall be so spaced as to avoid sag.

(2) Indoor Signalling cable shall normally be laid on ladders, channels or in any other approved manner. The cables shall be neatly tied/ laced.

(3) In AC electrified areas cables shall be laid underground only. For laying cables in RE area instructions laid down in IRSEM shall also be followed.

5.3.19 Cable markers

(1) Underground Cable Route shall be identified by Electronic Cable route Markers directly buried inside the trench at 100 m interval and at diversion and track crossing points with in the Station section from home to home with the approval of Engineer. Outside station section normal concrete type cable route route marker as per sketch given in Annexure 23 of Appendix 17 of this document and Electronic cable route markers alternatively shall be provided at every 50 m interval and at diversion and track crossing points with the approval of Engineer It shall also be provided at entry/exit of track/road crossing etc., during crossing of bridge on the ground level, on mid of slope, at diversion etc.

5.3.20 Entry of cable at cabin, relay room, location boxes etc.

(1) All cable entry points in the Signal/Telecom Equipment room, battery room, SM's room, location boxes, junction boxes etc. shall be properly sealed using modular based cable and pipe sealing system/other approved means. All cable entries from/to adjacent rooms through overhead duct/ladder shall also be sealed.

(2) All cable entrance ducts must be closed with suitable masonry works, sand covered and plastering to prevent entry of rats etc. RCC slab shall be provided on the cable pit of the Signalling/Telecom equipment rooms at the Stations.

(3) Cable shall be protected on both sides up to a distance of 10 metre beyond building line of Signalling/Telecom equipment rooms and battery room SM's room.

(4) Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation/masonry to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

5.3.21 Termination of cables

(1) No jointing of Signalling cables is permitted. All cables shall be terminated.

(2) The cable termination of Signalling cables shall be undertaken on approved type of terminations with ease of maintenance and disconnection facility on CT racks/ location boxes/junction boxes.

(3) All wire and cable conductors shall be clearly identified and numbered at each end using durable shrink on or tag type labels. A description of the terminating function shall be included. Each core so terminated shall be provided with identification marking on cable and on conductors/terminals and ferrules with letters or/numbers embossed on them as per requirement of circuitry. This will enable easy identification of conductors in case of any failures or cable disconnections or cable cut by outsider/miscreants. A proper marking and termination practice ensures quick and easy restoration during failures.

(4) Unused cable cores/pairs of multi-core/pair cables shall also be terminated and marked so.

(5) Crimping or other standard industry practice shall be used for terminating all conductors. Solder terminations shall only be used with the approval of the Engineer.

(6) Wherever practical, multiple pin plugs and sockets shall be used to connect multi- core cables and wiring loops to all items of equipment. These shall have some form of keying to prevent incorrect equipment modules from being installed.

(7) The cable terminations shall be secured enough to withstand vibration level that is likely to be experienced in the HORC environment.

5.3.22 Cable Termination Rack (CTR) and Location Box

(1) Cable Termination Rack (CTR) with 20% extra capacity for future expansion shall be provided.

(2) Only screw less terminals with isolation facility shall be used for cable terminations. The terminals and fuses used shall meet the requirements of RDSO specification No RDSO/SPN/189/2004 with latest amendments. If any alternative terminal type is proposed for use, it should be got approved by Engineer.

(3) All external power/ signalling / data lines susceptible to lightning or high induced voltage shall be provided with Stage 3 surge protection devices as per Para 5.5 of this specification.

(4) The Cable Termination Rack (CTR) shall be equipped with copper earth bar to which all cable shields shall be connected and soldered. The copper earth bar shall be connected to the earth.

(5) The Outdoor cables shall be terminated in Location Boxes.

(6) Location boxes shall be rugged and free from ingress of rodents, insects, dust, moisture and water.

(7) Location boxes shall be able to withstand vibration level, likely to be experienced alongside the track.

(8) Location boxes shall be theft and vandal proof as far as possible and shall be able to withstand the climate of the region.

(9) Cable entry points in the location boxes shall be filled with sand and plastered with cement.

(10) Separate Location boxes shall be used for UP and DN line cables.

(11) All location boxes shall be provided with 110 V AC LED lighting arrangement with ON/OFF switch to assist maintenance/repair work undertaken during night.

(12) The installation of Location boxes shall not be done on loose earth. It should be installed on proper concrete foundation. The foundation drawing shall be proposed by theContractor and approved by the Engineer.

5.3.23 Testing of cable

(1) Before the cable is laid in the trench, a visual inspection of cable shall be made to see that there is no damage to the cable. It shall be tested for insulation and continuity of the cores. Thereafter, the cable shall be laid into the trench. Record of insulation and loop resistant must be maintained.

(2) Testing of all main and tail cables after laying of the cable in trenches and also after termination in apparatus cases, in boxes and relay room shall be done.

(3) If any defect is noticed during the testing after laying the cable the same shall be replaced.

(4) The insulation resistance tests shall be made when conductors, cables and insulated parts are clean and dry. An insulation tester shall be used for insulation testing. Any metallic sheath or metal work of any rack or apparatus case shall be bonded to earth during test.

(5) Insulation Resistance so measured shall not be less than 5 mega ohms per km at buried temperature. If the insulation resistance is found to be lower than 5 mega ohms, the cause shall be investigated and immediate steps taken to repair or replace the cable to prevent any malfunctioning of the equipment and circuits.

5.3.24 Supervision of cable laying

(1) The work shall be supervised personally by an official authorized by the Engineer. The cable trench shall be inspected by the authorized person and jointly signed by him/her and the Contractor's authorized person before cable laying is undertaken on the request for inspection (RFI).. The record of joint inspection of the trench shall be maintained.

5.4 Earth Leakage Detector (ELD)

(1) ELD shall be provided to detect earth faults in the Signalling cables and circuits.

(2) ELD and alarms shall be provided at all the Signalling equipment rooms at the stations and at the IBS.

(3) ELD provided should cover all the Signalling cables and DC/AC power supplies/cables.

5.5 Earthing and Bonding

(1) General

(a) Earthing shall be provided for all Indoor & Outdoor Signalling installations to achieve the following objectives:

(i) Efficiently dissipate heavy fault currents and electrical surges, both in magnitude and duration, to protect equipment from being damaged so as to minimize down time, service interruption and replacement cost.

(ii) Provide a stable reference for electrical and RF circuits at the installation to minimize noise during normal operation.

(b) Protection of personnel who work within the area from dangerous electric shock caused due to "step potential" or "touch potential".

(c) To achieve the primary goal of assuring personnel safety and damage control, a low impedance path shall be made available to the current generated due to lightning or power system fault. The potential differences between any two points shall be as low as possible. Safety considerations also require the equipment chassis or enclosure to be earthed to minimize shock hazards to system staff.

(d) To achieve the secondary goal of providing protection for sensitive and interconnected electronic and electrical systems, earthing shall be designed to minimize the noise voltage generated by currents from two or more circuits flowing through common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potential.

(e) The Earthing and Bonding system shall meet or exceed the requirements of IEEE 1100, NFPA 780, IEC 62561-7 and IEC 62305.

(f) To minimize the effect of circulating earth loops and to provide equipotential bonding, "star type" bonding connection shall only be provided as required.

(g) The contractor shall submit the design for Earthing and Bonding of Signalling and Telecommunication systems for review and approval by the Engineer. OEM's original data sheets of the proposed devices shall also be submitted along with the protection methods adopted in their design.

(2) Indoor Signalling installation

(a) The Equipment rooms housing Indoor Signalling equipment and their Power supply shall be provided with suitable Earthing and Bonding system.

(b) There shall be one equi-potential earth busbar for each of the equipment rooms viz. Signalling equipment room, Power supply equipment room etc. The equi- potential earth bus bars located in individual rooms shall be termed as Sub equi- potential busbars (SEEB). The equi-potential earth bus bar located in the Power supply equipment room directly connected to Class 'B' SPD and the main earth pit shall be termed as Main equi-potential earth busbar (MEEB).

(c) The EEB shall have pre-drilled holes of suitable size for termination of bonding conductors. The EEB shall be insulated from the building walls using low voltage fire resistant insulators. All terminations on the EEBs shall be using copper lugs with spring washers.

(d) All the equipment/racks in the Equipment room shall be directly connected to its SEEB. Each of Sub-equipotential earth busbar (SEEB) installed in the rooms shall be directly connected to Main equipotential earth busbar (MEEB) using bonding conductors.

(e) The routing of bonding conductors from equipment/racks to SEEB and from SEEB to MEEB shall be as short as possible and direct with minimum bends and separated from other wiring. The connection from SPD to MEEB shall be as short as possible and preferably without any bend.

(f) The connection between any two moving parts, like doors with Bonding Ring Conductor, etc. shall be connected by 316L Stainless Steel Flexible braids, which are UL listed, RoHS compliant and meeting IEC 60439.1 & IEC 61439.1.

(g) All bonding connections, whether it is from equipment or SPD to respective lugs on

bus bars or of the Main earth bond with the Main Earth electrode, shall be with stainless steel nuts and bolts and exothermic welding while keeping in mind the conditions of UL listing, IEEE 837 & tamper proof weld metals.

(h) The Earthing system shall use maintenance free loop earth as per specification RDSO/SPN/197/2008 and shall be designed to give an earth resistance of less than 1 ohm. The design should be based on calculation methods as per IEEE 80 which require the parameters like target ohmic resistance value, soil resistivity, electrode length, electrode diameter etc. SM room equipment, Signalling equipment rooms/Object controller equipment room etc. shall be connected with this earth.

(i) The earth electrode shall be made of high tensile low carbon steel circular rods, molecular bonded with copper on outer surface to meet the requirements of UL 467. The Ground Enhancement material should meet the requirement of IEEE 80's Clause 14.5 (d) and should be tested as per IEC 62561-7 standard. All the earth electrodes shall be bonded together using Galvanized Steel tapes or Copper Bonded Steel Conductors of suitable size in continuous length of max. up to 100 metre to achieve equipotential bonding. For Power supply equipment, MSDAC equipment etc. separate maintenance free earthing arrangement shall be provided.

(j) Despite the provision of earthing, as specified above, if failures of Solid state electronic equipment occur on account of finite earth resistance, particularly due to high voltage transients and lightning, further protection as necessary shall be provided.

(3) Outdoor Signalling installation

(1) All the Outdoor Signalling equipment viz. Signals, Location boxes etc. shall be provided with suitable Earthing arrangement with earth value < 5Ω.

(2) The target earth resistance value for outdoor Signalling equipment shall be in accordance with the requirement specified for the equipment by the OEM/RDSO specification.

(3) The Signalling equipment having Solid State components and the enclosures housing them shall be provided with maintenance free earth using copper bonded steel electrode, earth enhancement compound and bonding connection through exothermic welding as per specification RDSO/SPN/197 with latest version and amendments. Each MSDAC DP shall be provided separate one maintenance free earth electrode or more with Earth value shall be <1Ω.

(4) In order to arrive at the required target resistance value, the number of earth electrodes should be decided based on the calculations involving soil resistivity as per the standards above, all interconnected in parametric ring form or in parallel manner.

(5) Where the equipment to be earthed are in close vicinity they should be connected to a common earth in star configuration.

(6) For outdoor Signalling items installed in Location boxes, one earth busbar of suitable size shall be provided in each location box and earth point of all equipment and cable armour etc. shall be terminated on this busbar.

(7) GI wire as earthing bond shall not be used.

(8) All earth pits shall have concrete cover, painting of earth value and date of testing.

(4) Lightning Protection

(1) All the structures housing Signalling and Telecom equipment viz. SER, TER, S&T Power supply Equipment rooms and other S&T rooms, shall be provided with lightning protection arrangements and protection against lightning surges travelling through conductors into equipment by using appropriate devices.

(2) The external Lightning protection arrangement shall have an air termination system, down conductors and Earthing system complete with accessories.

(3) The Lightning Air Terminal should be installed at a height at least 3m more than the top most projection of the building. In case there is a VHF antennae installed on the building, the lightning protection should be so designed to safely overcome the competing features of the antennae as well as any other higher projections on the building.

(4) The air termination system shall be connected to the earth electrode of earthing system using down conductor of Copper Bonded Steel Conductor or any other suitable material as approved by the Engineer. The Down conductors shall be installed straight and vertical such that they provide the shortest and the most direct path to the earth.

(5) Surge Protection

(1) The Surge protective devices shall be provided at the input and output power supplies to protect the Power supply equipment and the load equipment against any power surge due to lightning, switching, etc. The Surge arrestors shall also be provided for protection on external power/signalling/data lines.

(2) All surge protection equipment shall be grouped together in close proximity to the main earth bus bar and be physically and electrically isolated from other signalling equipment.

(3) The Surge Protection System provided to withstand the surge voltages shall be complying with IEC standards 62305, 61643, 60364.

(4) Surge Protection for Indoor Signalling equipment shall be provided as under:

(a) Stage 1 Protection (at the input 230V AC supply in the power supply equipment room)

(i) The Stage 1 protection shall consist of coordinated Class I/ B & II/ C type SPDs at the entry point of input 230V AC supply in Power supply Equipment room in TT configuration in a separate wall mountable box. The Class I/B SPD shall be provided between Line to Neutral & Neutral to Earth. There shall be a voltage switching device and tested as per IEC61643 with the following characteristics and features:

SN	Parameters	Limits	
		Between Line & Neutral	Between Neutral & Earth
1	Nominal Voltage (Uo)	230V	230V

2	Maximum continuous operating voltage (U)	255V	255V
3	Lightning Impulse current 10/350ps	25KA	* SOKA
4	Response time (Tr)	ñ 100 ñs	1 100 ñs
5	Voltage protection level (Up)	1 2.5KV	1 2.5KV
6	Short circuit withstand and follow up current extinguishing capacity withoutback up fuse (Inc & Ifi)		
7	Temporary Over Voltage (UT)	334Vmin. for 05 secs.	1200V min. for 200ms
8	Operating temperature / RH	- 25°C to + 80°C/ 95%	- 25°C to + 80°C/ 95%

SN	Parameters	Limits	
		Between Line & Neutral	**Between Neutral & Earth**
9	Mounted on		din rail
10	Indication	Mandatory	Optional
11	Pluggability	Optional	Optional
12	Potential free contact for remote monitoring	Optional	Optional
13	Encapsulation	Encapsulated	Encapsulated
14	Degree of protection		IP20
15	Housing	Fire retardant as per UL 94	Fire retardant as per UL 94

(ii) The Class I/ B SPD will be followed by Class II/ C SPD adjacent to it and connected between Line & Neutral. The device shall be a single compact varistor of proper rating and in no case a number of varistors shall be provided in parallel. It shall be voltage clamping device, thermal disconnecting type and shall be tested as per IEC 61643 with the following characteristics and features: -

SN	Parameters	Limits (between Line & neutral)
1	Nominal Voltage (Uo)	230V
2	Maximum continuous operating voltage (U‹)	z 300V
3	Nominal discharge current 8/20ps (In)	-> 10KA
4	Maximum discharge current 8/20ps (Imax)	40KA
5	Response time (Tr)	ñ 25 ñs
6	Voltage protection level (Up)	1 1.5 KV
7	Operating temperature / RH	- 25°C to + 80°C/ 95%
8	Mounted on	Din rail
10	Indication	Mandatory
11	Pluggability	Mandatory
12	Potential free contact for remote monitoring	Mandatory
13	Degree of protection	IP20
14	Housing	Fire retardant as per UL 94

(iii) Class I/B and Class II/C SPDs of Stage I shall be so coordinated that the voltage protection level of the coordinated devices is ñ 1.5 KV. As such, these devices shall be from the same manufacturer and necessary test certificate in this regard shall be submitted by the manufacturer/ supplier.

(b) Stage 2 Protection (Power line protection at Equipment level)

The Stage 2 protection shall consist of provision of Class II/ C type SPDs on 24V-110V AC/DC supplies at Equipment input level for protection against low voltage surges. The Class II/C type SPD shall be provided between Line to

Neutral & Neutral to Earth. The device between Line to Neutral shall be a single compact Varistor of proper rating and in no case a number of Varistors shall be provided in parallel. It shall be voltage clamping device and thermal disconnecting type. The device between Neutral to Earth shall be a voltage switching device of proper rating. They shall be tested as per IEC 61643 with the following characteristics and features-

SN	Parameters	Limits	
		Between Line & Neutral	**Between Neutral & Earth**
1	Nominal Voltage (Uo)	230V	230V
2	Maximum continuous operating voltage (U)	300V	* 255V
3	Nominal discharge current 8/20ps (In)	> 10KA	110KA
4	Maximum discharge current 8/20ps (Imax)	> 40KA	* 40KA
5	Response time (Tr)	1 25 ñs	1 100 ñs
6	Voltage protection level (Up)	1.5 KV	1.5 KV
7	Operating temperature / RH	- 10°C to + 60°C/95%	- 10°C to + 60°C/95%
8	Mounted on	DIN rail	DIN rail
10	Indication	Mandatory	Optional
11	Pluggability	Mandatory	Mandatory
12	Potential free contact for remote monitoring	Mandatory	Optional
13	Degree of protection	IP20	IP20
14	Housing	Fire retardant as per UL 94	Fire retardant as per UL 94

(c) Stage 3 protection (Protection for Powerl Signalling/ Data lines)

(i) All external Power/Signalling/Data lines shall be protected using preferably pluggable Stage 3 surge protection devices, consisting of a combination of

Varistors/Suppressor diodes and GD tubes with voltage and current limiting facilities.

(ii) These devices shall preferably have an indication function to indicate the prospective life and failure mode to facilitate the replacement of failed SPDs. If the device has any component which comes in series with data/signalling lines, the module shall have make before break feature so that taking out pluggable module does not disconnect the line. This protection shall be in compliance to IEC 61643-21 & VDE 0845 Pt. 3 with the following characteristics:

NominalVoltage(Uo)	5V	12V	24V	48V
Arrestor Rated voltage(U)	6V	13V	28V	50 V
Rated Load current(IL)	250 mA	250 mA	250 mA	250 mA
Total discharge current 8/20 |JS (in)	20 kA	>20 kA	>20 kA	>20 kA
Lightning test current 10/350 ps	a2.5 kA	*2.5 kA	*2.5 kA	a2.5 kA
Voltage protection level (Up)	s 10 V	s 18 V	s 30 V	1 70 V

(iii) If the Power supply/Data/Signalling lines (AC/DC) are carried through overhead wires or cables above ground to any building or any location outside the equipment room, additional protection of Stage 2 (Class II/C) type shall be used at such locations for power supply lines and Stage 3 protection for Signal/data lines.

(End of Chapter-5)

CHAPTER 6: TESTING AND COMMISSIONING

6.1 General

6.1.1 The general details of Testing and Commissioning Philosophy, Strategy, Program, Plan and procedures is covered in General Specifications (S&T). The specific requirements of Testing and Commissioning covered here shall be read in conjunction with the general requirements covered in GS (S&T).

6.1.2 Sequence of Tests

The sequence of tests shall generally comprise of the following:

(1) Type Tests, as and when required;

(2) Factory Acceptance Tests (FAT);

(3) Installation Tests;

(4) System / Sub-system Acceptance Tests (SAT);

(5) Integrated Testing & Commissioning; and

(6) Trial Run.

6.2 Type Tests

(1) Type tests are performed on sample of Equipment prior to full production. Type tests are used to confirm that the proposed equipment is fit for purpose in the environmental conditions specified and meets the requirements of the specification including the EMC.

(2) Type tests are not required to be conducted on Equipment procured as per Para 4.2.3 of this specification.

(3) The Type tests may be exempted if the Contractor is able to produce the Environmental and EMC test results earlier conducted on the Equipment and RDSO/HRIDC/Engineer are satisfied that the Equipment meet the required specification.

(4) Type tests on equipment for which RDSO specification exists, if required shall be done as per applicable RDSO specification.

6.3 Factory Acceptance Tests

(1) The FAT is carried out to demonstrate that each equipment/sub-system meets its functional specifications.

(2) The FAT shall be carried out on all material, components, sub-assemblies, unit assemblies (including software, cables and wiring). No equipment or software shall be delivered to the Site until the Contractor has demonstrated, to the satisfaction of the Engineer that the equipment or software conforms to the specifications by carrying out the FAT. If any item/equipment whether as per IRS/RDSO specification or otherwise is proposed to be procured without FAT, the same should be done only with the prior approval of the Engineer.

(3) FAT procedure shall be submitted for review by the Engineer Twenty-Eight (28) days in advance of carrying out any Test.

(4) The FAT shall be witnessed by Engineer/Employer's representative. For equipment procured as per IRS/RDSO specification and with RDSO inspection, FAT may be witnessed by Engineer's representative.

(5) Where processor-based equipment is to be used, the FAT shall also include verification of application software.

(6) Factory acceptance tests shall include but not limited to:

(a) Physical inspection;

(b) Layout and equipment profile;

(c) Dimension check;

(d) Electrical check;

(e) Calibration;

(f) Output check;

(g) Operational performance;

(h) Insulation test;

(i) Soak test; and

(j) Interface tests with other equipment.

(7) The EI application logic/software for every station will have to be tested completely for all tests including Control Table, Hot standby tests etc. as part of FAT. The controls/logic that are not possible to test at the FAT stage shall be identified and tagged for testing at SAT stage, in consultation with the Engineer.

6.4 Installation Tests

6.4.1 Prerequisites for Installation:

(a) Prior to installation, the Contractor shall ensure that equipment delivered to Site has not been damaged in transit and ensure for their dimensional accuracy. During pre-installation test/ inspection invoice, QA/QC test/ FAT report etc. shall be verified. RFI shall be submitted for this test/ inspection.

(b) The Installation designs and drawings have been reviewed and approved by the Engineer.

6.4.2 Post Installation tests and Inspection:

(a) The Installation designs and drawings approved by the Engineer shall be referred during this test.

(b) Post installation tests shall be carried out by the Contractor for each sub system following installation but before functional tests to demonstrate that the installation has been carried out correctly.

(c) Each test/inspection shall be against RFI. RFI shall be given to the engineer not less than 24 hours before the schedule of test. All related approved drawings shall be kept by the contractor on this site during test/ inspection. Compliance of comments of engineer's representative shall be submitted with the proof as photographs/ documents etc. This test shall check the availability of power,

continuity of wiring, earthing, labeling, name plates, painting etc.

(d) The Contractor shall carry out installation tests for each sub-system following Installation but before SAT to demonstrate that the installation has been carried out correctly and equipment is properly housed and fixed.

(e) The Installation shall be inspected by the Contractor and witnessed by the Engineer. The Contractor shall submit a Post installation Inspection and testing Plan for Engineer's approval, prior to commencement of Post Installation inspection and testing.

(f) During the inspection, it shall be verified that

i. The equipment has been installed as per the procedures and designs and drawings that have been reviewed by the Engineer and that equipment is correctly located and labelled.

ii. Any false feed, temporary wiring and redundant items have been removed and that equipment is correctly protected against interference, damage and deterioration.

iii. The Contractor shall submit Installation Checklist of individual items/ equipment/subsystems based on the designs and submit it for Engineer's review at least 28 days before commencement of Installation.

iv. Contractor shall prepare separate checklist for EI, MSDAC/HASSDAC, BPAC, IPS, Data loggers, FDPM, Signals, Points machines, Cables, Location Boxes, earthing and bonding etc. not limited to Installation checklist issued by IR/RDSO/OEM, where available. The installation check list shall include Structure gauge checks to ensure the installations are carried out to the Schedule of Dimensions requirements;

v. The Installation shall be inspected and witnessed by the Engineer/Employer's representative as per the Installation checklists and records maintained. The defects noticed during inspection shall be appended to/recorded on the Inspection checklists. Once the Contractor has rectified the defects, the same shall be informed to the Engineer with photographs of rectification. The same shall be verified by the Engineer and recorded. The Installation inspection records and Installation checklists shall form part of Installation test records.

vi. These tests shall culminate in SAT to verify the correct operation of all apparatus and where appropriate, correct response to the respective control commands or monitored function.

6.4.3 Installation Tests

i. After installation of the equipment, Visual inspection on un-energized equipment shall be carried out to check the following:

- Cleanliness;
- Workmanship;
- Confirmation of items conforming to ratings specified;
- Water and dust proofing;

- Levelling, mounting and positioning;
- Joints and connections tightness;
- Cables — dressing, bending radii, jointing and finish at terminals;
- Clearances and dimensions in conformity with drawings and SOD;
- Earthing and bonding;
- Layout and Equipment profile check.
- Protection devices;
- Painting
- Labeling
- Locks
- No breakages

ii. The Visual inspection shall be followed by (but not limited to) further Installation tests as under:

- Voltage measurements;
- Continuity test as per wiring diagram;
- Cable Insulation testing;
- Power cubicle function test;
- Wire continuity tests;
- Earth value measurements;
- Wire count tests;
- Software is correctly installed with the correct version and checksum;
- Circuit board is of correct version and is correctly installed;
- Strap and Function tests;
- Through circuit function test of the equipment;
- Signal Sighting tests;
- Functioning of circuit breakers, isolating switches and their interlocks;
- Interface tests with other equipment.
- Simulation test if applicable.

6.5 System Acceptance Test

6.5.1 Once the Installation tests on individual items/equipment/subsystems are complete and they are interconnected and configured to form a complete system, the System Acceptance Test is carried out to ascertain that all the equipment supplied under this Contract satisfy the functional and specified performance requirements in all respects.

6.5.2 System Acceptance Tests shall comprise of comprehensive testing of the completely

assembled installation to ensure that every item has been installed and adjusted and that all systems operate in every respect in accordance with the requirements of the specification and are ready for integrated testing and commissioning

6.5.3 The Contractor shall prepare and organize a comprehensive Program of Tests to demonstrate to the Engineer that all systems, sub-systems and apparatus defined under the Contract, when installed, connected and configured as a complete system meet the specified performance requirements in all respects.

6.5.4 Prerequisites for commencement of the System Acceptance Tests (SAT):

(1) All documentation for the System Safety report have been submitted to the Engineer for review;

(2) All Installation Tests have been completed and test records submitted to theEngineer for review;

(3) Facilities for the maintenance of the system are in place;

(4) Non interlocked working as per Appendix 19 at IR stations namely Patli (Phase 1 and 2), Faruqnagar, Garhi Harsuru for commissioning of new IR station Sultanpur and HORC station Manesar (Phase-2) shall be required to be undertaken by the contractor to perform SAT and final commissioning of stations. In this connection all IR Railway Board instructions on commissioning of RRI/PI/EI and Non interlocked working for commissioning of signalling works shall be followed.

(5) The SAT Plan has been submitted to the Engineer for review at least ninety (90) days before the commencement of the SAT. This test shall include functional test of all Signaling and Telecommunication equipment from the control equipment in SM room This test includes but not limited to:

- EI test as per approved selection table
- Track detection as per approved SIP
- Block instrument testing
- Any other equipment as per PS Signaling.

(6) Verification and Validation of Application logic

- The FAT tested Application logic shall be loaded in the installed EI and verified to see that it meets the requirement of the Control table.
- Tests shall be carried out on each Signalling function to ensure that all the controls specified in the Control tables are present and effective.
- It is permissible for the application logic to be verified by use of application tool/simulation systems. The extent of verification testing by application tool/ simulation shall be defined in the Test plan.
- Where a control is required to be in the Application logic but is not possible to test, this shall be stated in the test specification, together with any alternative testing to be performed to mitigate any reasonably foreseeable hazard.

(7) Functions commonly requiring to be tested include, but are not limited to:

- EI Hot standby tests;
- Point interlocking;
- Route interlocking;
- Sectional and sequential route releasing;
- Route initiation and setting;
- Approach locking;
- Train operated route release;
- Block controls;
- Emergency cancellations;
- Crank handle interlocking;
- Aspect sequence.
- Interfacing with other sub systems like Track detection system, BPAC etc.
- Verification shall demonstrate that correct correspondence exists between all commands, controls, status detecting mechanisms and their indications, both within the integrated system and to any external interfaces.
- Validation of Application logic involves testing of the Application logic in accordance with the requirements of the relevant safety case and product application requirements. The validation activities shall be defined in the test specification.

6.4 Integrated Testing and Commissioning

(1) Integrated Testing on Completion shall include the Work of other contractor(s). The Contractor shall, following satisfactory completion of tests on his works, equipment, sub- systems or system, perform, at the direction of the Engineer, Program of tests to verify and confirm the compatibility and complete performance of his works, equipment, sub- systems or system with the works, equipment, sub-systems or system provided by others.

(2) The Contractor shall submit to the Engineer the requirements and procedures in respect of the Contractor's scope of work for Integrated System Tests in conjunction with the other contractors to demonstrate that the complete system provided under the Contract is fully operational and meets the specified performance criteria.

(3) Non interlocked working as per Appendix 19 at IR stations namely Patli (Phase 1 and 2), Faruqnagar, Garhi Harsuru for commissioning of new IR station Sultanpur and HORC station Manesar (Phase 2) shall be required to be undertaken by the contractor to perform SAT and final commissioning of stations. In this connection all IR instructions on commissioning of RRI/PI/EI and Non interlocked working for commissioning of signalling works shall be followed.

(4) Integrated Testing and Commissioning refers to those tests undertaken in order to demonstrate that the various components of the railway systems operate satisfactorily between one another and meet all specified requirements for design,

operability, safety, and integration with other works and systems.

(5) Integrated testing and commissioning shall include the integration of the HORC section with the adjacent already commissioned sections, without disturbing the safety and revenue operation of the earlier commissioned sections.

(6) Conducting of these Integrated Tests by the Contractor and the other contractors shall include a period of Trial Run.

(7) The Contractor along with others Contractor(s) shall carry out all statutory tests and trials under the supervision of the Engineer, necessary for obtaining sanction of the competent authority, if required, for opening the Railway System.

(8) The results of the Integrated Testing and Commissioning shall be documented.

(9) If any Signalling equipment/sub system fails to pass Integrated Testing and Commissioning, the Contractor shall carry out at his own cost the necessary adjustment or modification to the equipment/sub system required to satisfy the requirements of Integrated Testing and Commissioning within such time as the Engineer may deem fit.

6.5 Trial Runs

(1) On completion of Integrated testing and commissioning to the satisfaction of the Engineer and System acceptance test, the Contractor shall confirm in writing to the Engineer that the works provided by him under the contract is ready for the Trial runs.

(2) During the Trial run, the Employer will run the actual trains. The objective is to check that the functions and operations of the various systems are satisfactorily integrated and to allow all technical systems to settle and operating staff to become conversant with the working procedures.

(3) The Trial run shall be made use for ensuring the following:

- Signal and indicators Sighting — approach sighting, focus, alignment, relationship with other signals, and interference from other sources of light (e.g. street lamps etc);
- Track Vacancy detection system operates correctly, reliably and continuously during presence/absence of a train; and
- Dynamic interfaces — Integrity of operation and indications across boundaries between different types of track vacancy detection equipment and between different interlocking;
- Specific types Signalling equipment could require a test train, especially where evidence of the correct operation of train / Signalling equipment interfaces is required; and
- Verify the layout to the Signalling plan.
- BPAC system operates correctly, safely, reliably and continuously during presence/absence of a train;

(4) The Engineer may issue instructions to the Contractor for particular works or actions required of him during this period. In addition, the contractor shall make

good all defects and complete all outstanding works within the Trial period so as to permit the commencement of revenue operations.

(5) The Contractor's personnel shall be available throughout the period of Trial run.

(6) After the successful Trial Run and after obtaining statutory clearances / approvals from CRS and or other relevant authorities, the Works shall be commissioned with the consent of the Engineer.

6.6 Statutory Clearances

6.6.1 The Contractor shall obtain all the mandatory clearances required for commissioning of Signalling work. In such case, the Employer shall extend all the requisite help and assistance to enable inspection, tests, verification of test records and trial run by CRS.

6.6.2 The CRS sanction, if required will be applied for by the Employer. The Contractor will, however be responsible for preparation of all supporting documents required for CRS sanction.

(End of Chapter-6)

CHAPTER 7: DOCUMENTATION

The Contractor shall submit the Designs and documents as per the GS(S&T) for the approval of the Engineer.

(End of Chapter-7)

CHAPTER 8: SPARES, SPECIAL TOOLS AND TESTEQUIPMENT

8.1 General

8.1.1 The Contractor shall provide Spares/Spare parts generally in accordance with the principles as given below. All Spare parts for which the Contractor has been authorized to provide through a written instruction by the Engineer shall be provided six weeks before commencement of train operations.

8.1.2 Coding and Tagging of Spare Parts and Special Tools and Test Equipment

(1) All Spares/Spare Parts and Special Tools and Test Equipment to be delivered to the Employer shall each carry a tag suitably marked, bar-coded (as directed by the Engineer) and numbered.

(2) The numbers on the tags shall correspond with those on the coding system developed by the Contractor for all Signalling components, parts and equipment's.

8.2 Supply of Spares

8.2.1 The Spare Parts to be supplied by the Contractor shall consist of:

(1) Commissioning Spares (as hereinafter defined);

(2) Defects Liability Spares (as hereinafter defined); and

(3) Contract Spares (as hereinafter defined).

8.2.2 Commissioning Spares

(1) The Contractor shall keep on the Site throughout the installation, erection and commissioning periods, sufficient stocks of Spare Parts ("Commissioning Spares")to enable immediate replacement of any item in the Permanent Works found to be defective or in any way in non-conformance with the Specification during the installation, erection and commissioning period.

(2) The Contractor shall submit the list of 'Commissioning Spares', with the types and quantities of Spares the Contractor intends to hold, at least three (3) months before the commencement of the installation activity, to the Engineer for review.

(3) The Contractor shall ensure availability of 'Commissioning Spares' on or before the commencement of any System Acceptance Tests (SAT).

8.2.3 Defects Liability Spares

(1) The Contractor shall keep sufficient stocks of Spare Parts in an off-site location in their site office throughout the Defects Notification Period to enable rapid replacement of any item in the Permanent Works found to require replacement as part of the Contractor's obligations during the Defects Liability Period ("Defects Liability Spares").

(2) The Contractor shall submit the list of 'Defects Liability Spares', with the types andquantities of Spares the Contractor intends to hold, at least six (6) months before the commencement of the DNP, to the Engineer for review.

(3) The Contractor shall ensure availability of 'Defects Liability Spares' on or before the commencement of the DNP.

8.2.4 When the Contractor submits the list of 'Commissioning Spares' and 'Defects Liability Spares' for Engineer's review, the Contractor shall provide calculation to support the proposed types and quantities taking into account the following:

(1) The expected failure rate of the parts.

(2) Population of the parts in the system.

(3) Criticality of the parts in the system.

(4) Availability and MTBF figures of the system.

(5) Spare delivery lead time.

(6) Workshop repair turnaround time.

8.2.5 The Contractor shall keep and maintain sufficient stock of his own 'Commissioning Spares' and 'Defects Liability Spares'. The Contractor will not be allowed to use the 'Contract Spares' for his Installation & Commissioning and Defects Liability needs.

8.2.6 The Contractor shall include details of the stock of 'Commissioning Spares' and 'Defects liability Spares' it holds, in the Monthly Progress Report. The Stocks shall include status of the Spares in the stores and under workshop repair.

8.2.7 Contract Spares

(1) The Contractor's supply of 'Contract Spares' shall be for Employer's operation andmaintenance need.

(2) Following 'Contract Spares' shall be supplied:

SN	Item	Unit	Quantity
1	Underground cable	km	5% of the total cable laid subject to aminimum of 1 km of each type.
2	All other Cable & wires, other thanUnderground cables	m	5% of the total cable/ wire used / laid subject to a minimum of 100 meter of each type.
3	Power supply — cards, modules, equipment complete withinterconnecting cables and connectors and all other associated accessories	Nos.	20% of each type installed subject tominimum of one.
4	Electronic Interlocking & Object Controllers — Control Terminal, cards, modules complete with interconnecting cables and connectors and all	Nos.	20 % of each type installed subject tominimum of one.

	other associated accessories.		
5	BPAC, Digital axle counter — cards, modules complete with interconnecting cables and connectors and all other associated accessories.	Nos.	20 % of each type installed. Subjectto minimum of one card.
6	All rail mounted equipment complete with interconnecting cables and connectors and all other associated accessories.	Nos.	30% of each type installed. Subject tominimum of one.
7	VRLA batteries	Nos.	10% of each type installed. Subject tominimum of one.
8	Signals complete including Signal	Nos.	5% of each type installed. Subject to
	posts, Signal base Anchor bolts CLS units etc.		minimum of one.
9	Integrated LED Signal Lighting Units complete with current regulator, interconnecting cables and connectors and all other associated accessories.	Nos.	20% of each type installed. Subject tominimum of one.
10	Point machines including groundconnections	Nos.	15% of each type installed. Subject tOminimum of one.
11	FDPM system including, Data loggers, data concentrators, HMU, CMU, FEP, LAN switch & other networking equipment (except Server) with interconnecting cables and connectors and all other	Nos.	15% of each type installed subject to minimum of one.

	associated accessories.		
12	MCB, surge protection device,fuses & terminals	Nos.	15% of each type installed. Subject to minimum of one.
13	All other interconnecting cables/connectors not included above	Nos.	10% of each type installed. Subject to minimum of 2 Nos.
14	Other items/equipment/ material.	Nos.	10% of each type installed Subject to minimum 2 Nos.

(3) List of spares with each IPS-

SN	Sub system	Spare components	Qty
1.	SMPS Charger Module	Module (as cold standby)	1 Module
2.	inverter Module	Module (as cold standby)	1 Module
3.	DC-DC Converter	DC-DC Converter for relay internal, relay external and block line	1 Module each
4.	Ferro-resonant type Automatic Voltage Regulator (AVR)	AC Capacitor	1 Set
5.	Fuses	All type of fuses used in IPS subsystem	1 Set
6.	Transformer	Module (as cold standby)	2 Modules
7.	Inverter/SMR	DC fan	2 Nos
8.	Cells	2V Cells	5 Nos

(4) The Contractor shall submit list and quantities of each type of 'Contract Spares' at least 6 months before start of 'Defect Notification Period', based on approved tentative BOQ which shall be adjusted on approval of As-Built BOQ. All spares quantities shall be rounded up to the nearest deliverable unit.

(5) The List shall include information on make, model, serial number, rating, description, part number, drawing number, shelf life etc. of each item of 'Contract Spares'. The Contractor shall also identify the lead times for all the Spare parts. Parts with long lead times shall be specially identified in the Spares list. In the event that any of the spares identified have a particular shelf life or storage requirement, this shall be made known to the Engineer with the submission of the Spares list, including the necessary action for disposal or storage.

(6) The Spare Parts shall be manufactured at the same time as the Permanent

(7) Works. All Spare Parts shall be works tested and inspected in accordance with the relevant quality system, suitably packed and labelled and delivered in accordance with this bidding document and GS (S&T). Test certificates for each piece or set of equipment shall be submitted to the Engineer.

(8) Before the Spare Parts are delivered, the Contractor shall submit to the Engineer a shipment/dispatch advice notifying details of shipment/transport such as date of dispatch, vessel/vehicle name, etc. as well as a packing list indicating the contract number, order number, the lot size, quantity and weight. The Spare Parts shall be consigned and delivered in accordance with the Engineer's instructions.

(9) The Contractor shall complete supply of the 'Contract Spares' on or before start of Defects Notification Period.

(10) The Contractor shall indicate the sources of supply of all 'Spares' and shall guarantee their availability during the design life of the project. For Spare Parts of consumable and high-use items, the Contractor shall ensure that a minimum of two alternative sources of supply are available.

(11) Spare Parts shall be fully interchangeable with their corresponding part. All Spare Parts shall be configured to the latest revision during the Defects Notification Period.

8.3 Special Tools and Test & Measuring Equipment

(1) Following Tools & Test equipment shall be supplied:

SN	Item	Unit	Quantity

1	General purpose Signalling tool kit consisting of screw drivers of various sizes; flat pliers, nose pliers, cutting pliers, etc. of various sizes; 500 gm. hammer; cable knife, flat chisel of various sizes; brass brush; nylon brush; steel measuring tape,; adjustable screw wrench of various sizes; soldering iron 220V, 60 W; solder wire; tin cutter; flat spanner/ box spanner/ ring/ flat spanner of various sizes; continuity buzzer; AC/DC analog Multimeter 2 nos. of Philips or similar make; AC/DC digital Multimeter Fluke or similar make; Megger one each for 100 V & SOOV. All the tools shall be from reputed manufacturers and shall be supplied in a suitable carrying case.	Nos.	02
2	Megger 500/ 1000 V AC 0 to 200 M ohms with earth tester, electronic push button type of Philips or any other reputed make	Nos.	02
3	Portable digital auto range Multimeter, Philips/ Fluke or similar make capable to measure from 0.1 mV / 0.01 mA AC/DC up to 10 Amp. AC/DC, 600 V AC/DC and resistance from 0.1 Ohms to 40 M Ohms complete.	Nos.	02
4	Supply of heavy duty electric drill machine of size 31 mm 230V AC with hammering action complete capable of working on metal/ wood/ concrete complete with chuck and drill bits of various sizes for all three surfaces in a suitable carrying case from reputed manufacturers.	Nos.	01
5	Supply of electric drill machine of size 6 mm and other description as per 4 above.	Nos.	02
6	Digital earth tester, 4 terminal, range 0-10/ 100 ohms with rechargeable battery complete with other required accessories in a suitable carrying case.	Nos.	01
7	Laptop based mobile maintenance terminal for EI and MSDAC	Nos.	02
8	Complete tool kit for maintenance of EI as per the recommendations of the manufacturer in a suitablecarrying case.	Nos.	1 at each EI
9	Complete tool kit for maintenance of HASSDAC & MSDAC as per the recommendations of the manufacturer in a suitablecarrying	Nos.	01 No for each Evaluator of HASSDAC/M

	case.		SDAC
10	Complete tool kit for maintenance of IPS as per the recommendations of the manufacturer in a suitablecarrying case along with maintenance tool kit for VRLA batteries.	Nos.	01 No for each IPS.
11	Computer based test set up with required software for automatic testing like 'Functional Testing' etc. of whole interlocking at a station.	Nos.	01 No.
12	Digital Cable route Locator	Nos.	01 No.

(2) These Special Tools & Test equipment are for use by the Employer during normal operation & maintenance after taking over of the installations. None of the Special Tools and Test equipment provided for the Employer shall be used by the Contractor on site prior to delivery/during DNP/Maintenance period. The Contractor shall make his own arrangement of Special Tools and Test equipment for use during Installation, Defects Notification Period and Maintenance period.

(3) The Contractor shall submit list and quantities of each type of 'Specials Tools and test Equipment' at least 6 months before start of 'Defect Notification Period', based on approved tentative BOQ which shall be adjusted on approval of As-Built BOQ.

(4) The List shall include information on make, model, serial number, rating, description, part number, drawing number, details of calibration etc. of each item of 'Special Tools and Test equipment'.

(5) All Special Tools and Test Equipment shall be accompanied with drawings, schematics, assembly and connection drawings, circuit diagrams/descriptions, calibration instructions and Operation and Maintenance Manuals to enable them to be used by suitably skilled (but not necessarily specially trained) personnel in a non-hazardous manner and to achieve the desired result in terms of accuracy and quality.

(6) The Contractor shall provide the means and instructions which describe the parameters of each item of Special Tools and Test Equipment that are critical to their proper methods of use and which enable the Employer's staff using the Special Tools and Test Equipment to achieve the proper performance and operation. Such means and instructions shall include, but not be limited to, any routine checking or re-calibration needs for the Special Tool and Test Equipment itself.

(7) The Special Tools and Test Equipment (together with the relevant calibration certificates) required to carry out all the functions described in the Operation and Maintenance Manual shall be suitably packed and identified in accordance with GS (S & T) consigned and delivered in accordance with the Engineer

instructions. The extent of supply shall include protective carrying cases as may be appropriate for the storage and use of each item. The supply of all 'Special Tools and Test equipment' shall be completed before the start of DNP.

(8) The Contractor shall indicate the sources of supply of all 'Special Tools and Test equipment' and shall guarantee their availability during the design life of the project.

(9) The Contractor shall set up an off-line Testing platform at a suitable place provided by the Employer. The Test platform shall consist of all sub systems of Signalling in minimum configuration, inter connected together. The Testing platform shall have the capability to test Signalling equipment/components/sub systems of EI, BPAC, MSDAC/SSDAC, IPS etc. The testing platform shall be commissioned before revenue operations.

(10) At any stage if the Employer feels that the 'Contract Spares' and 'Special Tools and Test equipment' being procured are less, then it reserves the right to order additional quantities before expiry of Defects Notification Period, as a Variation to the Contract Price at an agreed Price. Computer based inventory management plan for 'Spares' and 'Special Tools & Test equipment' shall be established by the Contractor for use of the Employer.

(End of Chapter-8)

CHAPTER 9 — TRAINING

9.1 General

9.1.1. The Contractor shall provide comprehensive training to the Employer's Personnel in respect of design, system engineering, construction/ installation, assembly, configuration, operations, fault diagnosis and maintenance of the systems/sub-systems, provided under the Contract. The Contractor shall arrange Training at Manufacturing facilities as well as at site, as per the approved Training Plan.

9.1.2. All the training courses at manufacturing facilities shall be conducted during design period and completed before the commencement of installation.

9.1.3. The training at manufacturing facilities has the potential of imparting maximum benefit and shall cover all Signalling and Telecommunication equipment provided under the contract.

9.1.4. All the training courses at site shall be conducted during installation period and completed before the commencement of testing and commissioning.

9.1.5. The Contractor shall also arrange training at site for Employer's maintenance and Operating personnel and Key Instructors. The Contractor shall set up training class rooms near to site, where he shall provide competent training instructors, training manuals, all necessary aids and materials as required for all the training courses. The training courses shall cover working principles, installation, operation, fault diagnosis & maintenance of all major equipment and works engineered by the Contractor.

9.1.6. The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields. The training instructors shall be either the system designer or engineering staff of the Contractor, the Contractor's subcontractors or the equipment manufacturers. No Training instructor shall be deployed without prior approval of the Engineer. The training shall be in English and Hindi languages as required. The Training abroad shall, however be in English language only. All training material shall be provided in English. If requested by the Engineer, the training material shall be provided in Hindi also.

9.1.7. The Employer intend to create some 'Experts' of each sub-system/equipment who need to be intensively trained by the Contractor in all aspects (design, installation, testing and commissioning, fault finding etc.) of each sub-system/equipment, and train them to the level that they can even undertake customization of the sub system as required by the Employer from time to time in future. The Employer will nominate up to 5 persons for training in each sub system.

9.1.8. The Training Program shall enable the basic staff to operate service, enhance, maintain and interact with the hardware, software and firmware such that the systems and associated equipment will perform in accordance with the specifications of this contract.

9.1.9. The training courses and/or sessions shall include system performance requirements and all major equipment and works engineered by the Contractor.

9.1.10. The Contractor shall submit assessment reports on the performance of individual trainees to the Engineer. Training evaluation shall be required at regular intervals to monitor the progress and suitability of the training program. Items that require further information or tasks that require additional training or practice will be discussed between Engineer and the contractor at the evaluation meetings. Such items or tasks must be appended to the

training program,

9.1.11. The Contractor shall bear all the training costs except for allowances, hotel and travel expenses of the Employer's trainees.

9.1.12. Throughout training program, the Engineer/Employer shall have free access to all training sessions to monitor the progress of the trainees and the Contractor's training instructors.

9.1.13. If required by the Engineer/Employer, any one or more of training courses may be repeated during currency of the contract to train additional batches of staff.

9.1.14. The Contractor shall provide full-time management, co-ordination and supervision of the entire training Program to ensure the continuity of classes and proper distribution of training materials and be responsible for interfacing with the instructors.

9.2 Scope of Training

9.2.1 Objective of Training is as follows:

(1) To enable the Employer's maintenance personnel to maintain the commissioned Signalling systems;

(2) To enable the Employer's Operating personnel to become competent in operating thevarious systems/sub-systems at work site; and

(3) To enable the Employer's Key Instructors to become competent to deliver futurecourses to other employees of the Employer;

(4) The Training shall be imparted on various Sub-systems. Aspects covered shall include, but not be limited to the following:

(a) Operating features and functional principles of the relevant Systems.

(b) System engineering aspects including design standards, design criteria and parameters, short-circuit and other calculations, insulation and protection co-ordination.

(c) Details of major equipment and components used in the System.

(d) System operating and maintenance management procedures and

(e) Control and monitoring systems for each System.

(5) The Training shall be in India and abroad, including training at manufacturing facilitiesas appropriate.

9.3 Training Plan

9.3.1 Within six months after the Commencement Date of the Works, the Contractor shall submit a Training Plan to the Engineer for review.

9.3.2 The Training Plan shall include, but not be limited to, the following:

- the program of the training courses at site and at manufacturing facilities;
- overview and description of objectives of each training course;
- the location where the training courses to be conducted;

- submission schedule of the training materials;
- set ups for practical exercises;
- the Contractor's training organisation chart, including the role and responsibilities of
- individual key persons;
- the qualifications and experience of the training instructors;

9.4 Training Courses for Signalling Sub- systems

9.4.1 The Contractor shall provide Training Courses on all facilities, systems, equipment, hardware, firmware and software. Each Course shall be specific and shall consist of classroom, hands-on and/or field training as necessary to accomplish the Course Objectives specified in the Training Program Plan. The Contractor shall develop detailed training modules based on information in the Operating and Maintenance manuals.

9.4.2 The technical training courses to the Employer's staff shall be programmed in phases with the progress of manufacture and installation to ensure that trainees are present during all stages of the manufacture, installation and commissioning of the equipment which is the subject of the training. The Contractor shall ensure that the courses fully encompass all aspects of the basic design, manufacture, installation, commissioning and maintenance of the Equipment with maximum effort being directed at instruction in the maintenance of the installations.

9.4.3 Training at site shall include operation courses and maintenance courses. The class will be of maximum of 30 trainees. The Contractor in consultation with Engineer and Employer shall determine the number of classes for each type of training course, within the provisions available in respective Particular Specification, to ensure the objectives of the course can be met.

9.4.4 Training Courses for Operating Staff

The Training courses for Operating personnel on Signalling and Telecommunication systems/sub-systems shall be developed to provide all necessary knowledge and skills that enable them to operate the system under normal and emergency situations and recovery from minor or simple faults. In particular, the Training course shall include the following as minimum:

- Overview of the system/sub-system;
- Brief description the operational principles of the system/sub-systems;
- Operational features and functions;
- Familiarisation and use of all man-machine interfaces involved;
- Reading and interpretation of system status and alarm messages or indications;
- Normal operating procedures;
- Operating procedures under emergency situations; and

- Procedures for recovery from minor or simple faults.
- A comprehensive list of Dos and Don'ts shall be prepared and explained to the Operating personnel and also shall be prominently displayed at the stations.

9.4.5 Training Courses for Maintenance Staff

The Training courses for maintenance staff at site shall, as a minimum, impart the following techniques to maintenance staff of Employer of the appropriate grades:

- Planned maintenance and overhaul of all the railway systems/subsystems supplied, installed or modified under the Contract;
- Fault diagnosis and rectification techniques for the systems/subsystems including equipment supplied, installed or modified under the Contract. These shall be developed from the Contractor's previous experience with similar equipment and also from the fault tree analysis and other analysis carried out as part of the reliability engineering studies undertaken by the Contractor;
- Normal and degraded modes of operation of the S&T systems/subsystems including equipment supplied, installed or modified under the Contract;
- All rules, regulations, practices and procedures necessary for the safe and efficient operation of the S&T systems/subsystems supplied, installed or modified under the Contract; and
- All contingency plans necessary to recover speedily and safely from any mishaps or emergencies that may arise with the S&T systems/subsystems supplied, installed or modified under the Contract.

9.4.6 The Training in Operation and Maintenance shall enable trainees to obtain competence, including obtaining Competency Certificate from the competent authority.

9.4.7 The training courses for system engineers at manufacturing facilities shall be developed to provide all necessary knowledge and skills to perform system engineering management including system parameter configuration, enhancement, expansion and provision of new circuits.

9.4.8 The Contractor shall determine the content of the system engineering courses, however the courses shall include the following as minimum:

- Overview of the S&T systems/subsystems;
- Brief description of the operation principles of the Subsystems and background theory;
- System/ operational features and functions;
- Description of system components and equipment down to card or module level;
- Test and commissioning procedures;
- Use of test equipment and special tools;

- Reading and interpretation of alarm indications, messages and print-outs;
- Preventive maintenance procedures;
- Fault diagnosis, troubleshooting and corrective maintenance procedures;
- Equipment settings and parameters configuration;
- Use of Equipment manuals, Operation and Maintenance manuals, circuit diagrams and wiring schematics;
- Methods and procedures to provide new circuits, system expansion and enhancement;
- Data, software backup and loading;
- Use of software such as peripheral control and configuration, utility, database structure, generation and modification;
- Periodical Maintenance schedules and impacts;
- Familiarisation and use of all man-machine interfaces involved;
- Normal operating procedures;
- Operating procedures under emergency situations; and
- Procedures for recovery from faults

9.4.9 During the Defects Notification Period, when the Contractor is responsible for fault finding and repair, he shall provide practical hands on training to Employer maintenance staff to facilitate successful handing over of the works.

9.4.10 Training Courses for Signalling Sub Systems

The Contractor shall provide training courses for each of the Signalling sub-systemsincluding but not limited to:

- Distributed architecture with object controllers of Electronic Interlocking (EI).
- Power Supply System (Auto changeover, IPS, Batteries etc.)
- Multi Section Digital Axle Counters (MSDAC) and Single section Digital Axle Counters (SSDAC) and High availability single section digital axle counter (HASSDAC).
- BPAC
- Data logger system and FDPM system.
- Point machines.
- Earthing and Surge Protection Systems.

The Employer's Key Instructors shall attend all types of training courses so that they shall be able to subsequently train the Employer's staff in future in all aspects of operation and maintenance of the System.

9.5 Training material and Equipment

- The Contractor shall provide such written or printed matter, functional equipment, samples, models, cutaway equipment, slides, films and other instructional material, as may be necessary for training. Such equipment and material shall remain the property of the Employer and shall be sufficient both for the persons trained by the Contractor and for those to be subsequently trained by Employer Training Instructors.
- The Contractor shall arrange all training material including tables, chairs, white boards, and so on. If available, the Contractor may however, use the training rooms of the Employer.
- With the prior approval of the Engineer, the Contractor may use the Works being erected, tested or commissioned for the training of Employer Personnel.
- The Contractor shall prepare a Trainer's guide for each training course. The Trainer's guide shall include the course agenda, objectives, list of resources and facilities required, detailed lesson plans, presentation notes, discussion guides, training aids and job aids, test papers, criteria and methodology for testing and assessment, and all other things that will enable Employer's Training Instructors to carry out repeat or refresher courses in the future.
- At the commencement of the training course, the Contractor shall, distribute two sets of Trainer's guides and one set of Training manual for each trainee and two sets of Trainer's guides and three additional sets of Training manual to the Engineer
- Training course notes shall be compatible and where appropriate, cross-referenced to the Manuals supplied by the Contractor as part of the Operation and Maintenance documentation.
- The Training course notes and Trainer's guides shall be submitted to the Engineer for review six (06) months prior to the commencement of the first training session of the course. Course notes and Trainer's guides shall be in a standard format as decided by the Engineer and in a form that allows for easy reproduction. At least two months before the commencement of the training course, the Contractor shall submit all the training materials including the trainer's guides, training manual for trainees, training aids and presentation materials to the Engineer for review. The training materials shall be prepared in a form allow easy future reproduction.

9.6 Test and Assessment

- The Contractor shall develop a system of assessment and certification of trainees at the end of each course. The system of assessment shall test the knowledge, understanding and proficiency of the trainees.
- The assessment and certification procedures shall be submitted by the Contractor for approval of the Engineer.
- At the end of the training period, the Contractor shall issue Training certificate to the trainees who pass the assessment.
- Training sessions, tests, and certification processes may be witnessed by the Engineer and the Employer.
- The Contractor in consultation with the Engineer, shall develop a system of

Feedback after each Training course. The Feedback forms shall measure the Trainee's level of satisfaction with the course content. The Feedback form shall be submitted to the Engineer for review four weeks before the commencement of the Training course.

9.7 Training Records

- The Contractor shall keep attendance records of trainees.
- The Contractor shall issue appropriate training certificate to the trainees who pass the assessment.
- The Contractor shall, at the completion of each training course provide the Engineer a consolidated training records listing the training course title, date of training, name of all trainees, training result and other relevant information.
- After two weeks, the Contractor shall submit a Training report to the Engineer for review. The Training report shall include a summary of the training course conducted, the results of trainees' assessment and the Feedback report.

(End of Chapter-9)

CHAPTER 10—OPERATION & MAINTENANCE AND SERVICE LIFE SUPPORT

10.1 General

10.1.1 Operation and Maintenance is an important element in the execution of a project. It is essential to have a well-designed Operation & Maintenance Support Plan and Maintenance Plan before the system is made Operational. These plans shall be submitted to Engineer for review, at least six months before start of Defect Notification Period.

10.1.2 It shall be ensured that the resource requirement in terms of men and material as identified in the Plans is available before the system is made Operational.

10.1.3 The Contractor shall repair and/or replace, in each case at no cost to the Employer, any part of the Works which is found to be defective by reason of faulty design, materials or workmanship or negligence or failure on the part of the Contractor to comply with any obligation expressed or implied under the Contract, during the DNP after the date of issue of the Taking Over Certificate of the Works. The Works shall include equipment being provided under this Contract Package and upgraded/augmented/reconfigured.

10.1.4 During the Defects Notification Period, as a result of an inspection made by or on behalf of the Employer at any time or times prior to its expiration, the Engineer shall have the right but not the obligation to instruct the Contractor in writing to execute all such work of repair, amendment, rectification and make good defects, imperfections or other faults in the Works and any part thereof, as the case may be.

10.2 Operation and Maintenance Support Plan

10.2.1 Operation and Maintenance Support Plan shall cover, but not limited to, the following items:

(1) Submission of Technical Manuals as required for both Signalling and Telecommunication;

(2) Submission of Operation & Maintenance Manuals and Warranty certificates for each item/unit/ equipment;

(3) Requirement of bare minimum Employer's Manpower for maintenance;

(4) Proposed Contractor's Manpower for supervision of Maintenance during one year Maintenance and Defect Notification Period;

(5) Provision of Software support during one year Maintenance and Defect Notification Period;

(6) Provision of Spares, Test Equipment, Tools, etc. for respective equipment and machines;

(7) Requirement of periodic operation of equipment and machines which would otherwise deteriorate because of non-operation for extended periods.

10.3 Support during One year Maintenance and Defect Notification Period (DNP)

10.3.1 Support and Call-out Services

- The Contractor shall provide the Support & Call-out-services for maintenance of the system. The maintenance will be done by the Employer with the support of the

Contractor. The Support and Call-out services shall be available 24 hours per day and 7 days per week.

- The Contractor shall deploy adequate, committed and competent resources for providing desired level Support and Call-out-services. As a minimum, the expert of each sub-system of Signalling and Telecommunication shall be provided by the contractor at Manesar Station. All the resources shall be trained before deployment.
- The resource deployment shall be as per Operation and Maintenance Support Plan approved by the Engineer. The Contractor shall provide a list of staff together with the contact landline/mobile telephone numbers who can be contacted for Support and Call-out-services. Any change in the staff or his call-out number shall be notified to the Engineer at least two weeks before such change becomes effective.
- The Contractor's response Time for Support & Call-Out-Services shall not exceed three hours for Signalling and Telecommunication both. The Response Time is defined as the time that elapses between the reporting of a fault and the Contractor's Call out personnel arriving at site where the faulty equipment is located.
- In case of any abnormal System behavior like intermittent faults, interference, frequent repeated faults, etc. occur or the performance is found to deviate from the specified tolerances, the Contractor shall conduct investigations and report the findings to the Engineer along with the recommendations and proceed after the recommendation has been reviewed without objection by the Engineer. The Contractor shall take every precaution to protect existing equipment from damage and make good any damage caused.

10.3.2 ~~Workshop~~ Repair

- The Contractor shall provide ~~Workshop~~ repair services for all defective and faulty items of the System and shall collect and repair defective parts that are removed from the System during corrective and predictive maintenance.
- The Contractor shall perform all necessary adjustments or alignments as required to the repaired parts. The repair of defective parts can only be considered as completed and returned to stock or back to the System if the parts are tested and verified fit for use in the System.
- The Contractor shall use only components of equal or better specification than the original components in his repair activities. The performance of the defective parts after repair shall not be degraded or deteriorated due to repairs.
- The maximum turnaround time for ~~workshop~~ repair shall be less than 28 calendar days. The turnaround time count shall start from the time the defective parts are removed from the System and shall continue till the parts are repaired and returned to stock or to the System. Any extension of workshop repair time shall be agreed with the Employer.

10.4 RAMS Targets Failures

In case of failure of the Contractor to achieve the RAMS Targets specified in the Employer Requirement:

- The Defects Notification Period shall stand extended for a further period corresponding to period of failure;
- The Performance Guarantee shall stand extended for a period corresponding to the
- extension of the Defects Notification Period; and
- All work required to be carried out by the Contractor for the rectification of defects, shall be carried out at the Contractor's own expense.

10.5 Operation and Maintenance Manuals

10.5.1 In addition to the various existing Codes and Manuals applicable to Indian Railways for operation and maintenance of systems, the Contractor shall produce manuals covering the additional provisions, over and above the various existing Codes and Manuals of Indian Railways in respect of the Operation and Maintenance requirements of various assets created under the Contract.

10.5.2 With reference to the requirements as above, the Contractor shall produce manuals for all equipment and manufactured items and sub-systems, supplied and created under the Contract, for their efficient operations and maintenance. These shall include, but not be limited to, the following equipment/sub-systems:

(a) Maintenance of Signalling Equipment:

- Distributed operation with object controllers of Electronic Interlocking System
- Point Machines
- Track Vacancy Detection System (MSDAC/Track circuit)
- ~~UFSBI, Block panel and~~ BPAC
- HASSDAC/SSDAC
- Power Supply System for Signalling
- Signalling cables
- Earthing, Lightning and Surge Protection System
- RDPM System
- Data Logger System for Event Logging and Predictive Maintenance

(b) System/Sub-System Manuals- A comprehensive description of all system principles at block diagram level.

(c) Operating/User Manuals - broken into as many sub-sections as necessary and providing sufficient information to enable non-technical staff to exploit fully the facilities of each system. The Operating Manual of EI shall contain detailed description of all the operations of the SM's Control terminal with coloured illustrations.

(d) Workshop Manuals - Installation and circuit descriptions, full schematics, circuits, wiring diagrams, mechanical construction/installation drawings and itemized parts list to enable all maintenance rectification and setting-up to be

carried out.

(e) Software System Manual - for each software package and each piece of equipment which incorporates Programmable Device(s), licensed copies of CD/DVD of application and peripheral software along with write up on software features, instructions for configuration, working of software and procedures for taking out report and data in the form of instruction manual/guide.

10.6 Maintenance Plan

10.6.1 While Operation & Maintenance Support Plan take care of day to day operation and maintenance of the systems/sub-systems, the Maintenance Plan is designed to put the maintenance practices on sound footing for proper upkeep of the systems. The Maintenance Plan shall be prepared by the Contractor and submitted to the Engineer for review at least 3 months before start of Defect Notification Period.

10.6.2 The Maintenance Plan shall describe, but not limited to, the following:

- Maintenance philosophy and approach,
- All necessary tasks for first line, second line, third line and corrective maintenance,
- Frequency of each maintenance task,
- Employer's and Contractor's proposed maintenance regime for maintenance,
- Maintenance Schedules (Daily, Weekly, Monthly as recommended by OEM) detailing maintenance task for each maintenance team member;

10.6.3 The Maintenance Plan shall be aligned with the Employer's maintenance policy.

10.7 Maintenance Management system (MIS)

10.7.1 The contractor shall develop and provide Maintenance Management system (MIS) to cater but not limited to for following:

10.7.2 Station Asset Documentation Module: Complete documentation and Inventory of relevant assets of Stations within the range of 2.5KMs of either side of station. User can create and document the station assets and Gears includes on Signalling side EI, MSDAC, IPS, RDPM, Data Logger, BPAC, LED Signals, Relay, Batteries, Junction box, Point Machine, Track Circuits, Cables (Copper and OFC details), Equipment at LC Gate, Gates Types, S&T equipment in LC Gate area etc. and on Telecom side IP MPLS/ STM, Quad cable, PIJF cable, Router, Switch, PD MUX,, FMS, Server Machine, Phone, DTMF equipment, Master clock system, VHF equipment, Power supply etc.. All relevant information like Asset Name and type, Make, Vendor, date of Installation, Purpose, Warranty Period, last service date, next service due date, detail of maintenance authority, Datasheet shall be available. Contractor shall do the survey along with Track route to get the asset information of asset details and its Geo-ordinates. All other relevant information shall be provided by Railway to feed into the application software. Station wise asset details / register shall be available online as and when required. Also, module shall be there to record site tools availability. GIS based

Network Visualization: Station wise all assets shall be mapped in the GIS to identify its exactlocation. On clicking on the asset, its complete detail information of that asset shall appear.

10.7.3 Master Asset Model Library Module: Application shall be flexible to create the master library of each object i.e. Gears and other assets. Once any object is created, must be store in the library. For multiple use of the asset, asset / object can be picked from the library and placed into the map. However, if required the attributes of the assets / Gears or created other objects can be changed.

10.7.4 Asset Administration and Maintenance Module: User shall able to quickly search and track the inventory related to movement of the asset in the project implementation and maintenance schedule; Faults can be easily located or placed as well as physical location of the faults; Searching of complete incident management of its previous failure etc. SMS or email shall be generated from the server with relevant information about the fault. It shall have facility for overdue gear alert and periodicity maintenance data.

10.7.5 Portable Device based scheduled Material Inspection Module: Singalling and Telecom equipment goes under schedule maintenance by Railway engineers or by contractors. Railways has issued SMC to be followed for maintenance of any gear. Mobile application based on Android shall be loaded in either Smartphone or Tabs for the scheduled inspection. Inspection forms as per SMC form can be filled only and when portable devices are within the perimeter of 15 to 25m of asset location. Customised forms shall be available for inspecting various non-schedule assets.

10.7.6 Report Generation Module: Customized reports of the assets, by its Failure, Make, Name, Date of installation, Date of Completion etc.

10.7.7 NMS (Network Management System) module to be installed at server machine for monitoring status / health of networking components such as Routers, Switches, STM, Servers and Desktop. Railway shall provide required MIB files of devices to be connected to NMS for its health monitoring.

10.7.8 REMOTE INFORMATION MONITORING SYSTEM FOR MAINTAINING SIGNAL FAILURE/FAULT REGISTER MODULE-The SFR (Signal Failure/fault Register) module shall provide mobile application for registering faults from fields along with web-based access for accessing SFR, reason of failure, date time stamp etc. All signaling gears failure history shall be stored in the central database and accessible from web application as and when required. The SFR report module shall be available for download and print. The formats for SFR will be provided by Railways during implementation which needs to be integrated with Asset management system. In addition, Codal Life notification module shall be provided for the asset for managing Codal life of signaling gears. The gears whose codal life is likely to expire in configurable time shall be notified to mobile user and also shall be displayed on web-based dashboard.

10.7.9 The scope of MIS is given in Appendix 20.

10.8 Maintenance Schedules

10.8.1 The Contractor shall prepare the Maintenance schedule for each item/equipment required to be maintained. The schedule should give the details such as the frequency of maintenance, the items to be maintained, the tolerances permitted and the safety checks to be performed. The Contractor shall submit the Maintenance Schedule to the Engineer for review.

10.8.2 In addition to the above, the Contractor shall include in the Maintenance Schedule the following information:

(a) The equipment, sub-systems covered in the task,

(b) Step by step procedure to carry out the task,

(c) Tools and test equipment required for each task,

(d) Diagrams and flowcharts by illustration, if applicable,

(e) Adjustment procedures for all field adjustable units,

(f) Recovery procedures, if applicable,

(g) Precautions including Safety to be followed by maintenance personnel and

(h) Estimated duration and manpower required;

10.9 Maintenance Manual

10.9.1 The maintenance manual shall contain the following, but not limited to:

1. Technical description of each system and sub-system of equipment installed to ensurethat the Employer's technical staff fully understand the scope and facilities provided.

2. Diagrammatic drawings of each system indicating principal components and items of equipment

3. Name, addresses, telephone, e-mail and fax numbers of the manufacturer of every item of equipment.

4. Manufacturer's service manual for each major item of equipment, assembled specifically for the project including detailed drawings, illustrations, circuit details, operating and maintenance instructions, modes of operation, control provisions, sequences and interlocks and preventative maintenance Program.

5. Procedures for fault location and isolation.

6. Maintenance procedures and their periodicity. The contractor must give list of Items to be checked, adjustments to be made, safety checks to be performed and frequency of maintenance for each item of the sub-system/equipment. These maintenance Schedules should be compiled in the

form of a register and shall be kept at stations for recording of the maintenance done by Signal maintainer. It should lead to computerization of the maintenance activities.

- Tools and Plant needed for maintenance of different Equipment provided in the Works.
- Configuration Manual for all equipment, wherever required.
- All test results conducted on the relevant equipment whether at the manufacturer's place or at site; and
- Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items, which may involve extended deliveries.

10.9.2 The Contractor shall submit all the Manuals for review by the Engineer prior to Factory Acceptance Tests which shall be submitted not later than 112 days before the targeted date of start of Trial Running for the Engineer's consent.

- The Contractor shall provide sufficient copies of all Manuals along with electronic version for use of the Employer's Staff/Engineer.
- The Contractor shall maintain all Manuals in an up-to-date condition throughout the Contract Period, wherever applicable.

10.10 Software Support

10.10.1 The Contractor shall submit a Software Support Plan at least ninety (90) days before commencement of Software installation. This plan shall require the Contractor to provide all changes, bug fixes, updates, modifications, amendments and new versions of the program as required by the Engineer.

10.10.2 The changes and modifications of the software shall not degrade the performance or have adverse impact on the system. The Contractor shall maintain backup copies of all software developed or delivered for the System.

10.10.3 The Contractor shall ensure that all new versions are fully tested and validated and reviewed without objection by the Engineer prior to loading into the system.

10.10.4 The Contractor shall provide training to the Employer's staff for use of new version, as and when incorporated.

10.10.5 The Contractor shall provide full support to the Employer and Engineer for all computer programs provided by the Contractor under the Contract.

10.10.6 The Contractor shall provide all tools, equipment, manuals, configuration and customization data and training necessary for the Employer's staff to maintain and re-configure all the software provided under the Contract. This shall include supply of any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers.

10.10.7 The Contractor shall submit all new versions to the Engineer for review at least two (02) weeks prior to their installation. New Versions of any program shall not result in any non- conformance with the Specification or degrade the performance or have adverse impact on the System. The Contractor shall:

(1) ensure that all new versions are fully tested and validated on the simulation anddevelopment system prior to installation;

(2) ensure that all new versions are fully tested and commissioned once installed on thesite; and

(3) deliver to the Employer any new version, together with the updated Operation and Maintenance Manuals.

(4) All new version of software shall be accompanied by a release note containing the following details:

- Version number
- modifications made to the previous version;
- check sum

10.10.8 The Engineer shall not be obliged to use any new version that shall not relieve the Contractor of any of its obligations. Any effect upon the performance or operation of the computer-controlled system that may be caused by a new version shall be brought to the Engineer attention including updating the files to suit new version.

10.11 Security obligations

10.11.1 Within fourteen (14) days of the installation of any software, which is developed or modified for this Contract, into the permanent works by the Contractor, the Contractor shall submit to the Engineer for retention by the Employer two (2) backup copies of the software, which shall include, without limitation:

- All source and executable code including all data configuration tables.
- All design documentation relating to the software;
- Any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers, and
- All licenses in favour of the Employer for their perpetual use by HRIDC for the entire life of the systems.

10.12 Monthly Maintenance Meeting

- The Contractor shall attend the Monthly Maintenance Meeting with the Engineer to discuss the maintenance matters during the Defect Notification Period. The dates and agenda of the meeting shall be agreed with the Engineer.

10.13 Service Life support

10.13.1 The Contractor shall ensure availability of full support to the Employer during the Service life of the project, for operation, maintenance, customization and upgradation of system/sub-system supplied and installed by him as part of the Contract. Wherever the equipment provided under this Contract Package are being upgraded/augmented/reconfigured, this support during service life for

operation, maintenance, customization and upgradation shall be available for these equipment.

10.13.2 The contractor shall ensure that the OEM should either provide support as above on his own or sign an MOU with suitable Indian companies or company having proven track record and are working in related areas for all systems/subsystems. The copy of the MOU shall be submitted to the Employer as a proof of continuous support.

10.13.3 The Contractor/OEM of the system/subsystem may be required to undertake comprehensive Annual Repair Contract (ARC) at the end of Defect Notification Period. The comprehensive ARC may include supply of cards/modules for repairs/replacement of the sub system/system. However, this ARC will be a separate contract and will not be part of this Contract.

10.13.4 The Contractor must ensure the following, but not limited to :

- Availability/Establishment of repair/servicing facility in India. The Local Service Centre shall have test and repair facility with simulation test set-up, fault diagnostic system, test jigs, software for testing of cards/modules along with required test instruments and tools.
- Availability/Establishment of Organization in India that can enter into Annual Maintenance/Repair Contract (AMC/ARC) with the Employer.
- Availability/Establishment of Customization facility to add/modify/re-engineer hardware/software of the subsystem as required by the Employer during the lifetime of the equipment for adding facilities/features with future yard modification/Signalling equipment up gradation etc.
- Supply of Spares for entire Service life of the equipment.
- Supply additional equipment required for replacement or expansion of the network in future.
- Training of Employer's Personnel in Operation and maintenance of existing and new/modified equipment/sub-systems.

(End of Chapter-10)

CHAPTER 11: DEFINITIONS

11.1 Definitions

11.1.1 Availability: The probability that an item will be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided.

11.1.2 Auxiliary/Subsidiary signals: Shunt signals — Independent or below Main signals, Calling-on signals, Route indicators.

11.1.3 Control Terminal: An Industrial grade computer complete with hard disc, VDU display monitor, key board and mouse, provided with SM.

11.1.4 Design life: The design life is the period of time during which the system is expected to work satisfactorily within its specified parameters.

11.1.5 Failure: A failure is an event which causes loss of function or performance within any part of the Signalling & Telecommunication System and requires a maintenance intervention to restore full functionality and performance.

11.1.6 Flank Protection: Protection of a train running on route set for it from trains or vehicles on neighboring lines through setting & locking of concerned points in required position.

11.1.7 Fouling Point: The position at the convergence of two tracks where the kinematic envelopes, one on each line, would come into contact.

11.1.8 Graceful Degradation: The transfer in quality or performance from the initial level to a lower operable level.

11.1.9 Headway: Minimum time interval between successive trains at any point on the line such that the speed of a train is not reduced by presence of any other train ahead.

11.1.10 Independence: The isolation between the investigating technician undertaking the work and a second person for example, responsible for checking or approving the work.

11.1.11 Main running signals: Home signal, Starter signal, Intermediate Starter signal, Advance Starter signal.

11.1.12 Maintainability: A characteristic of design and installation, expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when the maintenance is performed in accordance with prescribed procedures and resources.

11.1.13 Mean Time Between Failures (MTBF): The average time between failures causing service delays for a piece of equipment, a system or a subsystem.

11.1.14 Mean Time to Repair/ Restore (MTTR): The average time being required to repair a piece of equipment, system or subsystem to restore to its proper working conditions.

11.1.15 Reliability: The probability that an item/equipment/system can perform a required function under given conditions for a given time interval.

11.1.16 Running Lines: The HORC Running lines between New Prithla (excluding) and New

Harsan Kalan (excluding) Stations via Manesar, Kharkhoda along with all connecting lines to IR/DFC connecting stations.

11.1.17 Safety: Freedom from unacceptable risk.

11.1.18 Sub system: Each system comprising Signalling system. E.g. Distributed architecture with object controllers of EI sub system.

11.1.19 Supervisory Track Section: A Section of track between two DPs completely covering more than one track sections. Supervisory Track Section is used to automatically reset Track Sections under its jurisdiction.

11.1.20 Traffic Controller; The person deputed to control and regulate working of traffic on specified section of the railway provided with a system of speech communication.

11.1.21 Track Section: A Section of track between two DPs used for controlling the signal depending upon its clearance or otherwise

11.1.22 Video wall: A graphical representation of the railway and its global operating status.

11.1.23 Vital Relay : The relays associated with each track section & Supervisory track section. The status of vital relays indicate the clearance or otherwise of associated track section /Supervisory track section.

11.1.24 Wrong side Failure: A failure of a safety-critical system or subsystem which directly leads to a situation with the potential to cause harm, human injury, damage to property, plant or equipment, damage to the environment, or economic loss.

(End of Chapter-11)

Section VII: Employer's Requirements

Section VII-10: Particular Specifications (PS) Telecommunication

PARTICULAR SPECIFICATIONS(PS): TELECOMMUNICATION

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CHAPTER 1 - INTRODUCTION

1.1 General

1.1.1 Haryana Oribital Rail Corridor (HORC) Railway project will run from New Prithila to Harankalan via proposed Manesar and Kharkhoda stations. Part of this HORC project covered in this Package C2 will run from Manesar Jn. CH: 51.89 to New Patli Jn. Ch: 61.50 (double line), its connectivity (new BG single line) from proposed Manesar Junction of HORC to existing Patli Railway Station (NR) under PH-1 and its connectivities from proposed New Patli Jn. to Existing Patli (NR) and Sultanpur stations (NR) under PH-2 on IR Network.

1.1.2 Part of HORC will have 2 Junction Stations. The Junction Station Manesar will be connected to IR stations through single line tracks to IR Patli (PH-I) and New Patli Jn. Shall be connected to IR Patli & IR Sultanpur (PH-II) . The trains from/to Indian Railways will enter/exit the HORC at these two Junction Stations.

1.1.3 Control and Monitoring of Traction Power in the HORC shall be via a dedicated Supervisory Control and Data Acquisition (SCADA) System. Traction Power System includes Traction Sub-Station (TSS), Sectioning Post (SP) and Sub-sectioning Post (SSP). Details of these TSS, SP and SSP are given in this tender document.

1.1.4 In HORC, Integrated Maintenance Depots (IMDs) has been planned at Manesar station. This depots will have maintenance facilities for all the concerned departments viz. Electrical, Civil, Signalling and Telecommunication.

1.1.5 In HORC, residential complexes have been planned for its staff. A total no. Of 18 Residential Quarter/Houses shall be constructed in HORC at Manesar Jn. All the HORC section controllers viz. Traffic section Controller, Traffic controllers, Traction Power Controller cum Emergency controller, Traction loco controller and Signalling Fault Management Controller, telecom controller, Engineering/Track controller etc. shall monitor and manage all train operations and associated activities, including maintenance of entire HORC from the SCC situated at State Entry Road New Delhi Station.

1.1.6 Communication and Control Signals for both Signalling & Telecommunications shall be distributed in and around the HORC via an Optical Fibre Data Transmission/Quad cable Network.

1.1.7 A high design standard, incorporating redundancy, flexible system arrangement, together with good quality products, and adherence to strict manufacturing standards, are required to ensure high reliability of systems installed.

1.1.8 All server / computer-based equipment, routers, switches should be sized / configured such that the processor loading does not exceed 50% under full load conditions (including spare capacity) to ensure satisfactory performance under full load condition without any performance degradation like slow response, hanging of processor etc. leading to requirement of restarting / rebooting of computer systems. The Contractor would provide proper documentation in support of compliance to this condition.

1.1.9 All components of various sub-systems shall be hot-swappable and independently replaceable. Hot swapping of the components shall not affect the equipment operation.

1.2 Purpose

1) This Specification covers the Design, Manufacturing, Delivery, Installation, Testing & Commissioning and Defect liability and maintenance of Telecom system for one year on HORC.

2) The Main Purpose of the Telecommunication System shall be to provide Voice and Data Transmission Capabilities throughout the HORC to enable efficient operation and management of the Railway System.

3) Telecommunication System shall also meet all the Data Communication requirements of Signalling and Electrification Works etc.

1.3 Scope Of Work

1.3.1 General:

1) Design, Supply, Installation, Testing, and Commissioning, of the Telecom works. The Telecommunication System shall also include, but not be limited to, the Sub-systems namely, required alteration/modifications to existing Optical Fibre Communication System, Quad Cable Communication System, IP Ready EPABX System and Attendant console, Train control communication including emergency communication system, VHF communication system and required SMPS based Telecom Power Supply System, Room (if required) for housing telecom equipment & power supply system for NR station Patli (PH-1 & 2).

2) And Design, Supply, Installation, Testing, and Commissioning of the Telecom works. The Telecommunication System shall also include, but not be limited to, the Sub-systems namely, required IP-MPLS based Optical Fibre Communication System, Quad Cable Communication System, IP Ready EPABX System and Attendant Console, Train control communication including emergency communication system, VHF communication system, Public Announcement System, Clock System and required SMPS based Telecom Power Supply System for Sultanpur of IR.

3) Design, Supply, Installation, Testing, and Commissioning of the Telecom works. The Telecommunication System shall also include, but not be limited to, the Sub-systems namely, required IP-MPLS based Optical Fibre Communication System, Quad Cable Communication System, IP Ready EPABX System and Attendant Console, Train control communication including emergency communication system, VHF communication system, Public Announcement System, Clock System and required SMPS based Telecom Power Supply System for HORC stations namely New Patli Jn.

4) Design, Supply, Installation, Testing, and Commissioning of the Telecom works. The Telecommunication System shall also include, but not be limited to, the Sub-systems namely, required IP-MPLS based Optical Fibre Communication System, Quad Cable Communication System, IP Ready EPABX System and Attendant Console, Train control communication including emergency communication system, VHF communication system, IP based integrated passenger information system, Clock System and required SMPS based Telecom Power Supply System for HORC stations namely Manesar Jn.

5) Design, Supply, Installation, Testing, and Commissioning of the Telecom works. The Telecommunication works shall also include, but not be limited to the Sub-systems namely, required Optical Fibre Communication System, Quad Cable Communication System, IP Ready EPABX System and Attendant Console, Train control communication including emergency communication system, and required communication arrangement for TSS, SP, SSP between Manesar Jn. & New Patli, Jn.,between Manesar Jn. &IR Patli, between New Patli Jn. & IR Patli, and between New Patli Jn.& NR Sultanpur. This also includes alterations/modifications to existing signalling/telecom system at Farukhnagar (NR) and Garhi Harsuru (NR) stations telecom system of NR.

6) Maintenance of the aforesaid Telecommunication system for one year period after final taking over.

1.3.2 Scope of Supplies

1) The scope of supply shall include all necessary Hardware, Software, Firmware, Accessories, Materials and Documentation for Telecommunication System. The detailed requirements shall be as given in this Particular Specification.

2) The scope of supply shall also include supply of Spares and Tools & Test Equipment as stipulated in this Particular Specification.

1.3.3 Scope of Services

1) The scope of services to be performed by the Contractor shall include Design, Manufacturing, Delivery, System Assurance, Storage, Installation, Testing and Commissioning of the Telecommunication System and Maintenance of the system for one year. The detailed requirements shall be asgiven in this Particular Specification and General Specification.

2) The scope of services shall also include, but not limited to, Project Management, Interface Management, Quality Management, System Assurance Management, Safety Management, EMC Management, Design, Procurement & Manufacturing Management, Construction & Installation Management, Overall Site Supervision & Management, ESHS Management, Completion Management, Warranty & Defect Liability period including Maintenance Management, etc.

3) The scope of services shall also include Maintenance Support Services including rectification & removal of defects during the Defect Notification Period including one year Maintenance and Training for Employer's Personnel.

1.4 Relevant Documents

1.4.1 This Particular Specification (PS) shall be read in conjunction with the Conditions of Contract, the General Specification, GS (S&T) and any other document forming part of the Contract.

1.4.2 In the event of a conflict between this document and others, the following precedence shall apply:

(1) Employer's Requirements-Particular Specification (Telecommunication Works).

(2) Employer's Requirements-General Specifications (S&T)

(3) General and Subsidiary Rules (G & SR) of NR

(4) Indian Standards referenced in this document including Indian Railway Telecom Manual.

(5) International Standards referenced in this document.

(6) Other National Standards.

(7) Other International Standards.

1.4.3 Notwithstanding the precedence specified above, the Contractor shall seek clarification from the Engineer in the event of conflict among above specifications and decision of the Engineer shall be final and binding.

(End of Chapter-1)

CHAPTER 2 — STANDARDS

2.1 List of standards/specifications

RDSO Specification with latest amendment shall be considered for various Telecom equipment. A copy of this specification shall be submitted with the specification of the equipment for engineer's approval. A list of specifications has been indicated as following:

Standards/Specifications	Topic
RDSO/SPN/TC/110/2020	RDSO Specification of 24/48 Fibre Armoured Optical Fibre Cable
RDSO/SPN/TC/45/2013 Revision 2.0	RDSO specification of permanently lubricated HDPE duct
RDSO/SPN/TC/68/2014 Revision 1.0	Joint enclosure for armoured optical fibre cable
RDSO's STT/TAN/IP-MPLS/2020 Version 1.0 First Issue Dec- 2020	IP-MPLS technology for unified communication backbone
RDSO/SPN/TC/84/2008 Rev.0.0	Specification of Router
IRS:TC:68/2012 Rev.0	Indian railway standard Specification for Primary digital multiplexing equipment
RDSO/SPN/TC/34/2002 with latest versions and amendments.	Voice frequency communication system for Underground QUAD Cable
RDSO/SPN/TC/37/2020 Revision 4	Fibre Distribution Management System
IRS:TC 30-05 Ver.1	Indian railways standard specification for underground railway jelly filled telecom quad cables for signalling & telecom installations
RDSO/ SPN/TC/ 101/2012 Rev.0	Silicone Gel based Cable Jointing kit
IRS: TC 41-97	Indian railway standard specification for polythene insulated polythene sheathed jelly filled telephone cable with poly-al moisture barrier

RDSO/SPN/TC/57/2015 Rev.1	Specification for thermoshrink jointing kits for jointing underground PIJF cable
RDSO/SPN/TC/27/2007 Rev.1.0	Digital/ISDN & IP ready EPABX system and attendant console – for more than 256 ports & up to 5000 ports
RDSO/SPN/TC/102-2013 Version 1.0	SMPS BASED TELECOM INTEGRATED POWER SUPPLY SYSTEMFOR STATION
IRS:TC-42/20 Version 1.0	Specification for six pin emergency plug and socket
RDSO/SPN/TC/44/2002 Ver.2	Specification for emergency socket box of FRP material
RDSO/SPN/TC/45/2013 Revision 2.0	PERMANENTLY LUBRICATED HDPE DUCT
RDSO/SPN/TC/73/2008, Ver.-1.0	Specification For VHF Based Secured Station Communication Equipment (SSCE)
RDSO/SPN/TC/107/2018	VHF Sets
RDSO/SPN/TC/102-2013 Version 1.0	SMPS based Telecom Integrated power Supply System for Station (TIPSS)
RDSO/SPN/TC/62/2008 Revision 3.0	Digital Clock with GPS Synchronization
RDSO/SPN/TC/63/2006 Ver.-1	Public Address (PA) system
RDSO/SPN/TC/66/2007	Control Communication System
RDSO / SPN/TC/97/2012 Rev.1	Telecom cable termination boxes for indoor use (non metallic)
RDSO/SPN/TC/98/2011 Rev.0	RDSO specification for surge protective devices for telecommunication equipment
Specification No. RDSO/SPN/TC/108/2019, Ver.-0.0	IP Based Integrated Passenger Information System
RDSO/SPN/TL/23/99 Ver 4.0	Specification for Battery chargers
RDSO Spec: IRS: TC 30-05	Underground Jelly Filled Telecom 6 Quad cable

RDSO Spec: IR S93-96 TEC Spec: GR/BAT-01/03 March 2004	VRLA Battery cells
IEEE 1100, NFPA 780, IEC 1024	Earthing System Standards
IEC 62278	RAMS
EN 50121 IEC 61000	EMC - Intra & Inter System
EN 50121 IEC 61000	EMI — Equipment is adequately protected against EMI, EMC — EMC testing
EN-50159	All vital & safety related information shall be implemented as per this standard in both First & Second OFC network
IEEE 802.1d	Re: In-built Layer-2 Bridging & Aggregation functionality
IEEE 802	Layer-3, Layer-2 switches shall support: IEEE 802.3ad — Link aggregation control IEEE 802.1Q — VLAN on all ports IEEE 802.1q — VLAN (tagging) IEEE 802.1x — Port based authentication IEEE 802.1d — Spanning Tree Protocol IEEE 802.1s — Multiple Spanning Tree Protocol IEEE 802.1w — Rapid Spanning Tree Protocol
IEEE 802	Layer 2 Switch IEEE 802.3 — Support Half Duplex IEEE 802.3u — Full Duplex IEEE 802.3ab — Auto Negotiation
RFC 2138	For DHCP, RADIUS Protocol
IEEE 802.1p	Classification & Scheduling on all ports
IEEE 802.1x	Access control mechanism via Authentication, Authorization & Cryptographic key Validation
IEEE 802.3af	PoE
IEEE 1100	

NFPA 780 IEC 1024	Earthing System Standards
IEC 60065, IEC 60364	All equipment must comply to System Safety Requirement
IEC60793 & IEC60874	IEC Specification for Optical Fibres and Connectors
IEC 60950	Safety of Information Technology Equipment
IEC 60364	Electrical Installations of Buildings
IS 4759	Hot dipped galvanized iron compliance for towers
ITU-T M-3010	ITU-T Recommendation on Principles for Telecommunication Management Network.
ITU-T Rec. 803	Proven SDH technology
ITU-T Rec. G.821	ITU-T Recommendation on Error performance of an international Digital Connection
ITU-T Rec. G.822	Allowable clock slip in PBX network internal clock when Master Clock is absent
ITU-T Rec. G.823	ITU-T Recommendation on Control of Jitter and Wander in 2 Mbps Digital Network
ITU-T Rec. G.825	ITU-T Recommendation on Control of Jitter and Wander in SDH Digital Network
ITU-T Rec. G.652	ODF: Optical connectors compliance
ITU-T Rec. G.712	ITU-T Recommendation on Transmission performance characteristics of pulse code modulation channels
G.7041	SDH equipment shall be equipped with EoS at 10/100 Base T

(End of Chapter-2)

CHAPTER 3 - PERFORMANCE REQUIREMENTS

3.1 General

3.1.1 The Contractor shall ensure that all equipment and material used shall meet the specified availability throughout its service life as required to minimise disruption to the train operation and to minimise the maintenance costs.

3.1.2 The System so designed shall have a minimum service life as following:

SN	Sub system/Equipment	Service Life (Years)
1	All the cables including Optical Fibre Cables, Jelly Filled Telecom Quad Cable, Telephone Cables and RF Cables etc.	25
2	VRLA Cells	7
3	OFC System (Equipment)	15
4	Other Sub system/ electronic equipment	15

3.1.3 The System shall be designed to facilitate Passenger/freight trains and station operation, management of incidents and abnormal operations as well as of emergencies.

3.1.4 The System shall, to the extent practicable, have no credible failure mode, which will directly cause an interruption or delay in the Train services. The Contractor shall demonstrate that the probability of occurrence of the credible failure mode, if any, has been reduced to ALARP (as low as reasonably practicable) and no further cost-effective means of improving reliability can be identified.

3.1.5 Reliability-Availability-Maintainability-Safety (RAMS) Plan for Telecommunication System shall be developed and implemented in accordance with IEC 62278.

3.1.6 Wherever the equipment being provided under Contract Package C-2 for HORC is being upgraded/augmented/reconfigured, the service life of these upgraded/augmented/reconfigured equipment shall be minimum 15 years from date of commissioning of this upgradation/augmentation/reconfiguration.

3.2 Reliability Requirements

3.2.1 The inability to perform a required function, the occurrence of unexpected action by the equipment, or the degradation of performance to below the required specifications shall constitute a failure.

3.2.2 The Contractor shall submit Mean-Time-Between-Failures (MTBF) figure for major equipment of each sub-system as specified in relevant chapters of this Particular Specification. It should be possible to achieve the required level of system availability, as specified in the relevant chapters of this Particular Specification, with these MTBF figures.

3.2.3 The Contractor shall submit Reliability Plan to the Engineer for review in accordance with RAMS Plan.

3.2.4 The Reliability Plan shall describe the analytical methods to be used during design and development to demonstrate compliance with reliability requirements and identification of reliability-critical items in the System offered.

3.2.5 The Reliability Plan shall identify a comprehensive list of reliability-related submissions

such as specifications, standards, method statements, procedures, drawings and records to the Engineer for review.

3.3 Availability Requirements

3.3.1 Detailed availability requirements for individual sub-systems are given in relevant Chapters of this Particular Specification.

3.3.2 The Contractor shall submit calculations with reliability block diagrams for each sub- system to demonstrate the compliance with required availability figures. The availability calculation shall take all possible failure modes into consideration. The calculation shall be based on the Contractor's submitted equipment MTBF figures, MTTR figures and the configuration of each sub-system.

3.3.3 Equipment duplication, hot-standby protection, parallel-run, path diversity, etc. shall be adopted whenever necessary and appropriate to meet the required availability.

3.3.4 Error detection and correction mechanism shall be included in the communication links as appropriate depending on the nature and functional criticality of the data conveyed.

3.3.5 Switchover between redundant equipment, or between redundant routings, shall occur automatically and immediately upon failure and shall be transparent to the users. Toggling in switchovers shall be prevented.

3.3.6 The Contractor shall conduct analysis and propose methods, if any, for further improvement of the availability of each sub-system beyond the minimum required availability figures mentioned above.

3.4 Maintainability Requirements

3.4.1 The Contractor's Response Time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at site where the faulty equipment is located.

3.4.2 The System shall be designed such that the Mean Time to Repair (MTTR) shall not exceed 2 hours. The MTTR shall include the diagnostic time, active repair/replacement time and adjustment/testing time on site, but shall exclude the Contractor's Response Time.

3.4.3 All plug-in modules shall permit hot swapping so as not to affect the normal or emergency operation of the System.

3.4.4 The System shall be suitably designed to minimise the need for frequent preventive maintenance.

3.4.5 The System shall be so designed as to avoid the need for a total shutdown for preventive maintenance.

3.4.6 The System shall be so designed as to prevent failures or breakdown due to invalid or incorrect inputs.

3.4.7 Built-in self-diagnostics, power-up self-test and sufficient test points shall be provided in the System to minimise the time required to locate a fault.

3.4.8 All components, materials, software and supports required for repair and servicing of the System shall be available during the entire lifetime of the System.

3.4.9 The Contractor shall submit Maintainability Plan to the Engineer for review in accordance with RAMS Plan.

3.4.10 The Maintainability Plan shall describe the analytical methods to be used during design and development stages to demonstrate compliance with maintainability requirements specified

herein and to identify the maintainability-critical items of the System.

3.4.11 The Maintainability Plan shall identify a comprehensive list of maintainability-related submissions such as specifications, standards, method statements, procedures, drawing and records to the Engineer for review. The Maintainability Plan shall include the date of submission.

3.5 System Safety Requirements

3.5.1 The Contractor shall support other Project Contractors with the provision of information and relevant analysis where the availability and usability of the Telecommunications System is a contributing factor to the overall system risk.

3.5.2 All Man-Machine-Interfaces shall be designed with the risk of Repetitive Strain Injury (RSI), eye strain and radiation-induced illness (both non-ionising and ionising radiation) taken into consideration.

3.5.3 The design of the System shall minimise the risk of fire.

3.5.4 The design of the System shall minimise the build-up of static, as well as the effects of static discharge during maintenance.

3.5.5 Components or materials containing toxic chemicals or asbestos shall not be used in the System unless absolutely necessary and unavoidable. Specific Approval of Engineer shall be obtained before using these components or materials containing toxic chemicals or asbestos.

3.6 Electromagnetic Compatibility (EMC)

3.6.1 The Contractor shall prepare and submit, EMC Management Plan, for review by the Engineer, which shall be based upon a top-down approach, define the EMC philosophy, activities, means of control for the design processes and EMC submissions to be supplied to demonstrate compliance with the PS and GS. The EMC Management Plan shall also identify a comprehensive list of specifications, standards, method statements and procedures to be submitted to the Engineer for review.

3.6.2 In respect of the EMC Design Documentation, the Contractor shall demonstrate by theoretical analysis that the design, of the electrical and electronic systems under this PS, is fully compliant with the EMC requirements identified.

3.6.3 The Contractor shall provide detailed calculations and inter-modulation analysis to establish electromagnetic compatibility (EMC) among the Sub-systems and with other systems in close proximity as part of EMC Design Documentation.

3.6.4 The Contractor shall ensure that all Intra-system EMC are taken care of through proper design and other measures in accordance with EN 50121 and IEC 61000.

3.6.5 The Contractor shall liaise and co-ordinate with all other Contractors in the exchange of EMC data and related equipment performance characteristics. Inter-system EMC between Telecommunication System and other electrical and electronic equipment shall be in accordance with EN 50121 and IEC 61000.

3.6.6 The Contractor shall ensure that all electrical and electronic apparatus of Telecommunication System is designed and protected against electromagnetic interference in accordance with EN 50121 and IEC 61000, to operate without degradation of quality, performance or loss of function in the electromagnetic environment of the Project. Adequate safety margins between the immunity levels of the Telecommunication System and the emission levels of other electrical and electronic equipment must be maintained.

3.6.7 The cost incurred in the suppression of electromagnetic or electrostatic interference including any hardware shall be deemed to be included within the Contract.

3.6.8 EMC considerations shall be incorporated in the Contractor's procedures for product safety and design Verification.

3.6.9 EMC Testing shall be carried out on all equipment identified in the design stage which requires attention regarding EMC in accordance with IEC 61000 and to meet overall compliance to EN 50121.

3.6.10 Relevant EMC test certificates for all standard off-the-shelf products shall be submitted to the Engineer for review.

3.6.11 The Contractor shall implement corrective actions to rectify any EMC problems identified during design, on-site testing and when the whole system is in operational service.

3.6.12 The Contractor must be fully aware of the EMC requirements and any modifications to systems and equipment carried out by the Contractor during the Defects Notification Period shall not cause the immunity, or emission levels of the installed system and equipment to exceed such values.

3.6.13 Any equipment consisting of sensitive electronic components that is likely to be handled or touched by any person shall be protected against electrostatic discharge and shall be tested as defined in IEC 61000-4-2.

(End of Chapter-3)

CHAPTER 4 - DESIGN REQUIREMENTS

4.1 Design Approach

4.1.1 The Contractor shall adopt a structured, modular and top-down approach for the design and exercise proper design control to ensure that the designs are in accordance with the requirements given in the Specifications.

4.1.2 The technologies adopted for the design of Telecommunication System shall be:

(1) field proven with past successful applications references

(2) conforming to open international/RDSO/IRS standards

4.1.3 The System design shall be based on redundant hardware in hot-standby configuration to minimise the single point of failure of the System.

4.1.4 The System shall be designed for continuous unattended operation for extended periods of time.

4.1.5 The Contractor shall submit a Design Plan. The design shall be in three stages of Preliminary Design, Detailed Design and Installation Design. The Design Plan shall define Contractor's policy for the design of works and shall without limitation, define;

(1) The organization of Contractor's design staff with particular reference to the design interfaces in detail;

(2) The specific allocation of responsibility and authority given to identified staff with particular reference to the review and verification of design specification, drawings and calculations by the Contractor in detail;

(3) The design and performance requirements which shall be defined in terms of basicdata and design assumptions made, relevant codes, standards and regulatory requirements, safety, reliability, security and environmental requirements and commissioning requirements in detail;

(4) The process of formal design review, authorization and approval of design documentation; and

(5) The process of independent design Verification and Validation.

4.1.6 During the Preliminary Design, the Contractor shall prepare System Requirement Specifications (SRSs) for each Sub-system and submit to the Engineer for review, which includes, as a minimum, operational, functional, performance and design requirements. System Requirement Specification shall serve as Contractor's top level design document and shall state all the requirements completely and unambiguously and how each requirement can be verified and validated.

4.1.7 Preliminary Design of individual Sub-systems shall be prepared and submitted to the Engineer for review, which includes, as a minimum, the function of each System, Sub-system, equipment or other element within the overall SRS and specify the relationship and interfaces between each element of the System, including the systems of the interfacing elements of the other Contractors.

4.1.8 The Detailed Design for individual Sub-systems shall be developed based on the Preliminary Design for individual Sub-systems and submitted to the Engineer for review. Detailed Design shall also include electrical and control schematics to illustrate, how the various operational and functional requirements can be achieved.

4.1.9 Software design & development shall also be carried out during Detailed Design stage, and

shall be included in the Detailed Design Submission for review of Engineer.

4.1.10 The Detailed Design shall include as necessary all technical aspects of all interfaces with other elements of the Contractor's overall design and of any interfaces with works being supplied by other Contractors. Detailed interconnection specification shall also be developed during this stage and included in the Detailed Design.

4.1.11 The Detailed Design shall also include detailed design calculations, and supporting drawings, documents, etc., for the applicable subsystems The design calculations shall demonstrate that the Contractor's Design fully complies with the requirements given in the specifications and shall further demonstrate that the ratings, capacity and quantity of the proposed equipment are adequate.

4.1.12 The Contractor shall also furnish the following calculations and analysis for each Sub- system as a minimum:

(1) Estimation of the power consumption and heat dissipation per equipment location.

(2) Prediction of the reliability and availability of the Sub-systems.

4.1.13 Upon approval of Detailed Design, the Contractor shall produce the respective Installation Design, which shall include, inter alia, the Equipment Layout Drawings, System Specifications, Installation Drawings, Cable Route Plan, E1/Channeling plan, Termination Plans, Configuration Details and all other associated documents necessary to supplement the design covered in the Detailed Design and to comply with the Contract regarding the installation of the equipment such as detailed Method Statement, Safety Risk Assessment etc.

4.1.14 As part of Installation Design, specified clearance as per SOD of track side equipment in milli metres from centre line of adjacent track(s) shall be prepared in a tabular form.

4.1.15 Only those drawings and documents of Installation Design that have been endorsed and certified as having been reviewed shall be issued to the Site.

4.1.16 If the Contractor identifies the need for any change to the design due to site conditions or other reason, then the Contractor shall produce a Design Change Notice or Field Change Notice.

4.1.17 The Design Verification and Validation Plan, supplementary to Design Plan shall be prepared by the Contractor in order that design Verification and Validation activities are properly directed.

4.1.18 The Contractor shall by means of the design Verification and Validation process demonstrate that all requirements within the specifications have been met. For this the Contractor shall prepare a Design Verification Table (DVT) that identifies the Contractor's proposed methodology for demonstrating compliance, and submit to the Engineer for review. DVT shall include Acceptance Criteria for achieving the requirement. DVT shall be monitored throughout the design and construction of the works. Changes, if any to the DVT, shall be submitted to the Engineer for review before implementation.

4.2 Design Review

4.2.1 The Contractor shall ensure that all design submissions are accurate, fully compliant, relevant and of good quality before they are submitted to the Engineer for review.

4.2.2 The design submission shall include following but not limited to:

- Preliminary Design as per GS (S&T)
- Detailed Design as per GS (S&T)

- Good for construction/ installation drawings or documents as per GS (S&T)
- As-Built drawings or documents and Operation & Maintenance manuals for whole work as per GS (S&T)

4.2.3 The Contractor shall ensure that all comments of the Engineer have been properly incorporated or otherwise resolved before resubmission.

4.2.4 The Contractor shall exercise adequate control to ensure that the number of resubmissions is a minimum. The following issues shall be addressed during Design Review Meetings:

- Design Progress Interface Issues

4.3 Man Machine Interface Design

4.3.1 For all MMIs specially designed or customised for the System, the Contractor shall provide and organise prototypes for demonstration and submission to the Engineer for review prior to implementation.

4.3.2 All MMIs shall be equipped with virus checking and anti-virus protection facilities to prevent from virus infection.

4.3.3 The Contractor shall co-ordinate with the Project Contractors to ensure that the latter's recommendations are properly reviewed, commented upon and the agreed items incorporated in the Contractor's MMI design.

4.4 Submission of Samples

4.4.1 The Contractor shall submit samples to the Engineer for review, when so required and instructed by latter.

4.4.2 The Contractor shall arrange site visits and/or videos for illustration if the items are bulky or impracticable for submission.

4.4.3 The Contractor shall provide samples of individual types of cables to the Engineer prior to the commencement of cable installation. The samples shall be properly protected with transparent housing for independent cable components including sheath, armour, insulation, cable cores, etc. for ease of identification as well as inspection. Each sample shall be properly labelled with description of the cable type.

4.4.4 All samples submitted to the Engineer shall become the property of the Employer.

4.5 Equipment Design

4.5.1 General Considerations

(1) Specific equipment design requirements for individual Subsystems are given in relevant chapters of this Particular Specification.

(2) The offered equipment shall be field proven with past history of successful performance in railway environment.

(3) All equipment shall be designed and constructed to operate without degradation in quality, performance or loss of function in the electromagnetic environment prevalent in a standard Heavy Passanger/Freight Corridor Railway System.

(4) All Housing, Enclosures and Cabinets housing outdoor equipment shall be compliant to IP65 for Ingress Protection.

4.5.2 Fire and Smoke Precautions

(1) The cable routes shall be suitably designed to prevent trapping of rubbish which could later become a fire hazard.

(2) Every possible precaution must be taken to prevent the flow of fault currents through the cables, especially from the traction power system. Communication cables must be kept away from high tension power supply cables.

(3) All necessary measures shall be adopted to prevent the creation of hazardous conditions arising out of overheating and/or ignition of cables.

(4) All of the above requirements shall be fully complied with without compromising any of the mechanical or electrical properties of the cables.

(5) Portable Fire Extinguishers shall be provided in Telecommunication Equipment Room/Telecommunication Power Supply equipment Rooms at Stations, Interfacing IR Stations, TSSs, SPs, SSPs, IMD, Staff Residential Colonies etc. Portable fire Extinguishers shall be compliant to NFPA 10 standard and suitable for electrical equipment.

4.6 Environmental Conditions

4.6.1 All equipment shall be protected from damage or degradation in performance due to shock or vibration as experienced in railway environment.

4.6.2 Unless otherwise specified, all indoor Telecommunication Equipment installations shall be designed for operation continuously in environmental temperatures range of -5°C to +55°C.

4.6.3 Telecommunication Equipment Room (TER) at SCC and Stations shall be provided with Air-Conditioning. Provision of Air-Conditioning in TERs at SCC and at Stations is covered under Electrical scope of this Package C 2. TER at SCC is classified as 'Class-A' and TERs at Stations are classified as 'Class-B1' under Clause 1.3 of General Specifications (S&T).

4.6.4 Telecom Power Supply Equipment Rooms at HORC Stations shall be provided with suitable means to regulate temperature and maintain air-circulation with 1+1 standby, within limits so as to facilitate proper working of Power Supply Equipment and VRLA battery as during summer time the temperature inside the equipment room is likely to reach very high. These provisions of to regulate temperature and to maintain air-circulation shall be provided by Contractor under C-2 package electrical contract.

(End of Chapter-4)

CHAPTER 5 - OPTICAL FIBRE COMMUNICATION (OFC) SYSTEM REQUIREMENTS

5.1 General

1) The OFC System shall be a highly reliable system since it shall be the primary means of communications between Stations, Interfacing IR Stations, TSSs, SPs, SSPs etc. on which a number of other operationally critical systems will rely upon.

2) The OFC System shall provide a high degree of availability and redundancy by operating on two independent optical fibre rings. Proven technology of SDH (Synchronous Digital Hierarchy) as per ITU-T Rec. G.803 shall be used at IR Station Patli. Proven technology of IP-MPLS as per RDSO's Technical Advisory note No. STT/TAN/IP-MPLS/2020 Version 1.0 First Issue Dec- 2020 as mentioned in Chapter 2 of this document shall be used at all other Stations of HORC and IR.

3) The OFC System shall be capable to transport all of the user communication requirements. The OFC System shall provide sufficient bandwidth to cater for the communication requirements of various systems under this Contract.

4) This OFC system shall be integrated with existing OFC System of working provided at Interfacing IR Stations.

5.2 Scope of Supply for OFC System

5.2.1 The scope of supply shall include, but not be limited to, the following:

(1) SDH Equipment at Patli & Sultanpur Station of IR;

(2) IP-MPLS Equipment (LER, LSR and other)

(3) Network Management System for IP-MPLS/sdh & PDH equipment of OFC system;

(4) Local craft terminal (Laptop) for MPLS/ SDH equipment etc.

(5) Portable maintenance terminal for PDH Equipment

(6) Ethernet switch

(7) All required software and licenses;

(8) Single Mode Optical Fibre Cables;

(9) Splice Boxes

(10) Distribution Frames;

(11) Fibre Management System

(12) Equipment Cabinets, Racks and Cubicles;

(13) Terminating and Interconnecting Equipment;

(14) All required connectors and SFP;

(15) Installation materials;

(16) All required accessories;

(17) All required power and data cables and OFC patch chords

(18) Earthing arrangement, lightening arrestors and Termination Protection Devices.

(19) SMPS based Telecom Power Supply System at Stations.

(20) UPS system for power supply at TSS/SP/SSP and stations.

(21) Room to house telecom equipment/power supply equipment if required at Patli station of IR.

(22) Suitable Racks for TSS/SP/SSP and stations.

5.3 System Requirements

(1) The OFC System shall be a IP-MPLS Optic Fibre Communication Network, based on open standards and fully conforming to the relevant RDSO Recommendations as specified in the Chapter-2 of this document.

(2) It shall also be required to interface with existing SDH/PDH equipment provided at Patli & Sultanpur Station of IR.

(3) At connecting IR station namely Patli, necessary Telecom equipment required under the scope of work shall be provided in existing Telecom equipment room. If space is not available in the existing rooms separate Room shall be provided by the contractor.

(4) The OFC System shall support voice, data and video signal transmission between various locations and modes of transmission shall include, but not be limited to:

- point-to-point;
- point-to-multipoint;
- drop-and-insert;
- cross-connect; and
- any other modes required for the implementation of the Subsystems.

5.3.1 Optical Fibre Cable Network

(1) There shall be two separate optical fibre backbone networks namely First Network and Second Network. Each of these two networks shall be formed by utilizing separate OFC cables.

(2) Both First and Second network shall be terminated on ODFs in TERs at all Stations of HORC for providing protection path and for interfacing with IR & DFCCIL network.

(3) Both Network shall carry all Vital & Safety Related System and protection path for second network and interfacing requirements of IR/Railtel/DFCCIL using OFC System shall be implemented as per EN-50159. They shall also carry all Voice (including Emergency Communication and various Train Control communication circuits originating from IMD/SCC) and Data circuits (including Traction Power SCADA) between HORC Stations, TSS.SP, SSP and Interfacing IR Stations.

(4) Both the Networks shall be capable of providing protection path to each other.

(5) The Second Network shall also carry all Information between TSSs, SPs, SSPs, with SCC.

(6) In addition to IP-MPLS Network, optical fibres shall also be used for Data Networking

System , for Modern Signalling Systems like CTC,TMS, TCAS, GSM-R etc. and for RCIL use in future. Therefore the optical fibre cables shall have a minimum Fibre count of 24 fibres. At least 50% of fibres within each cable shall be reserved as spare for future use.

(7) At least 10 metres slack in each optical fibre cable shall be provided for future network modification before taking cables to ODFs.

(8) All fibres of optical fibre cables, including the spare fibres, at ODF shall be either spliced through or spliced with optical pigtails or terminated at the optical patch panels. At least 10 meter optical fibre cable loop shall be provided for each cable inside a suitable underground chamber at all Optical Fibre Cables Jointing Locations.

5.3.2 IP-MPLS Network

(1) The IP-MPLS routers shall be installed in Telecom equipment rooms at all stations and should work efficiently in similar environmental conditions. These shall be called MPLS-PoPs (MPLS point of presence). Two LERs at each crossing station, Two LERs & one LSR at each junction station OF HORC shall be provided. One LER at each IR/DFCCIL interface stations shall be provided.

(2) OFC Communication services will be mapped to the MPLS network as an E1 circuit, MPLS VPN (L3/L2) and at MPLS boundary locations, STM-1 interface with adjacent SDH network of IR depending upon the application.

(3) The communication network shall consist of MPLS rings connected to every station in section terminating at a junction station. The station to station MPLS connectivity shall be on 10GB optical interface. Suitable VPNs can be defined for segregation of the network.

(4) Data networks such as PRS/UTS/FOIS etc. on MPLS nodes at all stations shall have route redundancy function.

(5) IP exchange installation works shall include OFC and LAN cabling so as to cover the connectivity to all subordinate offices/IMD etc.

(6) LER with STM-I interface must be used to connect the HORC section with the IR connecting Station that has existing SDH equipment.

(7) HORC shall form an MPLS domain in itself or connect to IR Delhi division's/Railtel MPLS network using Border Gateway Protocol. Border Gateway Protocol (BGP) is an Internet Engineering Task Force (IETF) standard, and the most scalable of all routing protocols. BGP is the routing protocol of the global Internet, as well as for Service Provider private networks.

(8) Each MPLS Node of the First Network and Second Networks shall be IP-MPLS routers (Label Edge Router (LER) with Label Switch Router (LSR). The exact level of MPLS Node shall be determined by the Contractor to meet the bandwidth requirements for sub-systems under this Contract with 50% Spare Capacity.

(9) MPLS Traffic of Manesar Station shall be carried over to SCC via Patli and Sultanpur Stations of IR.

(10) Control/Processor Card (if its failure results in affecting traffic), Switch/Matrix Unit & Power Supply Modules of MPLS Equipment shall be provided with 1+1 Protection.

(11) The communication network shall consist of MPLS rings connected to every station in section terminating at a junction station. The station to station MPLS connectivity

shall be on 10G optical interface. Suitable VPNs can be defined for segregation of the network.

5.3.3 Access Network

Each MPLS/SDH Node shall support direct access of tributary signals including, but not be limited to:

(1) MPLS/SDH optical and electrical signals of same/lower levels; 2Mbps or the E1 tributaries;

(2) Ethernet tributaries at 10/100 Base T;

(3) The MPLS/SDH Nodes shall be fully equipped minimum for 63(sixty three) 2 Mbps tributaries. All the tributaries shall be terminated on distribution frame for access.

(4) Protection switching mechanisms shall be provided for the tributaries of the MPLS Node. 2 Mbps tributaries shall be provided with 1:3 (Minimum) Protection and all the other tributaries shall be provided with 1+1 Protection.

(5) The MPLS/SDH Nodes of First Network shall be equipped with minimum 4 Ethernet 10/100 BaseT tributaries. MPLS/SDH Nodes of Second Network shall be equipped with minimum 4 Ethernet 10/100 Base T tributaries.

(6) Primary Order Multiplexer shall be provided to connect to the 2Mbps tributaries of the MPLS/SDH Nodes for direct access of channel circuits with data rate lower than 2Mbps.

(7) Primary Order Multiplexer shall have minimum 50% spares for all types of Channel Circuits (Minimum 1 for all types of Channel Circuits).

(8) All the channel circuits, including spare circuits, shall be terminated at the main distribution frame, digital distribution frame as appropriate for circuit access.

(9) The MPLS System shall provide Voice and Data Communication Network/Channels or Bandwidth to meet the requirement for system/subsystems being provided under this Contract.

(10) Ethernet Connections for each application need to be implemented through Ethernet Virtual Private Line Service.

(11) The MPLS System shall include a bandwidth management tool to ensure sufficient transmission capacity for each application to function under all traffic circumstances on the MPLS System.

(12) LER shall provide the following minimum interfaces:

a) 8x10G (optical) to connect to the adjacent stations.

b) 16xE1 (G.703) for working various TDM circuits of stations utilising PD-Mux as well as directly.

c) 4x1GbE (copper) to connect various networks at stations.

d) 4x1GbE (optical) to connect various networks at stations optically.

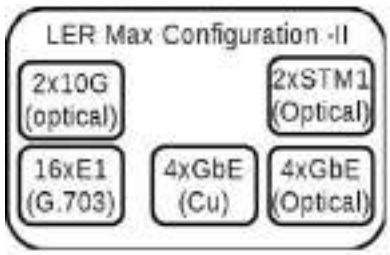
e) 6x E&M circuits to connect various 64K circuits.

f) 6x FXS circuits to connect various Auto exch telephones.

g) 8x FXO circuits to connect various Auto exch telephones

(13) All wayside LERs Shall have the following upgrade options:-

- Should be possible to upgrade the equipment to have a total of 32xE1 (G.703) ports by way of adding / replacing interface cards as LER Max Configuration-I. or
- Should be possible to add 2xSTM-1 (channelized, optical) ports. Thus by way of adding / replacing interface cards / ports as LER Max Configuration-II.

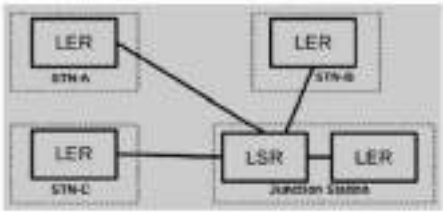


(14) LER should be configurable in all three configurations;

a) At the junction stations where there are more than two fiber path terminates, an additional Label Switch Router (LSR) should be used.

b) The LSR should be equipped with 8x10G (optical) ports.

c) The LSR will cater to junction stations having fiber coming from up to seven directions



(15) An all India IP plan for the loopback IPs and interface IPs must be in consonance with HORC/IR MPLS network so that in future if IP level connectivity is required to be done with RCIL, it becomes smooth.

5.3.4 OFC System Network Synchronisation

(1) The OFC System Synchronisation shall adopt master and slave synchronisation method.

(2) The Network Element equipment shall support programmable prioritized synchronization source selection scheme covering all available synchronization sources.

(3) The SDH/IP-MPLS Equipment shall derive the synchronisation timing signal from, but not limited to the following in order of priority;

- Master Clock Equipment/Sub Master Clock Equipment;
- an internal clock of the SDH/MPLS Equipment;
- incoming STM/MPLS Signal;
- incoming 2 Mbps Signal

(4) The SDH/MPLS Equipment shall switch automatically to another timing reference if the selected timing reference is lost under the criteria stipulated in ITU-T G.783.

(5) The priority list and the synchronization source currently used by the equipment shall be retrievable.

(6) The SDH/MPLS equipment shall provide user-selection of synchronizing the outgoing STM/MPLS signal in one of but not be limited to the following synchronization modes:

- Internal Clock Mode; and
- Incoming STM/MPLS to outgoing STM/MPLS Signals.

(7) When all incoming timing reference is lost, the equipment shall be capable of entering into Holdover Mode.

(8) Synchronization network shall be protected against single transmission network node/link failure, that is, a single node/link failure shall not cause a complete loss of synchronization reference to any other transmission network node.

(9) Engineering of the synchronization network plan shall ensure the normal functional operation and no voice performance degradation of the inter-telephone switch communication.

(10) Automatic re-configuration of synchronization source shall not cause any interruption or generation of errors in any low speed and high speed signals being transported by the Network Element equipment.

(11) Synchronization plan shall prevent repeated switchovers of synchronization sources automatically when intermittent/frequent failures occur in the clock sources(s).

(12) The Network Element equipment shall provide manual switchover to a specific synchronization source irrespective of its priority in synchronization sources selection with password protection. Manual switchover to a failed synchronization source shall be prevented by the equipment.

(13) Facilities shall be provided at the Network Element equipment to monitor the performance of the derived synchronization timing signals and report the corresponding alarm conditions to the NMS of SDH/MPLS.

5.3.5 Network Protection

1) The SDH/MPLS Equipment shall support Protection Mechanism such as Linear Multiplex Section Protection, Sub Network Connection Protection (SNCP), Multiplex Section Shared Protection Ring (MSSP Ring).

2) Path Protection implementation through SNCP is preferred. SNC Protection shall be provided at VC1/E1 level. Signal transmission shall be protected on a per path basis.

3) The normal and protected routes shall be routed through different Cables of the Optical Fibre Cable with path diversity. Between Manesar and New Patli OFC cable shall be laid on both sides of the track and at station in separate trench from signalling trench while single quad cable shall be laid on Telecom Equipment Room/TSS/SP/SSP side. Between Manesar and existing IR Patli (PH-I) and between New Patli to existing IR Patli (PH-II) & Sultanpur, single OFC cable & Quad cable shall be laid and used.

4) Automatic path protection switching shall occur upon detection of failure or alarm

conditions which will affect the quality of signal transmission. The protection switching shall be completed within 50ms.

5) Manual Protection Switching facility shall be available. Manual Protection Switching shall be initiated by a switch command from the NMS. The protection switching shall be completed within 50ms.

6) Failure of any single SDH/MPLS node shall not affect the operation of the remaining SDH/MPLS nodes in the network. Fault in any single fibre cable section shall not affect the operation of any SDH/MPLS node or Sub-systems data exchange. Alarm of the particular node shall be raised at the NMS.

7) PD-MUX shall be provided with 1+1 Redundancy for E1 Channels. Further 1+1 Protection for Control (if its failure results in affecting traffic) & Power Supply Modules/Cards shall be provided in PD-MUX Equipment.

8) No single failure shall affect the availability of OFC System or the Interfaces.

9) The OFC System, under the fault conditions, shall remain in operation and automatically reconfigure, if necessary, without the need for control by the NMS.

5.3.6 Service Telephone / Order Wire

- A Service Telephone/Engineers Order Wire with handset shall be provided at each and every SDH/MPLS Node locations for point-to-point and point-to-multipoint voice communication calls between maintenance staff at different SDH/MPLS Node locations. It shall permit selectiveand group call functions.
- The operation of Service Telephone/Engineers Order Wire shall not affect the operation of the signal transmission within the OFC System.

5.3.7 Network Management System

1) At the SCC/IMD, Network Management System (NMS) shall be provided to carry out Real- time centralised and remote monitoring and measurement of network status and performance, and the ability to take prompt action to control the flow of traffic when necessary. The equipment to be managed shall include SDH/MPLS Equipment, Primary Order Multiplexers, etc.

2) NMS Workstation(s) shall be installed at the SCC/IMD in TER (or any other location as decided by the Engineer) for the operation of the NMS.

3) The NMS shall be equipped with spare ports for future additional Workstations and the ports shall allow remote connection through commercially available modems.

4) Normally the open source software and equipment to be used for ease in integration and to optimize cost.

5) NMS Workstation(s) shall be equipped with a log printer for alarm and event print-out.

6) The NMS shall be equipped with mass storage device for storage of the configuration and alarm data-files.

7) The mass storage device shall provide facilities for downloading the configuration and alarm data files to Pen Drive/SSD.

8) Laptop Portable Service Terminals (1 numbers) loaded with Network Management Software shall also be provided for maintenance access to the network elements at various node locations.

9) When fault occurs in optical fibre, the NMS of the active system gets alarm and then intimates the fibre maintenance team about the link failure. The maintenance team goes to the FDMS for checking the fault distance by using traditional test equipment called OTDR to find the location of fault occurrence.

10) It shall be possible to generate customized reports for various types of faults, performance history, security management etc.

11) The Network Manager shall provide the complete view of the network elements and the interconnecting links. The NMS shall have the ability to include the network elements and the links in the visual/graphical map of the domain. The visual maps shall display the elements and the links in different color depending upon the status of the links.

12) The Network Manager shall have suitable system level backup mechanism for taking backup of NMS data of at least one month. It shall be possible to take any Network Element out-of-service and in-service from the NMS. It shall be possible to restart the Network Element from NMS.

13) Calendar Management: It shall be possible to execute any schedule administrative command i.e.- NE backup, software download, performance, operator log-in/ log-out etc., at any time by attaching a time tag to the command and it shall be executed when the Network real time matches the time tag. It shall be possible to define both time and date. If no date is mentioned, the command shall be executed daily at the time indicated.

14) The NMS shall have a messaging system which will generate and send alert messages on telephone (fixed and mobile), e-mail or SMS to the designated personnel depending upon the location of NE.

15) All critical components and units of the NMS i.e. – LAN interfaces, hard-disk, processor etc., shall be fault resilient. In case of loss of NMS connectivity, the LCT privilege shall remain for monitoring and for local configurations, as privileged by NMS administrator.

16) It shall be possible to store all the performance and traffic statistics for a month. It shall also be possible to generate daily, weekly, monthly reports for the individual element as well as complete domain. The report generation shall be supported for text and graphic reports. Network management security features shall include operator authentication, command, menu-restriction and operator privileges. The NMS shall support multilevel passwords as below:

17) The system administrator shall be able to monitor and log all operator activities in the NMS and NE.

18) The dynamic password facility shall be provided in which the operator may change his password at any time.

19) All log-in and log-out attempts shall be logged in the audit log file of the NMS system.

20) The network and the management system shall be protected against intentional or accidental abuse, unauthorized access and loss of communication.

21) The system shall provide a record of all log-ins for a period of at least six months.

22) The NMS shall enable operations like changing the system configuration, reconfiguration of input and output devices, loading a new software package, etc.

23) The NMS shall have an internal clock synchronised to the Master Clock for the time and date information. The internal clock shall allow free running in case of loss of signal from master clock.

24) The NMS shall provide Operations, Administration, Maintenance & Provisioning (OAM&P) functions in accordance with the Telecommunications Management Network (TMN) concept described in ITU-T Recommendations M-3010.

25) The software shall be compatible with Microsoft Windows and/or Linux operating systems

26) The Contractor shall provide a main and standby database for storing the system hardware and software configurations. Both the working and backup configuration database shall be automatically updated for any changes in the database.

27) Network Monitoring System Software shall be installed on a server grade PC with redundant Power Supply and RAID

28) The software shall come with an initial license for 1000 managed devices. The NMS software shall have the capability to extend the node limit in future by purchasing the additional node licenses.

29) Shall provide performance management including CPU utilization, Memory utilization, Bandwidth utilization, threshold-based alarming etc

30) Shall support comprehensive configuration Management like Bulk configuration, scheduled backup and restore, base lining and notification of changes etc

31) Network Management system and the network elements shall provide operation, administration, maintenance & provisioning (OAM&P) functions

32) Network Management system shall be able to automatically discover the network Equipment and associated links and place them on a topology map.

33) shall be capable of Collecting and aggregating logs and events from IT infrastructure devices such as Router, Switch, Wireless LAN, Security devices, Firewall, IPS/IDS, NAC, Authentication server, Hosts, Endpoints and Application systems via Trap, Syslog, Windows event log or Log file with both, agent based and agent-less technologies.

34) Network Management system shall provide a proactive and efficient monitoring system that helps to detect and avoid potential backbone problems.

35) shall have Real-time packet and flow analysis with web-based data visualization. Shall receive network traffic via SPAN, Mirroring port, Network Tap, Network Packet broker, NetFlow, sFlow, IPFIX, Net Stream.

5.3.8 Network security

It may require deployment of external devices/machines/ firmware at the network operation centre [NOC], like-

1) Firewalls

2) access control servers

3) data encryption devices/use of PKI keys

4) Anti-virus packages.

5) Loading of NE software from NMS.

6) Alarm shall be raised for disc memory usage at NE level. The same shall be displayed by NMS.

7) At the time of downloading the software, the message shall be displayed that the software has been downloaded successfully or failed and at what stage.

8) The operator terminals (local and remote) shall not allow loading of any software without the administrator's authorization.

5.3.9 Alarm and Status Monitoring

(1) The operational status and performance of all the network elements shall be monitored on a real time basis by the NMS. The status monitoring shall be down to the card level as a minimum.

(2) The network elements shall have alarm logging facilities so that detailed history of the failure alarms can be retrieved either locally using the portable service terminal or remotely by the NMS.

(3) Alarms to be collected from network elements shall include, but not be limited to, the following:

(1) loss of frame alignment;

(2) high error rate alarm;

(3) loss of pointer;

(4) loss of synchronisation;

(5) out of frame alignment;

(6) alarm indication;

(7) high/low optical power;

(8) high laser bias;

(9) tributary unit failure;

(10) power unit failure;

(11) external synchronisation failure; and

(12) any card/module failure.

(13) Loss of signal (LOS)

(14) RS-TIM

(15) MS-AIS

(16) B-2 Error* (Excessive) $1x10^{-3}$

(17) MS-RDI

(18) AU-AIS

(19) AU- LOP

(20) HP-UNEQ

(21) HP-TIM

(22) HP- RDI

(23) B-3 Error* (Excessive) 1x10-3

(24) LP- TU-AIS

(25) LP- UNEQP

(26) LP- TIM

(27) TU- LOP

(28) TU-LOM

(29) V-5 Error*

(30) LP- RDI

(31) GFP alarms as per G.7041- LFD, CSF

(32) LCAS as per G.7042.

(4) Failure alarms shall be classified into user configurable major/ minor etc. alarms. All alarms and status changes shall be stored in local storage of network elements, stored in mass storage device at SCC/IMD and output to the printer on demand. All alarms and status shall be stamped with time and date within an accuracy of 1 second.

(5) Each alarm log shall include details on the type and nature of the fault, alarm category, fault location, date and time fault is detected and date and time the fault is cleared. An audible alarm shall be given at NMS workstation and shall be reset by maintenance staff on acknowledgement.

(6) A local alarm indication for the network element shall be given and shall be reset automatically upon the alarm is cleared.

(7) A summary alarm shall be provided at the rack top to indicate the alarm status of any element within the rack. The summary alarm shall be reset automatically upon the alarm is cleared.

(8) The NMS shall provide function for user to enable and disable output of alarm events to the log printer.

5.3.10 Performance Monitoring

(1) The NMS shall calculate, display and provide print-out of the performance statistics for the SDH/MPLS System.

(2) In-service performance monitoring for all network elements shall include, but not be limited to the following performance parameters:

- optical power transmitted;
- optical power received;
- degraded duration in minutes;
- severely error seconds;
- protection switching counts;
- protection switching duration;
- error seconds of the received E1 and above signals; signal level of the received E1 and above signals;

- error free seconds of the received E1 and above signals; and
- bit error rate of the received E1 and above signals.

(3) Loss of power shall not cause any corruption or loss of data in the network elements and the NMS.

(4) The in-service performance data files shall be able to be transferred to disk or any other storage media subject to review by the Engineer. The data files shall be in format to allow analysis using commercially available software.

5.3.11 Network Configuration and Provisioning

1) The Contractor shall provide a main and standby database for storing the system hardware and software configurations. Both the working and backup configuration data base shall be automatically and simultaneously updated for any changes in the data base.

2) The NMS shall allow the user to configure all existing and new circuits with the following functions:

- interface port allocation;
- low speed (64 kbps & lower) interface cards configuration;
- lower order multiplex time slot allocation and routing;
- higher order multiplex/cross-connect switch configuration;
- logging of circuit routing data logged into configuration database;
- operator's configuration checks function prior to main and backup database update; and
- the OFC links from junction stations to the adjacent station of IR

5.3.12 User Interfaces

NMS functions shall be performed via a user-friendly graphical user interface (GUI) in real-time mode.

5.4 Performance Specification

5.4.1 General

1) In addition to what has been specified in Chapter 3 the following performance requirements for the OFC System shall be complied.

2) The OFC System shall be equipped with sufficient capacities and margins such that the System can operate properly under peak load or traffic conditions.

3) Fault tolerant design with protections against failure shall be provided in order to achieve the system availability. Protections shall include, but not be limited to path diversity, redundancy and duplication of reliability critical equipment, component and circuits.

5.4.2 Reliability

1) The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a failure.

2) The Contractor shall furnish for the following sub-systems/equipment, the reliability

figures, MTBF Hours from the OEMs.

(1) SDH/MPLS Node Equipment

(2) Primary Order Multiplexer

(3) Network Management System

5.4.3 Availability Requirements

1) The Contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the OFC System shall not be included in the determination of the system availability. The Contractor shall submit to the Engineer for review and consent the RAMS analysis for the OFC System to establish the requirements of availability specified here below.

2) The availability of OFC System at circuit level shall be defined as the availability of the circuit between both end points of the Optical Fibre Communication System Network where the required bandwidth is available for access. The equipment connected for the access for the circuit bandwidth shall be excluded from the availability calculation.

3) Any circuit of the OFC System shall be considered unavailable if;

4) there is a loss of communication between end points of the circuit; or

5) quality of the signal transmission within the circuit is below the performance standards stipulated in this Particular Specification.

6) The availability of any circuit at 2 Mbps level or higher within OFC system shall be better than 99.99%.

7) The availability of any circuits below 2 Mbps level shall be better than 99.95%.

8) The Network Management System shall be considered unavailable if any functions provided by the Network Management System cannot be properly exercised. The availability of the Network Management System shall be better than 99.5%.

5.4.4 Maintainability Requirements

- The Contractor shall comply with the maintainability requirements as specified in Clause 3.4 of this document.

5.4.5 System Safety Requirements

- In the event of a break in the optical fibre cable, the optical transmitter laser output shall shut down to a safe level as defined by IEC-60825, ITUT-G 958. The shutdown mechanism shall not be software dependent.
- All equipment must comply with, and be installed in conformance with IEC 60065 and IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.
- All metallic enclosures shall be provided with an earth terminal.

5.5 Technical Requirements

5.5.1 General

1) The Contractor shall submit the following information to the Engineer for review:

a) details on the specifications of each low speed data and voice channel interfaces

below E1 level;

b) details on all the available data and voice channel interfaces that the Primary Order Access Multiplexer can be equipped with and, the limitations;

c) details on the hardware modularity of each type of data and voice interface including the incremental number of interfaces that can be added to a partially equipped equipment shelf and limitations on the addition of the interfaces to the equipment already equipped with mixed types of interfaces shall be defined;

d) details on the electrical and physical specifications of the local maintenance port which support remote and local operation, administration, maintenance and provisioning (OAM&P) functions of the equipment;

e) the calculations of delay for signal transmission between SDH/MPLS nodes;

f) optical link budget calculations for all the transmission links;

g) a list of alarms for which the faults shall be detected;

h) format in which alarms shall be displayed and remotely accessed for printing and display;

i) the details on the maximum number of tributary signal interfaces that can be supported by the SDH/MPLS node and the limitations;

j) the details of the synchronisation network design and a synchronisation plan which describes the fall-back arrangement, failure and restore criteria used to determine the switchover of synchronisation sources, the associated timings under each failure and restoration event and the method used in preventing repeated switchovers of synchronisation sources automatically when intermittent/frequent failure occur in the clock sources;

k) the details of the NMS design, flow of management traffic and protection against SDH/MPLS node failures or cable failures;

l) types and maximum number of transmission equipment supported by the NMS;

m) self-healing mechanism, normal traffic flow diagrams, protected traffic flow details for various single and multiple cable(s) and/or node(s) failures; and

n) normal and protected bandwidth allocation, maximum traffic capacity and method of calculation for the SDH/MPLS Network.

o) The Contractor shall estimate and provide the bandwidth needed in order to guarantee the level of service required by all the Sub-systems.

2) At least 50% Spare Traffic Bandwidth and capacity between nodes shall be provided for SDH/MPLS Network and Primary Multiplexer Network. Spare capacity shall be achieved by providing additional cards and/or modules.

5.5.2 Technical System Performance

1) The OFC System shall conform to relevant ITU-T G-series Recommendation.

2) The jitter and wander performance shall conform to ITU-T Rec.G.823, and G.825, as applicable.

3) Voice Circuits shall have an end to end performance in accordance with ITU-T Rec. G.712.

4) Data circuits shall have an end to end error performance in accordance with the ITU-

T Rec. G.821.

5) The maximum traffic interruption time for any required service bit rates due to link, node or any other failure shall be less than 50 ms. It shall include the duration for protection switch time completion with the sequence of events below:

- from the onset of a failure detection to the completion of protection switching;
- from the clearing of a failure to the completion of protection switching recovery (in case of reversion switching)
- from the activation of the recovery command to the completion of protection switching recovery (in case of non-reversion switching; and
- reframing time required by equipment including, but not be limited to, SDH/MPLS equipment, PD-MUX Multiplexers, optical line terminal and data modem.

6) The absolute group delay, at the frequency of minimum group delay, shall not exceed the limit of 600 microseconds, as per ITU-T Recommendation, taking into account of the worst delay scenarios.

7) The system response times of the NMS shall be as follows:

- commands presented to the NMS from Management Workstation shall be processed and produce an appropriate output within 2 seconds maximum;
- real-time data presented to the Management Workstation from the network elements shall be processed and produce the appropriate output within 2 seconds maximum; and
- execution of parameter changes to SDH/MPLS Nodes initiated through the NMS shall be less than 2 seconds.

5.6 Equipment Design Requirements

1) General

- The equipment design of OFC System shall be of standard rack with plug-in units. Hot swapping capability shall be provided for all cards/units including redundant power supplies. Hot-swapping of the plug-in units shall not affect the equipment operation.
- Equipment shall be equipped with protected test points for measurement and performance monitoring without affecting the traffic.
- Test access facilities shall be provided at different transmission levels.
- Equipment shall be provided with natural cooling arrangement, however if natural cooling arrangements are not adequate, the use of fan shall be provided.

2) SDH Equipment

- All SDH equipment shall conform and be compliant with ETSI 300 147 and relevant ITU-T Recommendations including of G.707 to G.709, G.781, G.783, G.784 and G.957.
- The SDH Equipment shall operate satisfactorily at 48V+20% DC. The Contractor shall provide power supply equipment for power conversion if necessary. The equipment shall be capable of withstanding voltage spikes of up to 3 Volts over the

maximum voltage.

3) MPLS Equipment :

(1) All MPLS equipment shall conform and be compliant with RDSO's TAN document No. STT/TAN/IP-MPLS/2020 Ver 1.0.

(2) The MPLS Equipment shall operate satisfactorily at 48V+20% DC. The Contractor shall provide power supply equipment for power conversion if necessary. The equipment shall be capable of withstanding voltage spikes of up to 3 Volts over the maximum voltage.

(3) Label Edge Router (LER)

1) Chassis shall fit into a standard sized 19 inch rack mounting.

2) Router should have redundant DC power feeds: -48VDC nominal.

3) Router should be temperature hardened as it is normally placed at field locations without any air conditioning arrangement.

4) The router shall provide a non-blocked switching matrix up to system capacity.

5) Switching and packet routing (L2 and L3) shall be wire speed on all interfaces. Performance shall not be decreased at maximum traffic load.

6) The router shall be equipped with the following interfaces – 8x10G (optical), 4x1GbE (optical), 4x1GbE (copper),16xE1 (G.703), 6xE&M, 6xFXS and 8xFXO interfaces in case of LER Min configuration. It should be possible to add 2xSTM-1 (channelized, optical) as LER Max configuration-II or to have a total of 32xE1(G.703) interfaces as LER Max configuration-I by way of adding/replacing suitable interface cards. All the optical interfaces shall be equipped with suitable optics to work on two single mode fibres upto 40km.

7) The router shall support following Timing ports– TOD in, TOD out, SYNC/BITS interface/similar timing protocol required for LTE network.

8) The router should have external Alarm Option.

9) Router shall have IP-MPLS interoperability with routers of other multiple OEMs.

10) Router shall meet all the requirements given in RDSO's TAN document No. STT/TAN/IP-MPLS/2020 Ver 1.0.

11) Fan tray, controller cards, interface cards should be a hot-swappable and Field Replaceable Unit (FRU).

12) Must have out-of-band Management port

13) Must have a console port.

14) Router shall support layer3 and layer2 MPLS VPN, VPLS and EVPN

(4) Label Swith Router (LSR)

a) Chassis shall fit into a standard sized 19 inch rack mounting.

b) Router should have redundant DC power feeds: -48VDC nominal.

c) Router should be temperature hardened as it is normally placed at field locations

without any air conditioning arrangement.

d) The router shall provide a non-blocked switching matrix upto system capacity.

e) Switching and packet routing (L2 and L3) shall be wire speed on all interfaces. Performance shall not be decreased at maximum traffic load.

f) The router shall be equipped with 8x10G (optical) ports. All the optical interfaces shall be equipped with suitable optics to work on two single mode fibres upto 40km.

g) The router shall support following Timing ports– TOD in, TOD out, SYNC/BITS interface/similar timing protocol required for LTE network.

h) The router should have external Alarm Option.

i) Router shall meet all the requirements given in RDSO's TAN document No. STT/TAN/IP-MPLS/2020 Ver 1.0.

j) Fan tray, controller cards, interface cards should be a hot-swappable and Field Replaceable Unit (FRU).

k) Control plane should be redundant and should be able to take full load even with failure of one controller card.

l) Must have out-of-band Management port.

m) Must have a console port.

n) Router shall support layer3 and layer2 MPLS VPN, VPLS and EVPN

(5) Primary Digital Multiplexing Equipment

a) PD Multiplex Equipment shall conform to IRS:TC:68/2012 Rev.0, ITU-T Rec. G.703, G.704, G.706, G.707, G.708, G.709, G.711, G.732 and G.823 specification in chapter-2.

b) The equipment is proposed to be used either as a terminal Multiplexer or as a drop insert Multiplexer in tandem on a 2 MB stream on digital Transmission media with conference facility.

c) This equipment shall multiplex 30 analogue and / or data channel to 2048 kbps ITU-T compatible digital stream on send side and on receive side it shall demultiplex ITU-T compatible 2048 kbps digital stream to 30 analogue/data channels.

d) This equipment shall have at least two 2048 kbps ports (P1 and P2 port) each for send and receive. It shall be possible to drop / insert any channel from / to P1/P2 port or make any time slot through from P1 port to P2 port and vice-versa.

e) This equipment shall have facility of at least 3 party conference between any combination of time slots of either P1 port or P2 port and voice interfaces.

f) Programming of MUX shall be either through RS-232C/USB port or other ITU-T compatible port for MUX-configuration, diagnostic and performance evaluation. Compatibility between the ports provided in the MUX and NMS/Local Craft Terminal shall be ensured either by use of same type of ports in both or with use of suitable port converters. It should also be possible to access the multiplexer from remote location through the supervisory channel. Facility for extension of alarms to the remote monitoring and control centre shall be provided.

g) The equipment shall be mounted on standard 19-inch rack. The number of

system that can be installed on each rack shall be specified. Racks shall be provided with suitable covers on all sides to protect entry of dust, rodents, etc.

h) The equipment shall be compact and composite construction including power supply, switching circuits, control unit, ringer and remote supervisory facility (where required). The system shall have redundant power supply units (1+1) or each individual card shall have it's own in built DC-DC converter.

i) There shall be a maintenance portable terminal for local monitoring, control and configuration of individual multiplexers at same station or remotely. Facilities shall be provided to connect maintenance portable terminal remotely using modems or through a TCP/ IP network such as intranet or Internet.

j) There shall be a network management system/ NMS which shall continuously monitor the health of all the network elements. Hardware for NMS of PD-MUX and MPLS may be common but software shall be different. Hardware shall be in the scope of MPLS. Besides all the features of maintenance portable terminal. PD Multiplex Equipment shall support functionalities of Terminal Multiplexer, Protected Terminal Multiplexer, Drop/Insert Multiplexer, Bypass Multiplexer and Loop Protected Multiplexer.

k) PD multiplexer equipment shall be provided with 1+1 protection for all channel levels (VF, Data, etc.) with automatic switch over in case of fault.

l) PD Multiplex Equipment shall operate satisfactorily at 48V+ 20% DC. The Contractor shall provide power supply equipment for power conversion if necessary. The equipment shall be capable of withstanding voltage spikes of up to 3 Volts over the maximum voltage.

m) Following type of interfaces shall be available on the primary Multiplexer:

1) VOICE INTERFACES:

- 2Wire E&M Signaling confirming to ITU-T Rec.G.712
- 4Wire E&M Signaling confirming to ITU-T Rec.G.712
- 2Wire subscriber loop
- 2Wire exchange loop
- 2Wire hot line

2) DATA INTERFACES:

- 64 Kbps synchronous data interfaces complying with ITU-T Rec. G.703 unbalance interface.
- Nx64 Kbps synchronous data interfaces complying with ITU-T Rec.
- V.11 and V.35 interface.
- E1 branching Interface

3) DIGITAL SUBSCRIBER LINE INTERFACE:

- IDSL along with Network Termination Unit

n) Where required, the PD Multiplex Equipment shall provide voice frequency interfaces for analogue telephone sets located not at the switch site, including but not be limited to the following, subject to the Review by the Engineer:

- voice interface microphone current feeding, subscriber loop signalling, on hook/off hook detection, ring trip and ringing current provision.
- Voice interface providing voice line connection to Extensions (FXS Interface) & PBX (FXO Interface); and any other voice interfaces required for other Subsystems/ designated contractors.
- The Contractor shall determine and provide appropriate types and quantities of channel interfaces based on the requirements of the Subsystems.
- The Contractor shall submit the details of all the channel interfaces which can be supported by the Primary Order Multiplexer.

(6) Portable maintenance terminal for PD-MUX

One maintenance portable terminal for PD-MUX shall be supplied. The specification of the portable maintenance terminal shall be following but not limited to:

- Processor- intel i7-8100 CPU @3.6 GHz or better
- RAM- 8 GB RAM,
- Operative system-Industry standard operating system Windows having GUI with latest licensed version
- LAN/ Ethernet- Ethernet interface (10/100 Mbps)
- Hard Disk Drvie-1TB SSD
- Monitor- 15- inch Colour LED backlit VDU
- The portable maintenance terminal shall have state-of-art hardware.
- Make-DELL/HP/IBM
- DVD Writer

(7) Network Management System for MPLS/SDH/PDH equipment

a) As with any network, once deployed and running, we must continue to monitor and manage the network while supporting new service loads and demands. An advantage MPLS provides above and beyond IP is its capability to traffic engineer based upon utilisation and application demands as the business evolves. With MPLS traffic engineering, we can adjust primary paths and alternate paths in the network for supporting traffic. Split traffic over multiple paths, and optimize network resources for the virtualised networks being supported. Upon occasion, as network traffic grows, it may be necessary to add transport capacity and upgrade router interfaces to support new services as well as to deploy new routers to extend the reach of the network.

b) MPLS Routers with help of standard protocols, shall start monitoring various assets for complete visibility and control over IT infrastructure with proactive network monitoring. The discovery process immediately provides details and health of nodes. Proactively manage, monitor and control overall network health, availability and performance by collecting network information on various parameters such as temperature, power, packet loss, throughput, response time, utilisation, error rates,

downtime/uptime, etc., collected mostly using SNMP.

c) Provisioning and management requires visibility and control. Management Information Bases (MIBs) are significant to provide standardized visibility into the network. MIBs are available for all protocols and applications developed by the IETF and are used to manage the network. Service provisioning will be done quicker whether the service provision required one location or multiple locations. This will minimize the chance for errors, provide corrective actions and assist in detecting, troubleshooting, and resolving failures during the provisioning itself.

d) Network monitoring and provisioning system Hardware and Software will be deployed at IMD/SCC.

e) IMD/SCC NOC to be manned round the clock on 24X7 basis.

f) NMS for MPLS shall meet all the requirements given in RDSO's TAN document No. STT/TAN/IP-MPLS/2020 Ver 1.0.

g) NMS Server (which should be able to work 24x7, 365 days) hardware for IP-MPLS/SDH/PDH Management shall have the following minimum specifications:

SN	Parameter	Specification
1.	Processor	Latest Generation x86 Intel / AMD Processor
2.	No. of Cores & No. of Processors	Minimum 8 Cores in Single Processor or 2 nos. of 4 Core Processor (Dual Socket)
3.	No. of Threads	2 Threads per Core
4.	Frequency	2.1 GHz or higher
5.	Memory	32 GB or higher, DDR4 SDRAM or latest.
6.	Operating System	Windows Operating System or Linux, latest with required no. of Client licenses.
7.	LAN/ Ethernet	10/100/1000 base T,Onboard/ on slot Gigabit Ethernet (RJ45) with Load Balancing and Fail over Support, IPv6 compliant. (Minimum 2 nos. of 1G ports should be available)
8.	Interface type	FC or iSCSI or SAS or FCoE or Ethernet interface for connecting External Storage device.
9.	Hard Disk Drive	2 x 500GB SATA III SSD
10.	HDD RAID Controller	Hardware based - SATA / SAS / SSD - RAID Controller with RAID 0/1/5 configuration.
11.	DVD R/W Drive (internal)	Required
12.	USB Ports	USB 3.0 min. 2 Nos.

13.	USB/ PS/2 mouse and keyboard	USB wireless keyboard and mouse x Monitor 24-inch LED Color Monitor
14.	Power Supply	Dual and Redundant Power Supply
15.	Running time	Should be able to run 24x7 at ambient room temperature of 27 °C.
16.	Chassis Type	19" Rack mountable with sliding rails and fittings to install into a Rack.
17.	Regulatory Approvals/ Certifications	BIS/UL/EN/CE/IEC certification for Safety and BIS/CE/FCC Certifications for EMC & Immunity.

(8) Data storage and display unit for monitoring IP MPLS network

SN	Parameter	Specification
1.	Processor	Latest generation i5 - 10th generation Processor or better
2.	No. of Cores	2 x 10 Core or higher
3.	Frequency	1.6 GHz or higher
4.	Memory	32 GB or higher, DDR4 SDRAM or latest.
5.	Operating System	Windows Operating System or Linux, latest, must be compatible to the NMS to be installed
6.	LAN/ Ethernet	10/100/1000 base T, Onboard/ on slot Gigabit Ethernet (RJ45), IPv6 compliant.
7.	Hard Disk Drive	4 x 500GB SATA III SSD
8.	DVD R/W Drive (internal)	Required
9.	USB Ports	USB 3.0 min. 2 Nos.
10.	Monitor	24- inch LED colour monitor or higher
11.	Make	HP, DELL or similar
12.	Power Supply	Dual and Redundant Power Supply
13.	Running time	Should be able to run 24x7 at ambient room temperature of 27 °C.

14.	Chassis Type	19" Rack mountable with sliding rails and fittings to install into a Rack.
15.	Regulatory Approvals/ Certifications	BIS/UL/EN/CE/IEC certification for Safety and BIS/CE/FCC Certifications for EMC & Immunity.

(9) Local craft terminal (LCT) for MPLS/SDH equipment

Two no. Local craft terminal for MPLS/SDH equipment shall be supplied. The specification of the local craft terminal shall be following but not limited to:

a) Processor- intel i7-8100 CPU @3.6 GHz or better

b) RAM- 8 GB RAM,

c) Operative system-Industry standard operating system Windows having GUI with latest licensed version

d) LAN/ Ethernet- Ethernet interface (10/100 Mbps)

e) Hard Disk Drvie-1TB SSD

f) Monitor- 15- inch Colour LED backlit VDU

g) The portable maintenance terminal shall have state-of-art hardware.

h) Make-DELL/HP/IBM

i) DVD Writer

5.7 Cabling and Accessories

1) Optical fibre cables shall be supplied as per RDSO specification no. IRS: TC 55- 2006 with Latest Amendments.

2) The Optical Fibre Connectors shall comply with IEC60793 and IEC60874.

3) The requirements on cabling accessories, digital distribution frames, optical distribution frames, main distribution frames are as given in Chapter-11 of this Particular Specification.

5.8 System Expansion

1) The OFC System shall be equipped with sufficient capacities and margins such that the System can operate properly under peak load or traffic conditions.

2) It shall be possible to insert additional SDH/MPLS Nodes into the OFC Network without affecting the performance of the Network, limits on this, if any, shall be specified by the Contractor for review by the Engineer.

3) The OFC System shall be compatible with SDH/MPLS Equipment from other manufacturers.

4) The NMS for OFC System shall be designed and equipped with all necessary hardware, software and capacity for future additional SDH/MPLS Equipment and associated Flexible Access/ PD Multiplexers.

(End of Chapter-5)

CHAPTER 6 - TELEPHONE SYSTEM

6.1 General

6.1.1 The Telephone System shall provide voice communications between locations equipped with telephone consoles/sets within the HORC premises and other defined locations.

6.1.2 The Telephone System shall comprise of Administrative Telephone on IP based EPABX Network, DTMF based Train Control Communication System with Emergency Communication System.

6.1.3 Administrative Telephone Network shall be based upon IP Ready Electronic Private Automatic Branch Exchange (EPABX) System and Attendant console having SIP switching that support Voice over IP for the operation, maintenance and administrative staff to set up voice communication.

6.1.4 DTMF based Train Control Communication System shall be provided to meet omnibus voice communication requirement of Traffic Control between IMD and Stations/SCC. This Train Control Communication System is a communication system between the control office and various way stations or in other words it is a communication system to enable communication between the HQ control telephone provided at SCC and way station control telephones provided at various stations, TSS, SSP, SP and other locations.

6.1.5 Emergency Communication System shall provide an omnibus communication channel between SCC, all Stations,TSS, SSP, SP, at every Km. in the Mid-section in block section and other locations as per Railway practice.

6.1.6 Whenever existing equipment are upgraded/augmented to meet the requirement of this Particular Specifications, the available provision for Redundancy in existing equipment shall not be compromised and subsequent to upgradation/augmentation they shall meet the Technical Requirement and Performance Requirement as stipulated in this Particular Specifications.

6.2 Scope of Supply

6.2.1 The Scope of Supply for the Telephone System shall include, but not be limited to the following:

(1) PBX Switches;

(2) IP Telephony Server;

(3) Media Gateways;

(4) Line and Trunk Interfaces;

(S) Telephone Sets;

(6) Voice Mail System;

(7) Telephone Network Management System;

(8) Control Communication Equipments;

(9) Emergency Communication Equipments;

(10) Power Supply Equipment, Cables and Accessories; and

(11) Distribution Frames, Cabinets, Enclosures, Racks, etc.

(12) Portable maintenance terminal

6.2.2 The Scope of Supply for the IP ready EPABX System and attendant console shall include, but not be limited to the following:

(1) VoIP EPABX server (1+1) with server license, RAID controller, dual PSU of DELL/HP/IBM make and single PC workstation with 24-inch colour LED monitor

(2) NMS Server and license with 24- inch colour LED monitor

(3) NGX 512 port rack

(4) MEDIA GATEWAY CONTROL / RESOURSE CARD

(5) SUBSCRIBER CARD 32 PORT

(6) TRUNK CARD 12 PORT

(7) DIGITAL CARD 8 PORT

(8) IP PHONE

(9) 19" 42 U Network RACK- 1 No

(10) Colour Printer A-4 size

(11) Call Server software license for 200 users

(12) MDF 100 PAIR WITH SURGE PROTECTION DEVICE (IPM-64No)-01 No

(13) 1 KVA UPS with one hour back up with full load

(14) Any other card/ accessories

6.3 System Requirement

6.3.1 General

1) A highly reliable main VoIP based PBXs Telephone Network shall be installed and commissioned at Manesar station/IMD. The telephones of Main PBX shall be extended to all Stations, TSS,SP/SSP, SCC using Ethernet/E1 over SDH/MPLS Network as covered in Chapter-5 of this document.

2) In addition to PBXs based IP Telephone Network, IP Telephony Server (Call Server) shall be provided at SCC/IMD to provide VOIP based backup Telephony Communication Platform in future. Media Gateway shall be provided as required to meet the requirement of this Particular Specification.

3) The PBXs shall have connection to the Public Switched Telephone Network (PSTN). This shall allow pre-selected extensions to access the PSTN or vice versa.

6.3.2 Administrative Telephone Network:

1) Administrative Telephone Network shall provide voice communication between SCC, Stations, Interfacing IR Stations, TSSs, SPs, SSPs and other locations. Approximate requirements of Telephone Sets, which include Analogue Telephones as well as IP Digital Telephones, are as given in Table below:

SN	Station/locati	Telephone Sets

	on	Station Building		-	Tower wagon shed	Nearby Service Buildings/TSS/SP/SSP	Total PBX Telephones*
1	Patli IR	1				1	2
2	Manesar	4	-	-	1	2	7
3	New Patli	4				2	6
4	Sultanpur IR	4				2	6
5	TSS at Manesar					1	
6	SP in the HORC section					5	5
7	SSP in the HORC section					18	18
8	SCC/New Delhi						10

*The requirement of Telephone Sets at individual location may vary. Exact requirementwill be identified during Design Stage.

2) The telephones at Stations shall be directly terminated at PBXs, while telephones at locations other than Stations shall be either directly terminated at PBXs (if feasible) or connected to the nearest PBX via the OFC System.

3) The Contractor shall discuss with the Engineer to agree on the exact location of each Telephone Set and IP Phone.

4) The Administrative Telephone Network shall provide feature transparency across all the PBXs. The following PBX features shall be provided:

	1)	Automatic Call Back;		2)	Busy Hunt;
	3)	Break-In;		4)	Call Forward;
	5)	Call Park;		6)	Call Party Name & Number Display;
	7)	Call Pickup;		8)	Call Transfer;
	9)	Call Waiting;		(10)	Conference Call;
	11	Hot Line;		(12)	Abbreviated Dialling;

	13		Access Paginq;	(14)	Attendant Recall;
	15		Alternative Route Selection;	(16)	Last Number Redial;
	17		Line Lockout;	(18)	Malicious Call Trace;
	19		Recorded Announcement;	(20)	Direct Inward Dialling (DID);
	21		Direct Outward Dialling	(22)	Distinctive Ringing;
	23		Last Number Redial	(24)	Music on Hold;
	25		Speed Dial;	(26)	Voice Mail; and
	27		Forced Release.		

5) The assignment of the class of service and features to any telephone extension shall be configurable.

6) The Administrative Telephone Network shall support closed homogeneous numbering plan across the network such that the user has to just dial the extension number of the user, he wishes to reach from anywhere in the network. Further this numbering plan of HORC shall also be homogenous. The numbering plan shall be discussed with Employer/Engineer and implemented only after it is reviewed by Engineer.

7) The Administrative Telephone Network shall support a minimum of the following four levels of programmable restrictions to each telephone extension:

- totally restricted level in which user cannot make or receive calls to and from the PSTN through the telephone extension;
- semi-restricted level in which user cannot make PSTN calls but can receive PSTN calls through Direct Inward Dialling (DID);
- local level in which the telephone extension user can make or receive local PSTN calls only; and
- unrestricted level in which there shall be no restriction on the telephone extension for call connection.

8) Analogue Telephone Sets to be provided for Administrative Telephone Network shall be equipped with following facilities:

- Handset;
- 12 Push-button DTMF Keypad;
- On-hook Dialling function;
- Display Unit showing Calling and Caller's extension number for Incoming and Outgoing Calls;

- Feature Buttons for Redial, Hook-Flash, Mute and Hold;
- Hand-Free operation through built-in speaker and microphone; and
- Powered by the PBX.

9) IP Phones to be provided for Administrative Telephone Network shall be equipped with following facilities:

- Handset
- On-hook Dialling function;
- Hand-Free operation through built-in speaker and microphone;
- Adjustable volume control for speaker and ringer;
- Display Unit showing Calling and Caller's extension number for Incoming and Outgoing Calls;
- Display of call duration;
- System Clock Display;
- Powered via POE Class 2/3
- Support for H.323/SIP
- RJ-45 10/100/1000BT Ethernet Port POE
- Supporting DHCP Client or Static IP Address Allocation Plan;
- RTCP and RTP Support;
- QoS Support and TOS Diffserv (IEEE 802 1p/q); and

10) The Administrative Telephone Network shall have the capacity of ringing up to minimum of three telephone sets connected in parallel.

11) A Voice Mail System (VMS) shall be provided and integrated with the PBX Network to enable administrative telephone users to leave, retrieve and broadcast voice messages. Voice Mail shall only be provided to pre-selected groups of staff or telephones.

6.3.3 Telephone Networks

1) Administrative Telephone Networks shall provide following feature transparency across all the PBX telephones provided under this Contract:

	1)	Automatic Call Back;	2)	Busy Hunt;
	3)	Break-In;	4)	Call Forward;
	5)	Call Park;	6)	Call Party Name & Number Display;
	7)	Call Pickup;	8)	Call Transfer;
	9)	Call Waiting;	(10)	Conference Call;
	11	Hot Line;	(12)	Abbreviated Dialling;

	13		Access Paginq;	(14)	Attendant Recall;
	15		Alternative Route Selection;	(16)	Last Number Redial;
	17		Line Lockout;	(18)	Malicious Call Trace;
	19		Recorded Announcement;	(20)	Direct Inward Dialling (DID);
	21		Direct Outward Dialling	(22)	Distinctive Ringing;
	23		Last Number Redial	(24)	Music on Hold;
	25		Speed Dial;		
	27		Forced Release.		

2) It shall be possible to make IP Audio calls across IP Phones provided under this Contract.

3) The PRI over E1 Link between PBX provided under this Contract as well as under IR PBX shall be provided.

6.3.4 Telephone Network Management System

1) A Network Management System with a workstation, system database, logging printers and mass storage devices shall be provided at the designated place as decided by the Engineer.

2) The Telephone Network Management System has been set up to provide control, supervision and maintenance functions for the Administrative Telephone Network. The following management and administrative functions shall be provided through the use of the centralized maintenance console:

- User Data Management;
- Fault Monitoring;
- Performance Management;
- Call Detail Recording;
- Voice Detail Recording;
- Configuration Management;
- Application Program Interface;
- Accounting Management;
- Maintenance History Management;
- System Diagnostics;
- Remote Access (RA);
- Data Logging;

- Remote Alarm Monitoring; and
- GUI based Network Topology View.

3) Access to the Telephone Network Management System shall be password protected.

4) Failure in the Telephone Network Management System shall not affect the normal operation of the TDM based PBX Telephony Network or VOIP based Telephony Network if provided in future.

6.3.5 Emergency Communication System

1) Emergency Control Communication which is an omnibus communication channel terminating at SCC with the Traction Power Controller shall be provided. This Emergency Control Communication shall not have selective calling facility. Emergency Control Communication shall have Emergency Sockets as per IR Standards for RE Areas at all the stations, TSS, SP, SSP and at every Km. and other locations in block section as per IR practice to which this omnibus communication channel is terminated. The Portable Telephone of IR Standard for RE Areas, which will be carried by the crew, can be plugged in case of emergency. This Emergency Control Communication channel can be switched to the other controllers by the Traction Power Controller.

2) Emergency Control Communication shall be extended using Underground Railway Jelly Filled Telecom Quad Cable as per RDSO Specification No. IRS:TC 30-05 with latest amendments to all Emergency post locations.

3) SCC (Control Office): Control office exists at State Entry Road New Delhi of IR for Controlling and regulating train traffic on IR stations at Patli and Sultanpur and the same shall be extended for Controlling and regulating train traffic on HORC section.

4) Way stations: For the purpose of train control communication system, the following are referred to as way station (a) HORC stations (b) TSS/SSP/SP (c) Sidings (at Manesar) (d) Identified offices.

6.3.6 Control Communication System

1) Control Communication System shall be provided to meet omnibus voice communication requirement of Train Traffic Control.

2) This is provided for communication with one-touch button selective calling facility between the various Controllers including Traffic Controller in the SCC and Station Controller at Stations, Interfacing Stations and other important locations along the route as decided by the Engineer.

3) Control Communication System shall be provided using Control Communication Equipment as per RDSO Specification No. RDSO/SPN/TC/66/2007.

4) Train control communication system has different control circuits. These are:

a) Section traffic control

b) Deputy Traffic control

c) Traction power control (TPC)

d) Traction loco control (TLC)

e) Engineering control

f) C & W control

g) Signal control

h) Telecom control

The above list is not exhaustive and other control circuits may also exist.

5) These circuits consist of the HQ control phone of the particular controller and way station control telephones under control of the particular controller. In addition to above Remote control is used for remote operation of 25KV AC traction equipment. Remote control works on SCADA principle.

6) Section traffic controller communicates with a group of way stations in his jurisdiction. For other control circuits similar arrangement exists.

7) Emergency control circuit is omnibus circuit working on the underground cable laid in most of the sections. The length of this cable can go up to 20 km or more between two adjacent way stations. The emergency control circuit is generally a 4-Wire circuit. In normal case, conversations on this circuit are received by Traction power controller/ Power controller. However in case of need, Traction Power controller/ Power controller shall be able to transfer the conversations on section control circuit.

8) The underground Quad cable is tapped at intervals of about 1 KM and terminated on 6-pin socket. The control office (for a given section) can be contacted by plugging a portable control telephone (4 wire portable control telephone as per RDSO specification IRS TC 78/2000 with latest amendment) into any of these sockets provided in that section.

9) Emergency Control Circuit: An arrangement (gateway) shall be required for interfacing IP network and the emergency control circuit. It shall be possible to reach the control office by plugging a 4 wire portable control telephone into any of the Emergency sockets. The gateways can be provided either at every way station and at HQ. A two-way communication shall be setup between the emergency controller and the site. If any other person plugs his telephone in some other socket on the same emergency control section, he will also join the conference.

10) It shall be possible to join emergency conference call received on emergency control circuit, to the Section Controller's conference if needed, in control office by Traction Power Controller/ Power Controller who normally also works as emergency controller.

11) Total 40 no. lightweight portable emergency control phones shall be provided.

12) Tentative requirements of Control Telephone Sets, which include IP Telephones, are as given in Table below:

SN	Station/location	Control Telephone				
		Station Building		Tower wagon shed	Nearby Service Buildings/TSS/SP/SSP	Total Control Telephone

1	Patli IR					
2	Manesar	5		1	2	8
3	New Patli	4			2	6
4	Sultanpur IR	4			1	5
5	TSS at Manesar				2	2
6	SP in the HORC section				5	5
7	SSP in the HORC section				18	18
8	SCC/New Delhi					

The requirement of Telephone Sets at individual location may vary. Exact requirementwill be identified during Design Stage.

6.4 Performance Specification

1) General

- In addition to what has been specified in Chapter 3 the following performance requirements for the telephone system shall be complied.
- Fault tolerant design with protections against failure shall be provided in order to achieve the system availability. Protections shall include, but not be limited to path diversity, redundancy and duplication of reliability critical equipment, component and circuits.

2) Reliability

(i) The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a failure.

(ii) The Contractor shall furnish for the following sub-systems/equipment, the reliability figures, MTBF Hours from the OEMs.

- Switching Module of the PBXs;
- Processor Module of the PBXs;
- Memory Module of the PBXs;
- Line and Trunk Interface Module of PBXs;
- Power Supply Module of PBXs;
- Media Gateway;
- Control Communication Equipment; and
- Emergency Control Communication Equipment.

3) Availability Requirements

1) The Contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the Telephone System shall not be included in the determination of the system availability.

2) The availability of the connection within Administrative Telephone Network shall be better than 99.99%.

3) Voice Recording System, if provided in contract, shall be considered unavailable under any one or combination of the following conditions:

- messages cannot be recorded into the Voice Recording System;
- messages cannot be retrieved from the Voice Recording System; and
- corruption of voice message stored in the Voice Recording System.

4) Maintainability Requirements

1) The Contractor shall comply with the maintainability requirements as specified in Chapter 3 of this document.

2) The service life of the Telephone System shall not be less than 15 years. Service life of all types of cables shall not be less than 25 years. Service life shall be counted from the commencement date of the Defects Notification Period.

6.5 System Safety Requirements

- The Subsystem shall not present any safety hazard to the operation and maintenance persons.
- All equipment must comply with, and be installed in conformance with IEC 60065, IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.
- All metallic enclosures shall be provided with an earth terminal.

6.6 Technical Requirement

6.6.1 PBX Network

1) Administrative Telephone Network shall be based upon PBX Network, which shall conform to applicable RDSO Specifications No. RDSO/SPN/TC/27/2007 Rev.1.0

2) The PBX Network shall offer a fully integrated and transparent digital service acting as a single digital switch.

3) PBXs to be supplied, installed and commissioned for Administrative Telephone Network at stations shall be equipped to, as a minimum and not limited to, the following:

S.N	Description of Item	Stations	SCC
1	Equipped Ports	128	64
2	Wired Ports	224	128
3	Analogue Telephone Ports	96	32

4	IP Telephones Ports	32	32
5	Ports for CO lines	4	8
6	Ports for DID lines	4	8

4) The PBX Network shall provide non-blocking connection for extension calls within the same PBX.

5) For calls through trunks or tie lines, the Administrative Telephone Network shall provide a GOS of 1% for the following traffic intensity during an average busy hour under normal condition without traffic overflow:

- DID trunk traffic intensity at 1.5 HCS per extension;
- CO outgoing trunk traffic intensity at 1.5 HCS per extension;
- Traffic intensity of 18 HCS per digital extension;
- 25% of the station traffic intensity assumed to use tie lines; and
- Traffic intensity of 1.5 HCS per voice-mail system user assumed to use tie lines.

6) For calls through trunks or tie lines shall provide Grade of Service (GOS) of 0.1% during an average busy hour under normal condition without traffic overflow.

7) The extension line interface in the exchange equipment shall match the extension equipment as required and fulfil the following requirements :

- loop resistance of subscriber connected on physical cable pairs shall be limited to 1200V. The minimum value of the leakage resistance of the line shall be 20 K Ohms; and
- the exchange line shall block the extension line after certain period of "Off- Hook" condition without a selection being received. This period shall be between 10 and 20 seconds. Busy tone shall be sent to the blocked extension;

8) Redundancy for the important interfaces/modules such as power supply, processor etc. shall be provided.

9) The PBX Network shall be designed such that there is redundancy and diversity in terms of the communication links for call routing and call establishment. This redundancy and diversity shall be applicable for call routing and call establishment across HORC.

10) The system design shall ensure high system availability with minimum common mode failure allowing graceful degradation.

11) Network and system shall be resilient to failure providing automatic reconfiguration of equipment with minimum system loss in particular the avoidance of common mode failure of site equipment, fibre, cable and power supply and software affecting system operation.

12) Network architecture shall be future proofed to accommodate in the flexible manner enhancements to equipment and systems with respect to hardware and software upgrades.

13) PBX Network shall be synchronised to the Master Clock signal for merging into a single

synchronised network along with the OFC System. The PBX Network shall have internal clock in free running mode in the event of the failure or absence of the Master Clock signal. The slip allowable in the exchange network shall confirm to ITU-T Rec. G.822. A highly resilient telephone network synchronisation scheme shall be developed possibly employing multiple fall back protection and details furnished to the Engineer for review.

14) Each PBX shall be powered by 48 V Battery Back-Up System provided by the Contractor. Surge protection shall be provided in each switch.

15) The digital extension line equipment shall be capable of data transmission simultaneously with speech (ISDN working).

16) All software and configuration data operating the PBX shall be stored in non-volatile memory and shall not be corrupted or lost in case of PBX failure or loss of power supply.

17) The Contractor shall be responsible for reconfiguration of routing table of PBX being provided under Contract Package.

6.6.2 Voice Mail System (VMS)

1) The VMS provided in HORC shall enable internal and external telephone users to access specific mailboxes using the following peripherals:

- analogue telephones using DTMF;
- digital telephones;
- CO outgoing trunks and DID trunks; and
- digital trunk.

2) Telephone users assigned with VMS shall have a unique voice mailbox which shall be password protected.

3) The VMS shall supports 1000 users for 24 hours a day. The system shall be expandable to 2000 users. The ports connecting to the system shall support traffic intensity offered by 1000 users in such a way that 1% GOS shall be achieved. VMS shall provide storage for a total of not less than 240 hours of voice menu and message.

6.6.3 Telephone Network Management System

NMS Server (which should be able to work 24x7, 365 days) hardware for Telephone Management shall have the following minimum specifications:

SN	Parameter	Specification
1	Processor	Latest Generation Intel Xeon processor
2	No. of Processor	1
3	No. of Cores	4
4	Frequency	2.1 GHz or higher
5	Cache	8 MB
6	Memory	16 GB or higher, DDR4 SDRAM or latest.

7	Operating System	Windows Operating System or Linux, latest with minimum 3 Client licenses.
8	USB/ PS/2 mouse and keyboard	USB wireless keyboard and mouse x Monitor 24-inch LED Color Monitor
9	Brand	HP/DELL/IBM

6.6.4 Telephone Portable maintenance terminal

One no. Portable maintenance terminals (Laptops) shall be provided for field maintenance. Appropriate software shall be pre- loaded onto the Laptops to access the local maintenance port of the PBX switches for system administration and management. Portable maintenance terminal shall be of following specification but not limited to:

a) Processor- intel i7-8100 CPU @3.6 GHz or better

b) RAM- 8 GB RAM,

c) Operative system-Industry standard operating system Windows having GUI with latest licensed version

d) LAN/ Ethernet- Ethernet interface (10/100 Mbps)

e) Hard Disk Drvie-1TB SSD

f) Monitor- 15- inch Colour LED backlit VDU

g) The portable maintenance terminal shall have state-of-art hardware.

h) Make-DELL/HP/IBM

i) DVD Writer

6.6.5 Telephone PC Workstation:

PC Workstation (which should be able to work 24x7, 365 days) hardware for Telephone system shall have the following minimum specifications:

a) Processor : intel i7-8100 CPU @3.6 GHz or better

b) RAM : 6 GB or higher

c) Operating System: Standard modern desktop based OS such as Windows with latest licensed version

d) LAN/ Ethernet: Dual cards 10/100/1000 Mbps

e) Hard Disk Drive: 1 TB SSD

f) USB Ports: USB 3.0 min. 2 Nos.

g) USB/ PS/2 mouse and keyboard : USB wireless keyboard and mouse

h) Monitor: 24-inch LED Color Monitor

i) Make: DELL/HP/IBM

j) UPS for 30 minutes backup

k) DVD Writer

l) Printer A3 size laserjet

6.6.6 Telephone system Wiring

1) All the voice circuits from the PBXs shall be terminated at the Main Distribution Frame inside the TER for distribution of the internal and external lines and interface with relevant Subsystems and Project Contractors. The circuit termination shall be of IDC (Insulation Displacement Contact) type.

2) All the data circuits from the PBX shall be terminated at the Digital Distribution Frame inside the TER for distribution of the internal and external lines and interfaces with relevant Subsystems.

3) Multi-core cables shall be provided and connected from the distribution frames inside TER to the distribution frames at the MDF for connection between the PBX and the trunk circuits of PSTN. The interface between the Telephone system and the PSTN circuits shall be at the MDF.

4) Telephone distribution boxes shall be provided and installed at suitable locations for intermediate distribution of the circuits from the PBX switch. The telephone distribution box shall include connection blocks for the circuits termination.

5) Multi-core cables shall be provided and connected from the distribution frames inside TER to the telephone distribution boxes. A minimum spare capacity of 25% shall be reserved in the multi-core cables, distribution frame and the telephone distribution boxes.

6) Standard RJ-11 modular socket shall be provided for termination of the telephones via plug and socket arrangement. The RJ-11 modular socket shall be connected to the nearest telephone distribution boxes to complete the connection between the PBX switch and the telephone.

7) Short circuit and over voltage protection device shall be provided to protect circuits from faults occurring in all outdoor cables.

8) Switch board cable 20 pairs shall be used for indoor wiring.

6.6.7 Outdoor Telephone Cable

- Polythene Insulated Jelly Filled (PIJF) Telephone Cable as per RDSO Specification No. IRS: TC 41-97 with latest amendments for a minimum 10 pairs shall be used for extending external telephone lines out of building housing PBX.

6.6.8 System Expansion

- The PBX shall be expandable to the maximum line capacity by adding extra line cards only with the common control equipment, including the processor unit, memory modules, switching modules, power supply unit, remaining unchanged. However the software license for the full line capacity as per the wired requirement given in this PS shall be provided as part of this Contract.

(End of Chapter-6)

CHAPTER 7 - MASTER CLOCK SYSTEM

7.1 General

1) The Master Clock System shall provide 'Synchronized Time Information' using Global Positioning System (GPS) as time source.

2) This Synchronized Time Information shall be used to synchronize slave clocks which shall be located at Stations, Depots & Offices in HORC.

3) This Synchronized Time Information shall also be provided to other Interfacing Systems/Sub-systems and shall be achieved by means of the Network Time Protocol (NTP).

4) Master Clock System being provided shall conform to ITU-T Recommendations G.811 and G.812 for the synchronisation timing and timing distribution requirements.

7.2 Scope of Supply for Clock System

The scope of supply shall include, but not be limited to, the following:

1) A Master Clock System;

2) GPS Receiver and Antenna;

3) Sub-Master Clocks;

4) Slave Clocks (Analogue and Digital Clock Display Units);

5) Clock Management System;

6) Data & Power Supply Cables including Terminations;

7) Earthing and Lightning Protection Devices;

8) Installation, Testing and Commissioning Materials; and

9) Any other item required to complete the scope of the works.

7.3 System Requirements

1) The Master Clock System shall be based on a 'Central Master Clock', which shall be synchronised to 'Universal Time Co-ordinated' (UTC) by Radio Signals transmitted via the ISRO satellite of India/US Department of Defence's 'Global Positioning System' (GPS) Real Time Navigation Satellites.

2) A GPS Receiver at Manesar station shall receive the Time Source through a Rooftop Antenna from the satellites of the GPS.

3) The Time Source shall be sent to a Central Master Clock Unit which shall convert the Time Source to synchronization pulses for the use of the slave clock units. The Central Master Clock Unit shall also distribute the time information to Sub-Master Clocks using NTP by an Ethernet Interface.

4) HORC Stations and Offices and TSS/SP/SSP a Sub-Master Clock Unit shall receive the time information from the Central Master Clock and shall convert it into synchronization pulsesfor the slave clock units at those locations.

5) Slave Clocks shall be connected to the Central Master Clock Unit and the Sub-Master Clock Units. Slave Clocks Schedule is as below:

SN	SCC/Station/IMD	SM Room at Stations		Building/Concourse/Platform
		Digital	Analogue	Digital
1	Patli IR	1	1	2+2*PF
2	Manesar Jn.	1	1	2+2*PF
3	New Patli Jn.	1	1	2+2*PF
4	Sultanpur	1	1	
5	TSS/SP/SSP	-	-	------
6	SCC/New Delhi	-	-	-

6) The Slave Clocks shall be of analogue or digital types. The clock face design shall ensure that these clock units shall provide good visibility.

7) Each of the Systems/Sub-system that require Synchronized Time Information shall be connected to the SCC/IMD or Station LANs and shall obtain the information using NTP from Master Clock System.

7.4 Performance Specifications

7.4.1 General

1) In addition to what has been specified in Chapter 3, the following performance requirements for the Master Clock System shall be complied.

2) Fault tolerant design with protections against failure shall be provided in order to achieve the system availability. Protections shall include, but not be limited to path diversity, redundancy and duplication of reliability critical equipment, component and circuits.

7.4.2 Reliability

1) The inability to perform any required function, the occurrence of unexpected action or thedegradation of performance below the specifications shall be considered as a failure.

2) The Contractor shall furnish to the Engineer the reliability figures i.e. MTBF Hours from the OEMs of the following sub-systems/equipment:

- Master Clock;
- Sub-Master Clock; and
- GPS Receiver.

7.4.3 Availability Requirements

1) The Contractor shall implement a RAMS Plan defined in accordance with IEC 62278. The Contractor shall submit to the Engineer for review the RAMS analysis for the Master Clock System to establish the requirements of availability specified herein below.

2) The Master Clock System shall be considered unavailable if the clock signal is not available at any location or the accuracy of the clock signal is below the specification. The availability of the Master Clock equipment shall be better than 99.99%.

3) Maintainability Requirements

4) The Contractor shall comply with the maintainability requirements as specified in Clause 3.4.

5) The service life of the Master Clock System shall not be less than 15 years.

6) System Safety Requirements

7) All equipment shall comply with, and be installed in conformance with IEC 60065 and IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.

8) All metallic enclosures shall be provided with an earth terminal which shall be connected to Earth.

7.5 Technical Requirements

7.5.1 Central Master Clock

1) The Central Master Clock shall consist of Redundant GPS Receivers which shall continuously collect the external time information, e.g. Universal Coordinated Time (UTC) and derive Indian Standard Time by offsetting as required.

2) Antenna of GPS Receiver shall be weather proof. It shall be tolerant to direct sunlight, wind, rain and other sources of water. The Antenna shall be mounted at appropriate location to be identified during design. Surge Protector shall be provided between Antenna and Central Master Clock Units.

3) The GPS receiver shall not suffer from the GPS week counter rollover problems, which cause the week counter to reset to zero every 1024 weeks.

4) To protect the Master Clock equipment from lightning, surge protectors shall be provided to connect from the GPS antenna to the ground to safely shunt potentially damaging voltage on the antenna to the ground.

5) The Central Master Clock shall consist of Redundant Master Clock Units. The Master Clock Units shall detect the absence or corruption of the UTC time standard signal and give an alarm if either of these occurs. Bad data resulting from a satellite malfunction, temporary reception problems or an erroneous upload to satellite is not used. Errant timing that causes errors in the timing system shall be avoided.

6) The Master Clock Units shall have their own oscillator and be able to maintain accurate time with an accuracy of 30 milliseconds w.r.t. GPS Reference for duration of 24 Hours of loss of time synchronization with GPS.

7) The Master Clock Units shall be self-correcting in the event the synchronization from the GPS is lost and re-established.

8) The Central Master Clock Units shall support connectivity of Ethernet TCP/IP Network, RS485 and RS232 as required.

9) The Master Clock Units shall include Network Time Server to provide NTP timing for other interfacing Systems/Subsystems connected to the OCC/Stations/Depot/Office LANs. The type and quantities of the interfaces shall be determined by the interface requirements of the Subsystems under this Contract and relevant Interfacing Project Contractors. Network Time Synchronization over the Data Network using NTP shall be with an accuracy of +0.01 seconds per 24 hours.

10) Audio and Visual Alarm outputs shall be provided to indicate loss of Time Synchronization

or Power.

7.5.2 Sub Master Clock

1) The Sub-Master Clock at Station shall be synchronized by the Central Master Clock over NTP. It shall be possible for Sub-Master Clock to work both as NTP Server and NTP Client.

2) The Sub-Master Clock shall be able to detect the absence or abnormality of the synchronized time signal from the Central Master Clock. The Sub-Master Clocks shall have its own internal clock and be able to maintain time with a minimum accuracy of 1s a day when they do not receive signals from the Central Master Clock. On restoration of the Master Clock Signal, the Sub-Master Clock shall validate the signal and after successful validation the Sub-Master Clock shall self-correct if necessary.

3) Local Display of the time shall be provided. Display shall include hours and minutes.

7.5.3 Display Clocks

1) All display clocks shall be synchronized by the Central Master Clock Unit//Sub-Master Clocks. The slave clock shall be able to free run from local quartz oscillators with drift of one second per day in the absence of communication link or synchronisation sources.

2) Analogue Slave Clocks for indoor use shall be single sided with minimum dial diameter of 30 cm, with minimum viewing distance of 20 metre.

3) Digital Slave Clocks for indoor use shall be 7 Segments LED type with minimum digit height of 57 mm, with minimum viewing distance of 20 meter. For platform the minimum viewing distance shall be 100m.

4) The displayed time of all display clocks shall be hours and minutes.

5) The display shall be clear under relevant, frequently occurring lighting conditions, including direct sunlight (from behind and in front) and when there are any reflections in the clock faces.

6) The optical characteristics of the transparent display cover shall be selected such that the light transmission and display contrast are suitable for the environment in which the clocks are installed.

7) Subject to the architectural constraints for each specific location, the clocks shall either be wall mounted or ceiling mounted or pole mounted. The Contractor shall determine the mounting method and submit to the Engineer for review before installation.

8) The Slave Clocks shall be manufactured to be used in non-air-conditioned environment with high humidity exposure.

9) The Master Clock System shall be capable of working from 230 Volts +/- 10% AC 50 Hz Power Supply.

7.5.4 Clock Management System

1) The status of the Master Clock Systems including GPS Receiving System, Master Clock Units, Clock Distribution System, NTP Servers, Sub-Master Clocks and Slave Clocks shall be monitored using SNMP by proposed dedicated Clock Management System to be provided at SCC/Manesar.

2) The Clock Management System shall provide full configuration support for Master Clock Units and Sub-Master Clocks.

7.5.5 System Expansion

- The Master Clock System shall be equipped with capacity to provide clock signal and timing reference distribution to 50 additional locations for other System/Subsystem or Sub Master Clocks.
- The system shall be able to support the required number of display clocks plus at least 10 additional Slave Clocks at each location.

(End of Chapter-7)

CHAPTER 8 – Quad cable, PIJF Cable and other Telephone cables

8.1 General

Telecommunication lines are usually laid underground between, station yards and in the block sections alongside the track.

8.2 Spare capacity

All telecom lines shall, as far as possible, be laid in a manner that due provisions are kept for any future extensions or extra connection which can be catered for without considerable alteration to the existing circuits or reconstruction of the entire alignment.

8.3 Type of Cables

1) The following types of underground cables are generally used for various telecommunication circuits as indicated.

2) Quad Cable 0.9 or 1.4 mm conductor dia as per IRS specification No. IRS:TC 30/05. These are 4/6 quad polythene insulated jelly filled cable suitable for underground laying and are used for control circuits and block interfaces. 1.4 mm conductor dia cable is used for longer block sections. It is desirable to provide 1.4 mm Quad cable in block sections longer than 12 kms .

3) Multi pair (from 10 pairs to 200) Multi Dia (0.5mm/0.63mm/0.9mm) PIJF (Polythene insulated Jelly Filled) Cable as per IRS specification No. IRS:TC 41/97. This is suitable for underground laying and is generally used for exchange subscriber lines or branch cables branching off from the main Quad cable.

4) Twisted Pair Switch Board Cable of sizes 0.5 mm / 0.6 mm copper conductor dia as per IRS/TEC specification. These are not designed for underground laying and are generally used for indoor applications such as distribution to various telephone subscribers in a building, MDF to exchange wiring etc.

8.4 Out door underground cable

Sizes of conductor	**Circuit for use**
0.5 mm conductor Dia twisted Pair PIJF or 1.83 kg/km (6.5 lb/mile)	Subscriber's connectionup to 5 kms.
0.63 mm conductor Dia. twisted Pair PIJF or 2.81 kg/km (10 lb/mile)	Subscriber's connections up to 10 km.

1) The size of the telephone exchange cables, shall be specified in a manner indicating the number of pairs, dia. of conductor, type of insulation/sheath, jelly filled, armoured or unarmoured as illustrated below:

- 50 pair, 0.63 mm conductor dia armoured polythene insulated polythene sheathed

jelly filled armoured telephone cable as per IRS : TC- 41/1997.

- In underground laying, minimum 10 pair Jelly filled armoured cables to be used.

8.5 Indoor cable

Sizes of conductor	Circuit for use
0.5 mm Annealed Tinned Copper (ATC) Switch Boardcable1.76 kg/km	subscriber's connection in a building, exchange to MDF wiring etc.
0.6 mm ATC Switch Board cable 2.52 kg/km	Trunk connections etc.

8.6 Testing of cable before laying

- Before the cable is laid, it shall be tested for insulation and continuity of the cores. Continuity of armour and screen of the cable need to be checked before laying.
- Bedding and armouring of the cable shall also be inspected to see that there has been no damage during transit or in storage.

8.7 Laying out the cable

1) For laying out cables, the cable drums shall be mounted on cable-wheels
2) The drum on the wheel shall be brought to one end of the trench and the end of the cable freed and put into the trench.
3) The cable-wheels shall then be drawn along the road or track.
4) A party of labours shall follow the drum and guide the cable from the road into the trench carefully so that the cable is not damaged or bent unduly.
5) In case where the wheels are not available, the drum shall be mounted on an axle at one end of the trench and cable laid out and carried by labourers.
6) In no case, shall the drum be rolled off on to the road for laying the cable and the cable dragged on the ground for laying purposes.
7) While excavating earth for trenches or making other pits necessary for installation of cable junction boxes in between the tracks or in close vicinity of the track the Permanent Way Inspector or his representative shall be present. In 'Quad' type of cables, conductors diagonally opposite shall form one circuit.
8) In telephone cables, electro-static and electro-magnetic induction between different pairs of conductors shall be minimised by a lead or aluminium sheath and by the provision of twisted pairs.
9) Whenever a road-crossing or rail-crossing is encountered in busy areas, HDD (Horizontal Directional Drilling) method should be used to lay all types of cables in DWC pipes or any other approved protection arrangement.

10) Where concrete large size duct is provided in the station section for laying signalling cables, the same may be utilized for telecom cables also following due precautions.

8.8 Cable termination

1) Cables can be terminated in any of the following methods:
   - DP Box of approved type.
   - Direct termination.

2) PIJF telephone cable of various sizes shall be terminated through DP Box of approved type.

8.9 Jointing of PIJF telephone/Quad cable:

1) Jointing should be done by a skilled and experienced person using the correct RDSO specified jointing kit to ensure quality.
2) The entire cable laying and jointing to be done under close supervision of telecom staff.
3) Thermoshrinkable jointing material shall be used for jointing armoured PIJF cable with thermo shrinkable jointing technique using RDSO's code of practice described in the chapter-2 of this specification.
4) The jointing material is readily available in the form of a jointing kit. For different sizes of cable (No. of pairs and cond. dia.) the kits are different e.g. TSF-1, TSF-2 etc as per latest RDSO specification. For quad cable, only Reinforced Thermoshrink Jelly Filled kit (RTSF) type jointing kit to be used as per latest RDSO specification.
5) Quad cable joint may normally be kept underground or it may be housed inside a location box of proper size avoiding sharp bends. Wherever joint is kept inside the Location Box, EC Socket also should be fixed on that location box itself and that location box should be painted with black & yellow stripes
6) The screen and armour of copper cables to be jointed shall be made through with suitable wires. This is essential to get the specified screening factor in association with its earthing at stations. This should be done first to avoid any electric shock due to induction.
7) The copper cable screen and armour shall be earthed with a low value earth (<10) at stations to achieve the specified screening factor.

8.10 Planning for cable laying

1) While planning for cabling on a route, the number of conductors and sizes and type of cable (quad/PIJF) required should be first determined depending upon the type of circuits desired.
2) It will be generally desirable to leave 25% or more conductors spare for all cables carrying

5 or more pairs of conductors for future expansions as codal life of these cables.

3) Then actual route for taking the cables should be decided upon. This should be done by travelling/walking along the track and deciding upon the best alignment for the cable route.

4) The desired route should be shown clearly on a route plan showing the actual alignment of track giving offsets from permanent way or permanent structures. The diagram should indicate the various road and track crossings, crossing with power cable, water and sewage mains and other points of importance

5) After the route has been decided upon, the convenient points for distribution (main cable to smaller distribution cables in case of subscriber cabling for exchange, emergency socket locations in case of emergency communication etc.) should be chosen.

6) The telecom cables should normally be laid within 1 metre inside the HORC boundary. For this the reference should be taken from boundary pillars. Where such pillars do not exist, the concerned P.Way/works officials to be advised to provide the same. Further it should be laid at least 2 m away from the nearest track and beyond embankment. Trenches in/nearer to the formation area of track shall be made only after consultation with P.Way staff and it shall be filled up and rammed properly after laying the cables on the same day before sunset. Special care, in this regard, shall be ensured during the monsoon season and in alluvial soil. It shall also be ensured that it is separated by at least 1 m from the nearest electrical power cable.

7) Concrete & Electronic type Cable markers shall be provided all along the route at a nominal interval of 50m alternatively in block section. Additional markers shall be provided to indicate important points like cable joints, water and sewage mains, power cable, crossings, alignment bends/curves, etc. The Electrionic cable route marker shall be provided in station section at an interval of 100m. The cable shall be at least 1.2 m below the surface of the ground. The trench shall be minimum 0.3 m/ sufficiently wide to ensure smooth cleaning of trenches and laying of cables.

8) In exceptional cases, such as in yards and when the depth of the cable trench is limited to 0.5 m. due to local conditions a minimum distance of one metre shall be maintained between the cable and the OHE mast supporting the catenary or any other structure likely to come in contact with the high-tension conductors. When the observance of this rule creates difficulty, the cable shall be laid in RCC pipes and in that case the distance to be maintained as specified above can be brought down to 0.5m.

9) When the depth of the cable trench exceeds 0.5 m. near the OHE masts, it shall be ensured that the nearest edge of the cable trench is at least 3m away from the OHE mast.

10) Position of cable joints shall be marked on the nearest OHE mast by painting of an approved legend.

11) Laying of cables in the vicinity of traction sub-stations, OHE switching stations and their associated earthing system shall be governed by the following principles:

12) In the vicinity of traction sub-stations, the cable shall be laid at least one metre away from any metallic body of the sub-stations, which is fixed in the ground, and at least one metre away from the sub-station earthing. The cables shall, further, be laid in concrete pipes or enclosed brick channels for a length of 300 m. on either side of the sub-station. As far as possible, the cable should be laid on the side of the track opposite the sub-station side.

13) In the vicinity of the OHE switching stations (feeding posts, sectioning and sub-stationing

posts), the cable shall be laid at least one metre away from any metallic body of the station which is fixed in the ground and at least 5 m. Away from station earthing. The distance of 5 m. from station earthing can be reduced to one metre, provided the cables are laid in concrete piles

14) Where an independent earth is provided for an OHE structure, the cables shall be laid at least one metre away from such earthing.

15) Outside station limits, the cable shall generally be laid at a standard distance from 10m. from the centre of the nearest track.

16) When signalling and telecommunication cables are laid in the same trench, a distance of about 100 mm. is to be maintained between them by placing bricks between them.

17) HT and LT power cables and telecommunication cables shall not be laid in the same trench.

18) The cable laid parallel to the track shall normally be buried at the depth of 1.0 m in station area. While those laid across the track must be one metre below the rail flanges.

19) The trench for the telecommunication cable shall be kept as far away as possible from the trench for the power cables.

20) When cables are to be laid along the girder bridges, over the culverts, through the bed of culverts, over the rocky terrain and the like, they shall be laid as per the approved methods for each such location.

21) While laying, the cables shall not be subjected to sharp bends. The bending radius for the cable shall in no case be less than 40 times the diameter of the cable in case of aluminium sheathed armoured cables.

8.11 Methods of laying cable

1) Cables should invariably be unwound from the cable drum by mounting the cable drum on jack with the axle parallel to the base. It should never be unwound by keeping the drum on its sides.

2) Cables shall be laid using one of the following methods, viz., laying direct in the trench, drawing through ducts and laying solid. The choice of the method depends upon the type of the cable to be laid, the nature of the cable route, initial outlay, and future expansions, and economy in maintenance charges

3) Direct in the trench method-For direct laying, the bottom surface of the trench is made free of corrosive elements and the cable is laid on the bedding of the soft earth of the trench Where the bottom surface is rough, a 10 cm layer of fine sieved earth/s and shall be used as bedding.

4) Drawing the Cable through RCC ducts / Pipes-RCC ducts / GI Pipes or DWC / HDPE pipes may be used for laying the cable. Whenever the cable is laid in the duct, there shall be sufficient holes at the bottom of the duct for draining away of any water that may collect.

5) Laying solid- For laying solid, a trough is made in an excavated trench and the cable is laid in the trough:

- Molten bituminous compound or asphalt or similar materials of approved type is

poured in to fill the trough completely.

- It is then lined with bricks on the top after the compound is set.
- Care is taken to hold the cable in the trough on wooden pieces, so that the cable is entirely surrounded by the molten material.
- This type of laying is can be justified only in cases where the soil is chemically detrimental due to electrolytic corrosion, or at critical bridges and theft prone areas.

8.12 Testing

1) During cable laying work Cables section shall be tested after each joint is made to facilitate tracing of a fault during the course of jointing.
2) On discovery of a fault during the cable laying, the last joint must be opened out and defect rectified.
3) The wires in the cable must be tested just before laying and after laying and jointing and also regularly on the laid cable for the following:
   - Continuity
   - Absence of crossed pair/quad
   - Absence of conductor cores contacts
   - Insulation resistance
   - Absence of contacts between wires forming a pair (short circuit)
   - Transmission loss & cross-talk
   - Continuity of armour and screen of the cable need to be checked before laying

8.13 Procedure for preparation of cable

1) To facilitate testing, every wire at the starting end shall be twisted with its mate to form a loop in each pair, each twist being insulated from other pairs by means of PVC sleeves.
2) The tests shall be conducted from the other end of the cable.
3) In case of multi-layer cable, the layers of the cable shall be separated with cotton thread or twine to keep the wires in their proper places, so that the position of faulty wire or pair may be easily ascertained.
4) After the test is over, the end shall be cut and sealed or terminated as per the requirements at site.
5) In case it is desired to maintain the end for further tests, it may be suitably protected.

8.14 Testing for continuity, absence of crossed pair and absence of contacts

The following procedure may be adopted:

1) At one end the cable should be made ready to facilitate testing from the other end.

2) At the testing end, a Multimeter shall be used for the tests.

3) All conductors are to be bunched together and then earthed through the armour and screen of the cable with a soft bare copper wire and connected to one probe of the Multimeter. Multimeter to be kept in Continuity Test mode.

4) Now any of the wires from the bunch may be separated and when touched to the other probe of the Multimeter, it should give continuity buzzer sound and loop resistance value. If the loop resistance value is substantially less than the calculated value as per the loop length, it indicates shorting within the pair.

5) Disconnect the mate of the wire under test from the bunch and this buzzer sound should disappear proving the absence of crosses and wrong contacts.

6) If any of the wire shows the cross or contact, they should be earthed again to trace wires with which they are crossed or are in contact. Each pair of conductors should be tested in the above manner before jointing the next length.

7) Where the test proves that wires have been cross jointed, the joints shall be opened and the fault rectified to avoid crosstalk. Re-crossing in the next jointing does not clear the fault.

8.15 Testing for insulation

1) The insulation test shall be taken on half of the pairs of the cable bunched together, the other half being earthed to the armour and screen. The second half shall then be tested in a similar manner with the first half earthed.

2) The test shall be carried out with a megger before connecting it to the terminal equipment.

3) If a contact between the wires forming a pair exists, it will be shown by the megger registering a dead earth. In this case, each pair shall be tested individually until the faulty pair is found.

4) Insulation test of newly laid U/G cable shall be done with a megger of 5OOV and afterwards it shall be done with a megger of 100V/500V depending upon the overall condition of cable and spares available.

8.16 Routine test schedule

Underground cables shall be tested once every year for continuity, transmission loss, cross-talk, loop resistance, armour continuity, insulation resistance and tracing & up dation of cable route diagram and the results of tests shall be done.

8.17 Maintenance

1) Underground cable installations when laid strictly in accordance with the recommended practice will hardly need any maintenance throughout their anticipated span of life. As far as the buried portion of the cable is concerned, no repairs are generally possible except in cases where moisture or water has entered the cable and is detected before it has damaged the insulation.

2) No digging operations by other departments shall be carried out close to the cable route

without prior notice to the Telecommunication Engineer who shall supervise or arrange supervision to ensure necessary precautions to protect the cable from damage has been taken or being taken during the work.

3) Each Emergency socket provided through quad cable shall be inspected once in 15 days for its performance and good shape and the emergency socket markings on OHE masts shall be well painted.

4) Quad and PIJF cables in each section should be maintained by a cable gang. The staff strength should be as per the latest yardstick issued by Railway Board. The maintenance gang should have provision for a vehicle where the men and material can be loaded and comfortably reach the site.

8.18 Cable faults

1) TYPE

- Low insulation in one limb or both.
- Open/break in one limb or both.
- Short/Earth.
- Multiple faults.
- Foreign potential

2) Localisation of faults- Various types of cable fault locators available generally work on the following principle:

- Potential distribution method
- Pulse reflection (ECHO) method

3) Rectification of faults-

- After localisation of faults, the defective portion of cable may be replaced by healthy piece of cable with proper joint.

8.19 Specifications- Voice frequency communication system for Underground QUAD Cable shall be as per Specifications No. RDSO/SPN/TC/34/2002 with latest versions and amendments.

(End of Chapter-8)

CHAPTER 9 - VHF COMMUNICATION SYSTEM

9.1 25-Watt VHF Transceivers

9.1.1 General

1) Specifications given below shall be read in conjunction with RDSO Specification No. RDSO/SPN/TC/73/2008 Ver 1.0 or latest.

2) VHF Communication System shall be created at Stations using 25 Watt VHF Transceivers. VHF Transceivers along with Power Supply and Associated Accessories & Cables shall be supplied by the Contractor.

3) 25 Watt VHF Transceivers shall be installed in Station Control Room and any other specified place as decided by the Engineer. Omni-Directional Antenna for 25 Watt VHF Transceivers shall be mounted on a Station building/suitable Pole/Mast at a minimum height of 15 meters from the ground level. Omni-Directional Antenna and Pole/Mast shall be supplied by the Contractor.

4) SMPS based Telecom Integrated Power supply System as per RDSO Specifications given in Chapter 2 with latest amendment shall be used as a Power Source for these 25 Watt VHF sets.

5) Device for protection of 25 watt VHF Transceivers base station shall be provided in accordance with RDSO Specification No. RDSO/SPN/TC/98/2011 for Surge Protective Devices for Telecommunication Equipment Specification of 25 Watt VHF Transceivers shall be as given below:

General		
1.	Frequency Range	146-174 MHz
2.	No. of Channels	16 Channels or more
3.	Channel Spacing	12.5 KHz or 25 KHz
4.	Frequency spread	28 MHz
5.	Frequency Stability	5 PPM or better
6.	Type of Emission	8K5OF3E or 16KOF3E
7.	Type of Operation	Simplex/Semi Duplex, press to talk with built in condenser microphone and the speaker.
8.	Type of Antenna	Stacked Dipole Omni directional antenna complete with cable and other accessories.
9.	Speaker Impedance	8 U
10.	Speaker	Internal Speaker as well as Socket for External Speaker shall be provided (The Internal Speaker shall be cut-off whenExternal

		Speaker is used).

11.	Output Impedance	50 CI
12	Protection	Reverse Polarity protection shall be provided. The final transistor shall be protected againsthigh VSWR
Transmitter		
1.	RF Power output	10 to 25W
2.	Frequency Deviation	+/- 2.5 KHz (N type) +/-5 KHz (W Type)
3.	Modulation Sensitivity	80mV for 60% max. deviation at 1000 Hz
4.	Modulation Distortion	Better than 5%
5.	Modulation Fidelity	Within +1, -3 dB of 6 dB/Octave
6.	Spurious & Harmonics supersession	Better than -36 dBm (0.25 pW)
Receiver		
1.	Sensitivity	0.30pV/-118 dBm at 12 dB SINAD
2.	Squelch Sensitivity	Better than -119 dBm
3.	Selectivity	Better than 60 dB
4.	Image and Spurious Rejection	Better than 65 dB
5.	Audio Output	1W with less than 5% distortion at 1 KHz reference measured at specified audio frequency output.
6.	Audio Frequency Response	Within +1, -3dB of 6dB/Octave
Feature-wise Configurations		
1.	Simple press to talk	
2.	Protection against high VSWR	
3.	Channel spacing (12.5KHz) or 25 KHz	

4.	PTT ID Encode
5.	CTCSS/DCS Signalling alongwith Inverse Scrambling
6.	Busy Channel Lockout
7.	Channel scanning with call quieting facility
8.	DTMF/ Signalling with Selective Calling
9.	Selective Call Decode.
10.	Capable of being killed/Unkilled.

Stacked dipole omni directional antenna		
1.	Frequency Range- MHz	146-174
2.	Bandwidth-MHz	10 M Hz
3.	Impedance-Ohms	50 unbalanced
4.	VSWR – Less than	1.5
5.	RF Power handling capacity-Watt	100
6.	Termination	N-Female
7.	Lightening Protection	Direct Ground
8.	Support Pipe Material	Aluminum
9.	Support Pipe Length- feet	12
9.	Support Pipe O D - mm	50
10.	Support Pipe Wall Thickness - mm	2.5
11.	Radiating Elements Material	Aluminum

12.	Radiating Elements Material OD-mm	12
13.	Radiating Elements Mounting Clamp	MS galvanized power coated
14.	Mounting clamp for Antenna	MS galvanized power coated
15.	Shipping Length-Feet	6.5
16.	Gain of Antenna:	>3
14.	No. of dipole Antenna	> 2
15.	Earthpit on the ground	<1 Ohm earth resistance
16.	Distance between two towers	<15Km
17.	Mast:	15m self supporting, Top section width >300mm, Bottom section width>700mm, with monkey ladder
Antenna Cable		
1.	Length	As per site requirement
2.	Size	RG 217 Low Loss Cable
3.	Jacket	Polyethylene Black
4.	Outer diameter	14mm
5.	Characteristic Impedance	50 +/- 1 ohm
6.	Average Power Rating	1.00 KW at 100 MHz
7.	Attenuation	0.05 db/ Mt at 100 MHz
12 Volts Battery (SMF battery)		

1.	Voltage	12 V
2.	Backup Capacity	Min 120 AH
3.	Type	Maintenance Free

9.2 5 Watt VHF Walkie-Talkie Sets

1) The Contractor shall supply 50 Nos. 5 Watt VHF Walkie-Talkie Sets complete with their standard OEM Battery Packs, spare batteries, Carrying Case and Charger as per RDSO Specification No. RDSO/SPN/TC/107/2018.

2) The Contractor shall also supply 15 Nos. Multi-Unit Charger (for charging minimum 5 units) for charging of 5 Watt VHF Walkie-Talkie Sets. The Charger shall be Rapid Battery Charger.

3) The 5 Watt Walkie Talkie equipment shall be provided as per the following specification or better:

General		
1.	Frequency Range	146-174 MHz (Full Band)
2.	No. of Channels	16 Channels or more
3.	Channel Spacing	12.5 KHz or 25 KHz
4.	Frequency spread	28 MHz
5.	Frequency Stability	5 PPM or better
6.	Type of Emission	8K5OF3E or 16KOF3E
7.	Type of Operation	Simplex/Semi-duplex, press to talk with built incondenser microphone and speaker
8.	Type of Antenna	Helical Antenna suitable for Frequency Rangespecified.
9.	Speaker Impedance	8 CI
10.	Speaker	Internal Speaker as well as Socket for ExternalSpeaker shall be provided (The Internal Speaker shall be cut-off when

		External Speaker is used).
11.	Output Impedance	50 CI
12	Protection	(i) Reverse Polarity protection shall be provided. (ii) The final transistor shall be protectedagainst high VSWR
13.	Power Source	2000 mAH 7.2-7.4 V, NiMH or Li-lon Battery.
14.	Weight	600 g Maximum with Battery.
Transmitter		
1.	RF Power output	1-5 Watt RF power output switch able/ programmable
2.	Frequency Deviation	+/- 2.5 KHz Max. (N Type), +/- 5 KHz (W Type).
3.	Modulation Sensitivity	80mV for 60% max. deviation at 1000 Hz
4.	Modulation Distortion	Better than 5%
5.	Modulation Fidelity	Within +1, -3 dB of 6 dB/Octave
6.	Spurious & Harmonics supersession	Better than-36 dBm (0.25 pW)
7.	VSWR	Less than 1.5
Receiver		
1.	Sensitivity	0.3pV/-118 dBm at 12 dB SINAD
2.	Squelch Sensitivity	0.25 micro V or better at threshold.
3.	Selectivity	Better than 60 dB
4.	Image Rejection	Better than 65 dB
5.	Audio Output	Better than 250mW with less than 5% distortion at 1 KHz reference measured at specified AF output.
6.	Audio Frequency Response	Within +1, -3 dB of 6dB/ Octave

Feature-wise Configurations	
1.	Simple Press-to-Talk
2.	Protection against high VSWR
3.	Low Battery Alert
4.	Capable of VOX for Hands-free Operation.
5.	PTT ID Encode
6.	CTCSS/DCS alongwith Inverse Scrambling
7.	Busy Channel Lockout
8.	Channel Scanning with Call Quieting facility
9.	DTMF Signalling with Selective Calling
10.	Selective Call Decode.
11.	Capable of being killed/Unkilled.

9.3 General Requirements

All equipment shall be suitable for operation in the following environmental conditions.

- Operating Temperature Range: -5° C to +55° C
- Storage Temperature Range: -10° C to +70° C
- Relative Humidity: 95% Max +40° C non condensing.
- Environmental Test Reports in respect of main equipment of 25 Watt VHF Transceivers and 5 Watt VHF Walkie-Talkie Sets proposed to be supplied shall be submitted along with Design Submissions for review by the Engineer. Environmental conditions prevailing in the section where it is to be deployed have been listed in GS. The Contractor shall submit the Environmental Test Reports to the Engineer for review.

S No	Test	Conditions of test to be conducted as per ISO- 9000	
a)	Dry Test	Part-III/SEC.5/1977	55° C(+/-) 2^{O} C. RH<50% Duration 16 Hr.

b)	Dump Heat (Cyclic) Test	Part-V/SEC.2/Variant1/1981	40℃+/-) 2^{O} C, RH 95%. Two cycles of 24 (12+12) hrs each.
c)	Cold Test	Part-II/SEC. 4/1977	(-)10° C +/-3° C, Duration 16 Hrs.
d)	Drop test (inpacked	Part-VII/SEC.3/1979	Six drops one on each face, Height of all 1000mm in case of hand held items and 500mm in case of Other items.
e)	Vibration Test	Part VIII/1981	12 Hrs, 4 hours along each axis, at 15-150 Hz and with amplitude of 0.15 mm/2g
f)	Storage Test	Part III/SEC.5/1977 &Part II/SEC.4/1977	-10° C for 5 hours. Then raisethe temperature to 70° C for 16 hrs.
g)	Bump test	Part VII/SEC.2/1979	4000 bumps at peakacceleration of 400m/s.sq.

- Environmental Test Report with equivalent or superior conditions would be acceptable.
- In case of Transceivers, the functional tests shall be carried out at the commencement and at the conclusion of the environmental test sequence as above. The functional tests and permissible degradation shall be as under:

  (1) RF Power output It shall not degrade by more than 1 dB

  (2) Receiver Sensitivity It shall not degrade by more than 1 dB

  (3) Frequency Stability No degradation shall be noticed on any frequency.
- In the case of batteries, battery chargers and power supplies, the functional tests shall be carried out at the conclusion of the environmental test sequence as above. The functional tests and permissible degradation shall be as under:

  (1) Battery: No degradation in battery capacity

  (2) Battery Charger: No degradation in output voltage.

  (3) Power Supplies: No degradation in output Voltage.

(End of chapter-9)

CHAPTER 10 - SMPS based Telecom Integrated Power Supply System for Station (TIPSS)

10.1 General

10.1.1 The SMPS based Telecom Integrated Power Supply System for Station(TIPSS)at each station, shall be sized to power its full load including, but not limited to, VHF Communication System, Telephone System, OFC System and master clock system. The VHF Communication System shall work on 12 V DC. The System will also provide galvanically isolated 24V, 12V, and 3-6V DC for other telecom applications with the help of DC-DC Converter.

10.1.2 The Battery Backup System shall include Line Protecting Devices, Battery Chargers, Battery Banks and Load Distribution Arrangement. The Battery Banks shall consist of Valve Regulated Lead Acid Maintenance Free Cells

10.1.3 TIPSS shall be as per RDSO specification described in the chapter-2 with latest amendment shall be provided.

10.1.4 Surge Protective Devices connected to low-voltage power distribution systems shall be as per RDSO specification described in the chapter-2 of this specification with latest amendment shall be provided.

10.1.5 Protection against Lightning Electromagnetic Impulse shall be as per RDSO specification described in the chapter-2 of this specification with latest amendment shall be provided.

10.2 Design Requirements

10.2.1 Design shall take into consideration the voltage drop between the Power Supply Source and the Telecommunication System Load individually at each location.

10.3 Technical Requirements

10.3.1 For high availability, the Battery Backup System at each location shall include 2x100% SMPS based 48 V Battery Chargers in Load Sharing Mode with individual 48 V Battery Bank for each Battery Charger.

10.3.2 Each of the two Battery Banks shall provide busy hour reserve of four(4) hours, for all Telecommunication Equipment powered by 48 V DC Battery Backup System, at each location.

10.3.3 For sizing the battery capacity at each location, relevant factors like K Factor (as applicable), Ageing Factor (1.25), Design Margin (1.1), Temperature Factor and ECV (as applicable for the type of battery) shall be considered. In addition spare capacity of 25% shall be provided to cater for any requirement of additional equipment at that location.

10.3.4 The design shall ensure that the failure of a single component does not cause failure of the 48 V DC Battery Backup System.

10.3.5 All Battery Cells shall be of the Valve Regulated Lead Acid Maintenance Free type to RDSO specifications IRS S93-96 with Latest Amendments for capacities up to and including 500 AH and to TEC Specifications No.GR/BAT-01/03 March 2004 with Latest Amendments for capacities beyond 500 AH. The life of these Battery Cells

shall not be less than 7 years.

10.3.6 There shall be no break in the 48 V DC Power Supply to the Telecommunication Systems during failure of one of the Battery Charger with Battery Bank.

10.3.7 The following data shall apply to 48 V DC Battery Backup System:

(1) Input Voltage Range (Single phase): 230 V AC (+10 %, - 20%)

(2) Input frequency: 50 Hz +/- 5%

(3) Output Current: As required for each location

10.3.8 Battery Backup System functions shall include:

(1) Low Voltage Battery Disconnection (LVD)

(2) Battery Disconnection Pre-Alarm

(3) Battery Current Limiting

(4) Temperature Compensated Charging

(5) Test Mode Facility

10.3.9 System Protection shall include

(1) High Voltage Input Disconnection (HVD)

(2) Lightning Protection/Surge Protection

(3) Transient Absorbers for Component Protection

(4) Load Fuses/MCB's as required

(5) Battery Fuses /MCB's as required

10.3.10 Alarms for the Battery Backup System shall be implemented through Network Management System (NMS) provided in HORC at SCC/IMD. Contractor shall extend these alarms using appropriate interface such as RS-232, RS-485, TCP/IP etc. Following Alarms shall be provided on the NMS at SCC/IMD for each of the 48 V DC Battery Backup System at all locations.

(1) Mains Available/Mains Not Available

(2) Mains Out of Range

(3) Float Mode

(4) Charge Mode

(5) System Overload

(6) Rectifier Modules Fail (one or more than one)

(7) Battery Cut-Off Pre-AIarm

(8) Battery Fail/lsolated

(End of Chapter-10)

CHAPTER 11 - PUBLIC ADDRESS SYSTEM

11.1 General

This chapter covers the technical requirements of Public Address System to be provided at Railway Stations for making announcement at platforms, concourse, Ticketing area foot over bridges/Subways etc.

11.2 Scope of Work

The specification of Public Address System covers technical requirement of Call Station, Paging Microphone, System Controller, Booster Amplifier, and various types of loudspeakers like column speakers, horn speakers, sound projector speakers and ceiling speakers for making announcement at platforms, concourse, Ticketing area foot over bridges/Subways and other areas of railway stations at New Patli and Sultanpur Stations as per RDSO specification RDSO/SPN/TC/63/2006, Ver.-1 with latest amendment.

11.3 System Requirements

1) Public Address System, suitable for small stations, shall consist of a Paging Microphone, one or more booster amplifiers, and suitable speakers.

2) System shall have facility to announce on all the platforms at a time, or at only certain locations selected from the Call Station. This does not apply to C category stations where no Call Station is used.

3) Public Address System shall also take audio input from PC Based Announcement System for making prerecorded announcements, playing music, slogans etc

11.4 Technical Requirements

11.4.1 Constant Voltage Transformer (CVT):

1) Suitable capacity of Constant Voltage Transformer (CVT) of standard make shall be provided to ensure stable power supply to all devices and equipments of PA system. Adequate capacity of 24 Volts maintenance free battery with charger suitable for telecom system shall also be provided to ensure battery back up of complete Public Address system for at least three hours in case of interruption in normal supply.

11.4.2 Cabinet:

1) Separate standard cabinet of suitable dimension is to be provided in TER to house all type of devices and equipments required for PA system such as System Controller, Routers, Booster Amplifiers, CVT, battery, charger and other accessories.

11.4.3 Paging Microphone:

1) Paging Microphone shall be used for making announcements, at stations. It can be used with a System Controller for announcements to be made from the Control Room.

2) The Paging Microphone shall be supplied with a suitable shielded cable of minimum length 10 meters with a connector suitable for connecting it to the booster amplifier & system controller

11.4.4 Wall Loudspeaker:

1) A Wall Loudspeaker shall be used for wall mounting in indoor areas and in covered areas where false ceiling is not available

2) The Wall Loudspeaker shall consist of an 8W loudspeaker housed in a steel cabinet (suitably painted to avoid rusting) or high quality ABS cabinet, with inbuilt line matching transformer for operation on 100V line.

11.4.5 Ceiling Type Loudspeaker:

1) A flush-mounting ceiling loudspeaker shall be normally used in indoor locations where a false ceiling is available like offices, cabins etc.

2) The speaker assembly shall consist of a 6 Watt loudspeaker and frame with a metal fire-dome. It shall be suitable for connecting to the 100V line running from the booster amplifier, and shall include an inbuilt line matching transformer with taps on the primary winding to allow different power settings. The taps on the line matching transformer shall be connected to a terminal strip for easy access during installation.

11.4.6 Line Array Loudspeaker (Column Loudspeaker):

1) The line array (column) loudspeakers shall be normally used in large indoor and covered environments like covered part of platforms, waiting rooms, lobbies, ticketing/ enquiry areas etc. It shall be suitable for both announcement and music reproduction.

2) The column loudspeaker shall be suitable for connecting to the 100V line running from the booster amplifier, and shall include an inbuilt line matching transformer with taps on the primary winding to allow different power settings.

11.4.7 Horn Loudspeaker:

1) Horn loudspeakers with inbuilt driver unit shall provide excellent speech clarity and sound distribution. They are normally to be provided for outdoor like uncovered part of platforms, overhead bridges, parking areas etc. Since sound pressure level of horn loudspeakers is high, these can also be used on covered platforms or in indoor areas where ambient noise is high.

2) The horn loudspeaker shall be suitable for connecting to the 100V line running from the booster amplifier, and shall include an inbuilt line matching transformer with taps on the primary winding to allow different power settings. The different power taps shall be selectable through an inbuilt rotary switch.

3) A cable of minimum 50 cm length shall be attached to the horn loudspeaker for connection to the 100V line coming from the booster amplifier. The cable shall be two core sheathed cable with each core having minimum 20 copper strands of 36 SWG

11.4.8 Sound Projector:

1) The sound projector shall be normally used in indoor applications where directing the sound beam is desirable like corridors, entrance of lobbies etc.

2) Sound Projector units shall be suitable for connecting to the 100V line running from the booster amplifier, and shall include an inbuilt line matching transformer with taps on the primary winding to allow different power settings. It shall be possible to select different power taps by rotating an inbuilt switch.

11.4.9 Booster Amplifier:

1) Booster amplifier shall be 19" rack mountable, or to be supplied with accessories which enable it to be mounted on a 19" rack

2) Booster Amplifier shall be able to drive 70V/100V constant voltage and low impedance loudspeaker loads

3) In case the booster amplifier has more than one input socket, it shall have an inbuilt priority circuit to ensure that announcements can override any music source which may be connected directly to the booster.

4) The booster amplifier shall have, on the front panel, a suitable display of the signal level through a set of LEDs, or LCD panel, or VU Meter and power ON status

5) The booster amplifier shall have an input socket with sensitivity of 1 volt

11.4.10 System Controller:

1) System Controller shall have provision for attaching a Paging Microphone to make announcements simultaneously in all zones. The System Controller shall give priority to these announcements over the background music source

2) System Controller shall have provision for attaching a music source with nominal output 200mV for playing background music in all zones.

3) The System Controller shall be 19" rack mountable, or be supplied with accessories which enable mounting it on a 19" rack.

(End of Chapter-11)

CHAPTER 12 – IP Based Integrated Passenger Information System

12.1 General

This chapter covers the technical requirements of IP Based Integrated Passenger Information System suitable for displaying Train arrival/ departure indication, coach guidance and PC based announcement system and for showing True colour Commercial Advertisements and video displays. Announcement system to be provided at Railway Stations for making announcement at platforms, concourse, Ticketing area foot over bridges/Subways and other areas of railway stations.

12.2 Scope of Work

This covers the general, functional, technical and performance requirements of IP Based Integrated Passenger Information System used for giving train arrival/departure information and any other video/image/alert information to passengers, which includes different type of display i.e. Single Line, Multiline, True colour indoor and outdoor video display, At a glance, coach guidance and PC based announcement system, placed at various places of the station with feature of networking, Operations from local operator and remote monitoring from a central place. Announcement System covers technical requirement for making announcement at platforms, concourse, Ticketing area foot over bridges/Subways and other areas of railway stations at Manesar Station as per RDSO specification RDSO/SPN/TC/108/2019, Ver.-0.0 with latest amendment.

12.3 System Requirements

1) The IP Based Integrated Passenger Information System (IPIS) will consist of Central Data Controller (CDC) loaded with software for announcement & display, Remote monitoring Software (RMS), PDC, LED display (TV) and display boards of different sizes like Single Line, Multiline, At a glance, True colour Indoor and outdoor video display, Coach Guidance.

2) Multiline Display Board to display train Information in mono colour i.e. Train number, Name, time of arrival/departure and platform number. It will show information of up trains/ down trains both. The multiline display boards will be placed at main entrance/ concourse of the station.

3) True colour Indoor and Outdoor Video Display shall display train information in multi-colour, commercials, entertainment programs and other information to passengers.

4) Platform Display Board to display the information of the train scheduled for arrival/departure from that platform i.e. Train number, Name, time of arrival/ departure in mono colour. The Platform display boards will be placed at suitable places on platforms/ foot-over bridges.

5) At-A-Glance Display Board for displaying information of the train arriving/ departing from that platform along with coach composition in mono colour.

6) Coach Guidance Display Board to indicate position of coach No. scheduled for arrival/ departure from that platform for guidance of passengers in mono colour.

7) Display Monitor/ LED TV (Industrial grade capable of working 24x7) to display train information being displayed on Multiline Display Board. Display monitor shall be provided in the enquiry offices, waiting rooms or at any suitable Indoor application only.

8) It should also be possible to network all systems provided at different locations at a station for carrying out operation from a centralized place.

9) All devices shall be connected at the station with LAN network.

10) System shall have facility to announce on all the platforms at a time, or at only certain locations selected from the Call Station. This does not apply to C category stations where no Call Station is used.

11) All hardware and software shall be provided according to aforesaid latest RDSO specification.

(End of Chapter-12)

CHAPTER 13- INSTALLATION, EARTHING, LIGHTNING AND SURGE PROTECTION

13.1 General

1) The Contractor shall supervise all installation of the Works and shall ensure all technical, safety and quality matters adhered to the Design reviewed by the Engineer.
2) The Contractor shall take every precaution to protect existing equipment and facilities on Site from damage, and shall make good any damage caused. Care shall also be taken not to interfere with the operation of existing equipment.
3) The Contractor shall provide all necessary and sufficient resources such as tools, test instruments, spares, equipment, manpower and communication facilities to complete all the installation activities.
4) The Contractor shall ensure his staff are competent and possess all the necessary skills to carry out the installation in a proper and safe manner.
5) The Contractor shall carry out site surveys to ensure sufficient knowledge on the Site before submitting the relevant installation design & drawings and other installation relatedsubmissions to the Engineer for review.
6) The Contractor shall submit calculations, if required, by the Engineer to demonstrate that the proposed mounting methods are sufficient to withstand the wind loading for the equipment. All submitted calculations shall be undertaken and certified by relevant Registered Structural Engineer
7) The Contractor shall submit installation method statements for each type of installation activities at least three months before the commencement of the activity to the Engineer for review.
8) The installation method statement shall include the details on the methods and procedures of installation, site arrangement, manpower resources, equipment and tools required. Drawings shall be included to illustrate the proposed installation details.
9) All installation activities shall commence only after the method statement and related submissions have been reviewed without objection by the Engineer.
10) The Contractor shall assign competent site supervisors for each work site to be responsible for all site-related matters.
11) The Contractor shall carry out regular site audit on both technical and safety matters and maintain records of the site audits. The Contractor shall make these records available to the Engineer for inspection upon request.

13.2 Installation Program

13.2.1 The Contractor shall submit the Installation Program for review by the Engineer. This Installation Program shall take into account the following:

(1) Installation schedule
(2) Milestones
(3) Site Access
(4) Interfacing with relevant Project Contractors
(5) Interfacing with Indian Railway at the junction stations.

13.2.2 The Contractor shall co-ordinate with relevant Project Contractors to agree the date of access to the physical areas to carry out installation activities.

13.2.3 The Contractor shall ensure sufficient floats or slacks in all activities and avoid critical paths built in his Installation Program. In case critical paths cannot be avoided, the Contractor shall take adequate measures to complete all critical paths activities in time and also highlight these critical paths for the Engineer's attention.

13.2.4 Any subsequent change3.3s in the reviewed Installation Program shall be submitted to the Engineer for review.

13.3 Installation Works in Telecom Equipment Rooms

13.3.1 Telecommunication Equipment Room at Stations and IMD, will be constructed by C1 and C 2 Civil Contractor to install the Telecommunication Equipment.

13.3.2 Additional space if not available shall be provided through construction of Porta cabin/hut by contractor besides Telecommunication Equipment Room/Telecom Power Supply Equipment Room at Interfacing IR Stations, TSSs, SPs, SSPs and any other location as required. These rooms shall be preferably be co- located with the existing Signalling Equipment Room/Signalling Power Supply Equipment Room.

13.3.3 Electric Power for Telecom System up to Main AC Distribution Panel common for Signalling & Telecom Systems shall be drawn as covered in Clause 5.3.10 of Particular Specification for Signalling Works. From this Main AC Distribution Panel, electric power for Telecom System shall be taken to Telecom AC Distribution Panel for distribution to Telecom Power Supply Equipment and Telecom Equipment.

13.3.4 48V, 12V, 24V and 3-6V DC Power Supply from SMPS Based Telecom Integrated Power Supply System shall be taken to DC Distribution Panel for further distribution to Telecom Equipment.

13.3.5 Provision of Lighting, Power Outlets, Fans, Ventilator and Air-Circulation shall be made in accordance with Interface Requirements as mentioned in General Specification (S & T).

13.3.6 All floor-mounted equipment cabinets at the equipment rooms shall be securely bolted to floor/ground, properly aligned and levelled.

13.3.7 All wall-mounted equipment shall be installed at appropriate height to avoid any hazards to the person passing by. The Contractor shall ensure that the wall of additional space if required at interfacing IR stations is of sufficient strength to hold the wall-mounted equipment in a secure and safe manner.

13.3.8 The floor mounted equipment cabinets shall be arranged in the way to allow sufficient space at the front and rear side of the cabinets for maintenance access. Sufficient space shall also be allowed for front maintenance access of the wall mounted equipment.

13.3.9 The equipment layout within the equipment room shall be designed to allow sufficient clearance for escape out of the equipment rooms in case of emergency.

13.3.10 All cable and wires inside the cabinets shall be housed in appropriate cable conduits or tied neatly along the side of cabinets. They shall not cause any obstruction to the access of equipment within.

13.3.11 All optical cable fibres which run outside shall be contained in protective conduits.

13.3.12 Portable Fire Extinguishers shall be provided in Telecom Equipment Room and Telecom

Power Supply Equipment Rooms. Portable fire extinguishers shall be compliant to NFPA 10 standard and suitable for electrical equipment. Automatic fire and detection system provided under Particular Specifications (Signalling) shall also be extended to cover various Telecom rooms.

13.3.13 The Contractor shall submit the following to the Engineer for review at least one months before the commencement of the installation inside the equipment room:

1) drawings showing the equipment layouts and positions of the racks, cabinets and enclosures;
2) racks, cabinets layout drawings showing the arrangement of individual module;
3) specifications, sample of all the mounting brackets and accessories;
4) equipment mounting and installation methods;
5) schematic diagrams and wiring diagrams of the compete HORC Telecommunication System;
6) electrical distribution schematics within each equipment room including the earthing details; and
7) cable route diagrams for cables within each equipment room.
8) Diagram for VHF antenna installation on the self supporting mast and VHF system architecture diagram.
9) IP-MPLS based OFC system architecture and PDH architecture diagram.
10) Control Communication system architecture and Emergency communication system architecture diagram.
11) IP ready EPABX system and Attendant console architecture diagram.
12) Master clock system architecture diagram.
13) Public Announcement system architecture diagram.
14) SMPS based integrated power supply for telecommunication system
15) Earthing drawing at stations, TSS/SP/SSP, IR stations, outdoor equipment etc.
16) Quad allocation chart and Communication channeling Plan

13.3.14 Installation works inside the equipment rooms shall be carried only after these submissions have been reviewed without objection by the Engineer.

13.4 Installation Works within Buildings

13.4.1 The Contractor shall provide all necessary mounting brackets and accessories for installation of all indoor Telecommunication Equipment as covered in this Particular Specification.

13.4.2 All the mounting brackets and accessories shall be corrosion resistant, aesthetically designed to match with all architectural finishes and of sufficient strength to mount the equipment securely.

13.4.3 All the cable trays/trunks/conduits for cable laying between equipment rooms and indoor Telecommunication equipment shall be provided by the Contractor. The size of trays/trunks/conduits shall be so selected to ensure that cables shall not occupy cross-sectional space in excess of 50%.

13.4.4 After conduits have been laid, they shall be thoroughly cleaned by a mandrel of diameter slightly less than the conduits being drawn through. Subsequently a draw wire of galvanized steel shall be left in each conduit to facilitate the drawing of cables. The conduits ends shall be sealed temporarily to prevent the entry of foreign matter.

13.4.5 The Contractor shall submit the following to the Engineer for review at least three months before the commencement of the installation activities:

- specifications, sample of all the mounting brackets and accessories;
- equipment mounting and installation methods;
- cable trays/trunks/conduits route plan within building showing cross-sectional occupancy; and

13.4.6 Installation works within the building shall be carried only after these submissions have been reviewed without objection by the Engineer.

13.5 Outdoor Installation Works

13.5.1 The Contractor shall provide all necessary mounting brackets and accessories for installation of all outdoor Telecommunication equipment as covered in this Particular Specification.

13.5.2 All the mounting brackets and accessories shall be corrosion resistant, aesthetically designed to match with all architectural finishes and of sufficient strength to mount the equipment securely.

13.5.3 All the cable ducts/troughs/trenches or cable trays/trunks/conduits for cable laying between equipment rooms and outdoor Telecommunication equipment shall be provided by the Contractor.

13.5.4 The Contractor shall submit the following to the Engineer for review at least three months before the commencement of the installation activities:

- specifications, sample of all the mounting brackets and accessories;
- equipment mounting and installation methods; and
- schematic diagrams and wiring diagrams of the System.

13.5.5 If the equipment is installed at location exposing to direct sunlight, the equipment, mounting brackets, cables and accessories shall be made of materials which are resistant to ultra violet rays.

13.5.6 All trackside equipment and the mounting method shall be designed in the way to minimise the frequency of preventive maintenance.

13.6 Cabling

13.6.1 All Outdoor Cables (Optical Fibre Cable inside HDPE Duct, Jelly Filled Telecom Quad Cable & PIJF Telephone Cables etc.) shall be laid within HORC boundary and as far away from the track as possible. If it is necessary to lay cable outside the HORC boundary, permission shall be obtained in advance from the concerned authority or cable can be laid on berm with interfacing with civil contractor and proper compaction after backfilling. It shall also be ensured that Jelly Filled Telecom Quad Cable and PIJF Telephone Cables shall not be laid between HORC Track and Indian Railway Track to the extent possible.

13.6.2 The detailed guide lines for Signalling cable laying have been laid down in Appendix 17in this bidding document. These are applicable for Telecommunication cable laying also.

13.6.3 The Contractor shall prepare a Cable Route Plan in consultation with Civil structure Contractor of this Package as well as Package C 1 and get it approved from the Engineer before starting the trenching work. Instructions of Railway Board given in Appendix-18 of PS/Signalling in this connection shall be followed.

13.6.4 All Ducts/Troughs/Trenches for outdoor cable laying, shall be provided by the Contractor.

13.6.5 Outdoor Cables in a trench with depth of 1.2 metre from the natural earth profile or from the rail level whichever is lower and width of 0.3 metre and suitably protected with bricks.

13.6.6 Electrical Cables (Low Tension & High Tension) shall not be laid in same trench along with Outdoor Telecommunication Cables. Minimum separation between Electrical Cablesand Outdoor Telecommunication Cables shall be maintained as specified in Indian Railway Telecommunication Manual.

13.6.7 Outdoor Signalling Cables and Outdoor Telecommunication Cables shall not be laid in same trench. If it is inescapable to lay Signalling Cables and Outdoor Telecommunication Cables in same trench, suitable separation shall be provided between the two as per the requirement of PS-Signalling Works, IRSEM and Indian Railway Telecommunication Manual and approved by the Engineer.

13.6.8 Cable laid in the slope of track formation shall be laid in Double Wall Corrugated Pipes. It shall be so laid to maintain a continuous depth of 1 meter (top of DWC Pipe) from the nearest ground level. The slope of track formation shall be restored to its original condition after laying of cables.

13.6.9 Optical Fibre Cable shall be laid in Lubricated HDPE pipes.. Cables shall be laid in DWC pipe through trenchless method while crossing the road or the railway line DWC pipe shall have a minimum 6 mm wall thickness.

13.6.10 Before commencing work on any part of the Site, the Contractor shall ascertain that the Engineer and also, where applicable, the local and statutory authorities or other bodies/persons concerned have reviewed each cable route without objection. The Contractor shall further ensure that all necessary permits in such cases have been obtained and notices served.

13.6.11 The Contractor shall provide his own brackets and clips to secure all the cables at an adequate interval. Where cables are to be laid in troughs, the Contractor shall remove and re-instate trough covers prior to and after cable installation.

13.6.12 A labelling scheme shall be applied for all cables installed. Each cable shall be uniquely identified. Labels shall be tied at both ends, at entry and exit points of cable trays, ducts and trenches and at appropriate locations where necessary. Type of labels to be used shall be got approved by the Engineer.

13.6.13 Cable drums shall always be mounted on jack and rotated for uncoiling and paying out of cable. Cable shall not be pulled for this purpose.

13.6.14 Cable drum shall never be kept on its side and cable uncoiled. Since this can result in twisting of cable conductors resulting in damage to them, any such instance noticed shallresult in the following liabilities on the Contractor:

- Remove such laid cable and cut into pieces of scrap of about 2 metres each;
- Lay new cable in lieu;

13.6.15 The installation and handling of cables shall be undertaken at all times by adequate staff suitably trained and supplied with all necessary plant, equipment and tools. The arrangement of the cables and all methods of laying shall be planned to provide an orderly formation, free from unnecessary bends and crossings.

13.6.16 Cables in any trough/duct or tray/trunk/conduits shall not occupy cross-sectional space in excess of 50%.

13.6.17 At no location shall the cable be bent with a radius lower than the minimum radius recommended by the manufacturers. Sharp edges shall be avoided.

13.6.18 Every precaution shall be taken to ensure that cables and equipment are not installed in a manner or under conditions likely to cause electrolytic or other corrosive action or damage to, or be detrimental to, the performance of the cables and equipment during operation.

13.6.19 Tail cables shall be mechanically protected to avoid being damaged from track side maintenance activities and shall be immune to any malfunction from electromagnetic interference.

13.6.20 All cables shall be adequately rated for their duties. All power cables shall be able to withstand full load current for peak operation when the equipment is at its ultimate capacity.

13.6.21 Unused cable cores/pairs of multi-core/pair cables shall also be terminated and marked so

13.6.22 Underground Cable Route shall be identified by Electronic Cable route Markers directly buried inside the trench at 100 m interval and at diversion and track crossing points with in the Station section from home to home with the approval of Engineer. Outside station section normal concrete type cable route route marker as per sketch given in Annexure 23 of Appendix -17 of this document and Electronic cable route markers alternatively shall be provided at every 50 m interval and at diversion and track crossing points with the approval of Engineer. It shall also be provided at entry/exit of track/road crossing etc., during crossing of bridge on the ground level, on mid of slope, at diversion etc.

13.6.23 The Contractor shall ensure that the maximum length of parallelism is suitable to the requirement of 25 KV AC traction Feeding of HORC 25 KV AC Traction and that of nearby IR and shall meet the EMC/EMI requirements of individual equipment and system as a whole. The Contractor shall ensure that due to parallelism hazardous touch potential is not created.

13.6.24 The Outdoor Cables (Jelly Filled Telecom Quad Cable & PIJF Telephone Cables etc.) in sufficient spare lengths (minimum 10 meters) shall be kept coiled in a circle of suitable diameter at 1.0 meter depth before being taken into TER /Location Boxes for termination /either end of the bridges etc.. Such coils of cables in pits shall be adequately covered to provide protection against damage and theft.

13.6.25 All the cable entry into TER/Location Boxes etc. shall be suitably sealed to prevent entry of rodents etc.

13.6.26 Selection of cables and connectors shall be appropriate to their function. The Contractor must be able to demonstrate satisfactory usage of the type of cables proposed for use under tropical conditions, be able to comply fully with the specifications herein.

13.6.27 For Metallic Armour of the Optical Fibre Cable, Jelly Filled Telecom Quad Cable & PIJF Telephone Cables an earthing and gapping policy shall be incorporated into an overall earthing policy as reviewed by the Engineer.

13.6.28 A correctly coloured fibre splice protector shall be used to enclose each individual splice. Each fibre splice shall be tested to ensure correct fibre continuity and splice loss.

13.7 Identification

13.7.1 Descriptive labels shall be provided for all cabinets, enclosures, panels, assemblies and sub-assemblies. Labels shall be of engraved type, metallic with durable markings and shall have character size not less than 6 mm high.

13.7.2 The details of the labels including the material and size of the characters and sample of the labels shall be submitted to the Engineer for review.

13.7.3 Labels and notices on equipment shall be fixed with roundhead brass screws or self- tapping screws. Stick-on labels or fixing by adhesive shall not be accepted.

13.7.4 All enclosures containing terminals or exposed live parts where a voltage exceeds 120 volts shall have a label with lettering indicating the maximum voltage present in the enclosure.

13.7.5 Warning signs shall be provided with graphical symbols and wordings in red for hazardous electrical or optical laser equipment.

13.8 Marshalling and Termination

13.8.1 General

(a) Main distribution frames, digital distribution frames and optical distribution frames shall be provided at appropriate locations for signal termination, distribution, disconnection, diversion and in-circuit testing. Intermediate termination points shall also be provided as appropriate to allow cable network flexibility.

(b) The signal termination and distribution practice shall adopt a consistent approach for easy circuit identification and is subject to the review of the Engineer.

(c) The circuit terminations shall be secure enough to withstand vibration level, which is likely to be experienced in the railway environment. These terminations shall be designed to allow repeated circuit termination and disconnection.

(d) Jelly Filled Telecom Quad Cable and PIJF Telephone Cables shall be terminated on Disconnection Type Terminal Blocks complying with IEC 60947-7-1. These Terminal Blocks shall be made of Polyamide 6.6 Insulating Material and shall use non-corrosive Metal Parts. These Terminal Blocks shall have provision for identification/number for each termination and shall be securely attached to Mounting Rails.

(e) Wherever possible, standard multi-pin plug/socket shall be used to terminate multi-core cables for connecting to the equipment. Heat-shrinkable sleeves shall enclose all exposed and terminated contacts inside multi-pin connectors.

(f) All RF Joints outside the cabinets shall be sealed by waterproof tapes or jackets.

13.8.2 Main Distribution Frame

(a) Main distribution frame with 20% extra capacity for future expansion shall be provided at Telecommunication Equipment Room for the signal distribution of all voice, analogue, alarm and control circuits.

(b) The Contractor shall provide at least one sets of the following accessories at each location where the main distribution frame is installed:

- tools for circuits connection and disconnection
- plug-in devices for circuit disconnection

- test cords and loop-back cords
- signal patch cords

(c) The outgoing circuits connecting to external lines and all circuits affected by lightning or high induced voltage shall be provided with lightning arrestors and surge protection devices with the required earth connections.

(d) All voice, analogue, alarm and control circuits including spares shall be properly terminated at the main distribution frame.

(e) The main distribution frame shall be divided into different zones for different types of circuits.

(f) The main distribution frame shall be equipped with copper earth bar to which all cable shields shall be connected. The copper earth bar shall be connected to the earth.

(g) The main distribution frame shall be equipped with facilities such as use of different colours or markers to aid circuit pairs identification.

(h) The Contractor shall maintain records of all the circuit terminations.

13.8.3 Digital Distribution Frame

1) Digital distribution frame shall be provided at Telecommunication Equipment Room and at other locations as appropriate for data circuit termination.

2) The Contractor shall provide at least five sets of the following accessories at each location where the digital distribution frame is installed:

- plug-in devices for circuit disconnection
- test cords and loop-back cords
- signal patch cords.

3) Different modules in the digital distribution frame shall be provided for different types of data circuits.

4) The digital distribution frame shall be equipped with sufficient capacity for data circuits including spare circuits. The digital distribution frame shall also be equipped with an extra of 20% of termination capacity for future use.

5) Markers or labels shall be included in the digital distribution frame for easy identification of the circuits.

13.8.4 Optical Distribution Frame

1) Optical distribution frame shall be provided at Telecommunication Equipment Room, and at other locations as appropriate for optical signal distribution. Distribution frame shall comprise of equipment cabinet(s) or enclosures housing,

- fibre splice module
- fibre storage panel
- optical patch panel

2) All fibre cores terminating in the optical distribution frame shall be spliced to factory manufactured pigtails or properly stored in the fibre storage panel.

3) Optical patch cords shall be provided to connect the optical terminal to the

optical distribution frame and for patching within and between optical patch panels.

4) Fibre storage panels shall be provided in the optical distribution frame to stow the excess length of pigtail and patch cords.

5) All splices shall be fusion splices and heat shrink splice sleeves shall be used for splice protection and housed in a fibre splice module.

6) All fibre splice modules shall be either telescopic or hinged type for easy access of splice elements.

7) All fibre splice modules shall be equipped with built-in fibre slack take-up mechanism.

8) All optical distribution panels shall be either telescopic or hinged type for easy access of rear side of panels. The optical distribution panel shall be fully equipped with adapters for optical signal termination.

9) All spare adapters shall be protected with jackets.

10) One high quality optical connector such as LC/FC/PC single mode (SM) 10/125pm type shall be standardised. Optical connector type specified on the transmission equipment shall be compatible with the optic fibre termination. The coupling loss of the connector shall be below 0.2dB.

11) All optical connectors shall comply with the ITU-T Recommendation G.652.

12) All pigtails and patch cords shall be properly labelled.

13) The optical distribution frame shall be equipped with sufficient capacity for all optical signal distribution and fibre storage. An extra of 20% capacity in each module shall be provided for future expansion.

14) All optical fibre splice configuration at each location shall be designed to fulfil the System fault tolerant requirement.

13.9 Power Supply Distribution

1) Electric Power Supply for Telecommunication Equipment is drawn from Main AC Distribution Boards as covered in Particular Specification for Signalling Works.

2) This 230 V AC Telecom Power Supply from Main AC Distribution Boards shall be taken to Telecommunication AC Distribution Board, from where it shall be distributed to all Telecom Equipment/Telecom Power Supply Equipment operating on 230 V AC. Telecom AC Distribution Board are equipped with MCBs of adequate capacity at Inputs and Outputs.

3) 48 Volt DC Power Supply from 48 V DC Battery Backup System shall be taken to Telecom DC Distribution Board, from where it is distributed to all Telecommunication Equipment operating on 48 V DC. Telecom DC Distribution Board are equipped with MCBs of adequate capacity at Inputs and Outputs.

13.10 Earthing Policy

13.10.1 General

1) Earthing shall be provided for all indoor & outdoor Telecommunication installations toachieve the following objectives:

- to provide safety to the operating & maintenance personnel against the electric shock on account of any potential (voltage) appearing on exposed parts with respect to earth or due to electromagnetic or due to electrostatic induction;
- to ensure safe & reliable operation of the equipment by limiting or eliminating the induced voltages and transients in the Telecommunication equipment;
- to protect the equipment against build-up of unduly high voltages, which can cause dielectric (Insulation) breakdown or damage to the equipment or their parts;
- to serve as common voltage reference point wherever required.

2) An earthing system shall be designed to assure personnel safety and protection of installations against damage. It shall also serve as a common voltage reference and to contribute to the mitigation of disturbances.

3) To achieve the primary goal of assuring personnel safety and damage control, a low impedance path shall be made available to the current generated due to lightning or power system fault. The potential differences between any two points shall be as low as possible. Safety considerations also require the chassis or enclosure to be earthed to minimise shock hazards to system staff.

4) To achieve the secondary goal of providing protection for sensitive and interconnected electronic and electrical systems, earthing shall be designed to minimise the noise voltage generated by currents from two or more circuits flowing through common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potential.

5) Earthing and other protective measures in the following paragraphs are given only as indicative guidelines. The Contractor shall design, manufacture, install and be responsible for safe and correct working of all equipment/subsystems under the scope of the Contract.

6) The Contractor shall submit, for review and approval the design for earthing, transient protection and lightning protection of all Telecommunication Subsystems including earthing and lightning protection of the VHF mast, telecom equipment etc. OEM's original data sheets of the proposed devices shall also be submitted.

13.10.2 Requirements of effective Earthing

1) The Earthing system shall meet or exceed the requirements of IEEE 1100, NFPA 780, IEC 1024 and ITU-T Recommendation K.27 or relevant International standards.

2) Earthing and other protection devices shall be designed to accomplish the following minimum requirements but not limited to:

- protect personnel and equipment from electrical hazards, including lightning and reduce fire hazards;
- reduce potential to system neutrals;
- enable signalling with earth return;
- reduce or eliminate the effects of electrostatic and electromagnetic interference arising from within the EDFC on account of traction voltages, traction return current, electric locomotive characteristics and other extraneous sources;
- minimise service interruptions and equipment damage:

- minimise radiated and conducted electromagnetic emissions:
- reduce radiated and conducted electromagnetic susceptibility:
- improve system tolerance to discharge of electrostatic energy and lightning interference:
- provide a proper earthing method for all equipment enclosures, cabinets, drawers, assemblies and sub-assemblies; and
- provide a clean zero-volt reference point where required.

3) The earthing system shall be so designed as to give earth resistance within the stipulated limits at all locations and under all climatic conditions.

4) Any electrical joints in the earthing system shall be protected from moisture ingress by using proper wrapping, sealing with waterproof tapes, or such other measures.

5) For the purpose of measurement of earth resistance, a small interconnecting copper strip of appropriate cross-section shall be provided in the ring earth in a small manhole chamber so that the ring earth can be broken from the loop.

6) The earthing methods, design and details shall be submitted to the Engineer for review and approval.

13.10.3 Earthing of Indoor Equipment

1) Main earth bus bar shall be provided in the power supply room by the Contractor. The Contractor shall provide minimum 16 mm* cable from the power supply room to the TER and terminate on copper earthing strips of sufficient size and specifications. These earthing strips shall be used by the Signalling Contractor to extend individual earths to cables and racks/equipment etc.

2) In order to ensure a captive earth connection to the cabinets and racks in TER, a minimum cross-section of 16 mm* copper wire shall be used for earthing.

3) The cabinets within a row are to be conductively connected by means of screws and contact washers. Two or more rows are interconnected via the earth bus and if necessary, also by additional earthing cables. In case that one of the cabinets/racks is removed, it shall be ensured that the other cabinets in the row remain earthed

4) Earthing strips will be connected to a Common Bonding Network (CBN)

5) Telecommunication equipment in TER, other S&T rooms and Power supply system etc. shall be earthed with maintenance free ring earthing. The earth value shall be < 0.5 Ohm

13.10.4 Earthing of Outdoor Installations

1) Outdoor installation, listed below, shall be earthed to the nearest Main earth bus bar witha minimum 16 mm° copper conductor and a maintenance free earth:

- metallic sheath and armouring of all cables at regular intervals;
- location boxes;
- racks;
- clocks display units; and
- any other Telecommunication installation as may be necessary to cover

completescope of works defined in the Contract.

2) The Contractor shall also use suitable safety methods such as screen of wire mesh (earthed) for safety of maintenance staff wherever there is infringement of equipment installation in the signal clearance zone as per Indian Railway's Railway Electrification practices.

3) Outdoor equipment as PA System equipment, Clock system equipment etc. shall be earthed with maintenance free earthing. Mast for VHF system shall be earthed with two no. of conventional earthing. Earth pits shall be covered with concrete cover.

13.10.5 Earthing Arrangement

1) The Contractor shall provide two separate earth connections, a maintenance free ring earth connection to the earth terminals provided inside the rooms where the Telecommunication equipment is installed, and a main earth connection for the earthing of VHF mast, antenna feeder cables, equipment chassis, etc. of the Telecommunication System.

2) The earthing system shall meet, but not be limited to, the following:

- The resistance to earth of the system "earth terminal" shall remain within the stipulated limits at all locations and under all climatic conditions.
- Any electrical joints in the earthing system shall be protected from moisture ingress by using proper wrapping, sealing with waterproof tapes, or such other measures.

3) The earthing arrangements for Antenna Towers and Antennae shall be such that:

- The zone of coverage shall afford protection of all objects forming part of the Antenna Towers and Antennae including any objects near the base of the tower, and this factor shall be taken into consideration while deciding the height of the lightning conductor at the top of the tower.
- Earthing of VHF/UHF Antenna Feeder Cables having Copper Sheaths shall be such as to maintain a low resistance connection to the earth. Any junction forminga part of this connection shall be protected from ingress of moisture by using proper wrapping, sealing with water-proof tapes, or such other measures. The connection shall be inspected periodically at intervals frequent enough to ensure that the earth connection meets all the requirements. Earthing kits of approved type shall be used for this purpose.

4) The earthing arrangements for Telecommunication Equipment shall be as below:

- All Telecommunication equipment shall be protected using a mesh of copper "earth" strips of appropriate cross-sectional dimensions, forming a local clean earth bus.
- Each equipment rack shall be connected electrically to this bus. This bus shall be connected to the external ring earth forming a Common Bonding Network (CBN) atthe shortest possible distance from two opposite points of this bus.
- All joints of this connection shall be protected from ingress of moisture by using proper wrapping, sealing with water-proof tapes, or such other measures.
- The earthing connection shall be inspected periodically at intervals frequent enough to ensure that the earth connection meets all the requirements.

5) The metallic sheath and armouring of all cables (RF Cables/Optical Fibre Cable/Quad cable/PIJF telephone cable etc.) shall require earthing. In the section earthing shall be done as per the established practices in RE areas of the Indian Railways.

6) The earthing electrodes for the clean earth shall be located at least 20 m away from the main earth.

7) The route for the clean earth shall be so chosen as to minimise the effect of any inductive interference.

8) For the purpose of measurement of earth resistance, a small interconnecting copper strip of appropriate cross-section shall be provided in the ring earth in a small manhole chamber so that the ring earth can be broken from the loop.

9) The earth resistance at any point on the clean earth shall be below 0.5 Ohm, and that for the main earth shall not exceed 1.0 Ohm at any location and under any soil and/or climatic condition.

10) All metal work and metallic items shall be earthed to the main earth to ensure the safety of personnel.

11) The earthing methods and details shall be submitted to the Engineer for review.

12) VHF equipment shall be provided with isolated terminations for the connection of coaxial cables extending to equipment in external locations.

13.11 Transient and Lightning Protection

13.11.1 It is recognized that lightning and faults on nearby electrical installations as sources of dangerous disturbances in telecommunications lines, which may cause damage leading to interruptions in service and the need for repairs or even hazards to personnel.

13.11.2 It is therefore essential to set out principles which enable the frequency and seriousness of such disturbances to be limited to levels which take account of quality of service, operating costs and safety of personnel. The disturbing phenomena, when they appear, are relatively rare or of very brief duration (usually of the order of a fraction of a second) and hence consideration must be given to methods of avoiding interruption of the functioning of equipment during an actual disturbance. (ITU-T Recommendation K.11, 06 October, 1993 and ITU-T Recommendation K.36, 08 May, 1996)

13.11.3 General considerations

1) Origin of dangerous over voltages and over currents.

a) Direct lightning strikes may cause currents of some thousands of amperes to flow along wires or cables for some microseconds. Physical damage may occur and overvoltage surges of many kilovolts may apply stress to the dielectrics of line plant and terminal equipment.

b) Lightning strikes nearby - lightning currents flowing from cloud to earth or cloud to cloud cause over voltages in overhead or underground lines near to the strike. The area affected may be large in areas of high earth resistivity.

c) Induction from fault currents in power lines including electric traction systems. Earth faults in power systems cause large unbalanced currents to flow along the power line inducing over voltages into adjacent telecommunications lines which follow a parallel course. The over voltages may rise to several kilovolts and have

durations of 200 to 1000 ms (occasionally even longer) according to the fault clearing system used on the power line.

d) Contacts may occur between power and telecommunication lines when local disasters, e.g. storms, fires, cause damage to both types of plant or when the normal safeguards of separation and insulation are not followed. Resulting overvoltage may cause excessive currents to flow along the line to the exchange earth causing damage to equipment and danger to staff.

e) Earth faults in power systems cause currents in the soil which raise the potential in the neighborhood of fault and of power supply earth electrode. Raised earth potentials affect telecommunication plant in two ways:

(a) Telecommunication and Signalling Systems may malfunction if the Signalling earth electrode is in soil whose potential rises by as little as 5V with respect to true earth.

(b) Higher rises of earth potential can cause danger to staff working in the affected area or, in extreme cases, may be sufficient to break down the insulation of the telecommunications cable causing extensive damage.

2) Protective measures by the Contractor external to the conductors themselves.

(1) Telecommunication lines should be shielded from lightning to some extent by adjacent earthed metal structures, e.g. power lines or electric railway systems. Efficient metallic screens either in the form of cable sheaths, cable ducts or lightning guard wires, reduce the effects of lightning surges or power line induction. In areas with a high risk of lightning strikes special cables with multiple screens and high strength insulation should be used including bonding all metal work for useful protection.

(2) Induction from power lines may be minimized by coordinating the construction practices for the power and telecommunication lines. The level of induction may bereduced at its source by the installation of earth wires and current limiters in the power system.

(3) The likelihood of contacts occurring between power and telecommunications lines is reduced if agreed standards of construction, separation and insulation are followed. Economic considerations arise but it is often possible to benefit from jointly using trenches, poles and ducts, providing suitable safe practices are adopted. It is particularly important to avoid contacts with high voltage power lines by a high standard of construction since, if such contacts occur, it may be very difficult to avoid serious consequences.

13.11.4 The Contractor shall use special cables as follows:

(1) Cables of high dielectric strength where high over voltages are likely to occur.

(2) Cables with strengthened insulation in situations where there is exceptional proximity or length of parallelism to power lines, high rise of earth potential in the immediate neighborhood of power stations or extreme exposure to lightning due to high koranic level and low soil conductivity.

(3) Cables with metal sheaths which provide a good reduction factor to screen circuits within the cable.

(4) Cables which carry circuits to exposed radio towers and which must be able to carry lightning discharge currents without damage.

(5) All di-electric (i.e. non-metallic) optical fibre cables to effect isolation between conductive lengths of cable.

13.11.5 It is also essential that the Contractor uses protective devices under circumstances, as follows:

(1) Where cables with extra thick insulation may themselves be undamaged by over voltages or over currents but they can nevertheless conduct such conditions to other more vulnerable parts of the network. Extra protection is then required for themore vulnerable cables and is particularly important if these are large undergroundcables which are expensive to repair and affect service to many customers.

(2) Where induced over voltages from power or traction line faults may still exceed levels permitted by the Directives even after all practicable avoidance measures have been followed.

(3) Protective devices to include air gap protectors with carbon or metallic electrodes, Gas discharge Tubes, semi-conductor protective devices, fuses, heat cols, self-restoring current limiting devices, fusible links, MOVR.

(4) Suitable electronic devices (such as silicon avalanche suppressor devices/transzorbs) having high surge handling capability, fast response time and low clamping voltage, etc.; shall be incorporated in the Telecommunication equipment to ensure that the latter withstands the above mentioned conditions without any damage or permanent degradation in performance throughout the system lifetime. The selection criteria for such devices shall include, but not be limited to, the following:

(a) reverse standoff voltage shall be at least twice the maximum operating voltage;

(b) pulse power rating shall be adequate to handle the peak pulse power of the transients and ensure their decay in less than 10% of the rise time for the worst pulse likely to be encountered from all possible sources including lightning and transients from overhead traction power system;

(c) device lifetime shall not be less than that of the system for which it affords protection.

13.11.6 Surge protection devices shall be provided at TER end and outdoor equipment end, on power and data cables extending to outdoor telecommunication equipment installations as a minimum as defined below:

(1) clock displays surge protection devices at both ends

(2) radio frequency feeder cables separately for each individual cable of VHF antenna & GPS antenna on both ends;

(3) armour of optical fibre cable shall be directly earthed at TER end and earthed through a surge protection device at the other end station;

13.11.7 Transient Lightening Protection Specifications

1) An effective transient protection system, complying to the following as a minimum must be provided to protect the telecommunication equipment from transients:

2) Peak transients of up to 700 Volts on the DC Power Supply line for several

microseconds.

3) Average transient duration of 2 microseconds with a repetition frequency of 15 KHz to 100kHz.

4) For short duration transients (<5ms) the variation approaches a sine wave.

5) For longer duration transients (>5ms) the variation approaches rectangular pulses with an initial rate of rise up to 5x104 Volts per second

13.11.8 Housing, Enclosure and Cabinet

1) All equipment installed shall be able to withstand vibration levels likely to be experiencedin railway stations and along railway track side structures.

2) All design of housing and enclosure shall be submitted to the Engineer for review.

3) Unless specified otherwise, all equipment to be housed in outdoor environment (openareas, etc.) shall be with IP 65 enclosures as a minimum.

(End of Chapter-13)

CHAPTER 14 - TESTING AND COMMISSIONING

14.1 General

1) The Contractor shall perform stage-wise testing and commissioning activities in accordance with the requirements given in this Specification.
2) The Contractor shall ensure that prior to the commencement of tests; documentation associated with tests has been reviewed without objection by the Engineer.
3) The Contractor shall ensure that the equipment/Subsystem/System is in a state ready for testing and commissioning before the commencement of the tests. The Contractor shall conduct trial tests and satisfy himself before offering the equipment/Subsystem/System for the tests. Test results of the Contractor's own trial tests shall be made available to the Engineer on request. This is to indicate the readiness of the equipment/Subsystem/System for tests.
4) The Contractor shall provide all necessary test instruments, special tools, emulators, simulators and test software to carry out the tests.
5) The Contractor shall satisfy himself that all items interfacing to Project Contractors are in satisfactory condition for the Contractor's tests to be carried out. The Contractor shall provide simulation for testing in case the interfacing equipment is not available for testing.
6) The Contractor shall extend full support to the Engineer and provide all necessary facilities to enable convenient inspection of materials, work and testing.
7) The Contractor shall investigate and provide corrective actions for all the faults detected during the tests. The tests shall be resumed only after all the faults are properly cleared. The Contractor shall submit fault report to the Engineer to describe the symptom and causes of the faults and the corrective actions taken.
8) If the operation of other Project Contractor's system or equipment is suspected to be affected by the system during the test, the Contractor shall withhold the test, investigate and take corrective actions, if necessary, before resumption. The test shall be resumed only after the interference has been eliminated or found not to be related to the System.

14.2 Testing Stages

14.2.1 The Contractor shall carry out testing and commissioning activities in the following phases:

(1) Factory Acceptance Tests;
(2) Installation Tests;
(3) System Acceptance Tests; and
(4) Integrated Testing and Commissioning.
(S) Service Trial.

14.3 Factory Acceptance Tests

14.3.1 The Contractor shall prepare and submit, at least three months before the tests, for review by the Engineer the Factory Acceptance Test Plan, detailing and explaining how the contractor

shall plan, perform, and document all inspections and tests that shall be conducted to verify and validate the works prior to delivery to Site. In addition, the Factory Test Plan shall also include the following:

a) a list of equipment and cables for individual Subsystems to have FactoryAcceptance Test;

b) the program of all the activities related to factory acceptance tests;

c) the locations where factory acceptance tests to be carried out;

d) the estimated duration of tests activities at each location; and

e) submission schedule of all the factory acceptance test procedures for equipmentand cable.

14.3.2 Factory Acceptance Test shall be carried out for equipment and cables of all the Subsystems.

14.3.3 The Contractor shall carry out factory acceptance tests at the place of manufacturing. The test shall include, but not be limited to, visual inspection, environmental tests, electrical tests, functional tests and fatigue tests on each individual equipment and associated Subsystem as well as cables before delivery of the equipment to the Site.

14.3.4 The environmental tests and fatigue tests are not required; if it has already been conducted and independently witnessed previously on similar item and test results are accepted by the Engineer.

14.3.5 The Contractor shall prepare the factory acceptance test procedures for equipment and cables and submit to the Engineer for review. The factory acceptance test procedures shall describe in detail all tests to be performed on the equipment and cables along with pass/fail criteria (i.e. the standards or limit to be achieved).

14.3.6 The Factory Acceptance Test shall not be started unless the factory acceptance test procedures have been reviewed without objection by the Engineer.

14.3.7 Factory Acceptance Tests shall be witnessed by the Engineer

14.3.8 Where any part of testing is carried out by an independent laboratory, a copy of Test Certificate issued by the relevant authority of that laboratory shall be submitted along with the Factory Acceptance Test Procedure.

14.3.9 The Factory Acceptance Tests are considered completed only if the Engineer without objection reviews the Factory Acceptance Test results.

14.4 Installation Tests

14.4.1 Installation Tests shall be carried out on individual Subsystem location by location after the completion of equipment physical installation. Pre-Installation Inspection shall include the verification of FAT/Quality test report, Invoice, OEM manuals etc. Post installation test shall include the installation of equipment as per approved drawing, Particular specification etc. Power supply test shall be the part of Post-installation test.

14.4.2 The objective of the installation tests shall be to ensure the following:

a) the equipment is installed in accordance with the reviewed design documentation

b) the equipment is installed in accordance with the requirements detailed in this Specification

c) all cables are properly and accurately connected and terminated

d) all installation works are of acceptable workmanship

14.4.3 The Contractor shall develop procedures for Installation Tests and submit to the Engineer for review. The installation test procedures shall describe in detail all tests to beperformed on the equipment and cables along with pass/fail criteria (i.e. the standards or limit to be achieved).

a) The Installation Test shall not be started unless the installation test procedureshave been reviewed without objection by the Engineer.

b) All installed equipment and cables shall be physically inspected against allrelevant reviewed design documentation.

c) The Contractor shall measure the end-to-end performance of all cores of the copper cables and optical fibre cables, including all spare cores, laid between different locations.

d) The Contractor shall verify all the connections within the antenna network and measure the attenuation and VSWR values of all the connections.

e) All the installation test results, physical locations of the equipment and serial numbers shall be captured in the test record forms. The Contractor shall include completed test record forms in the Test Report and submit to the Engineer for review.

f) The Installation Tests are considered completed only if the Engineer without objection reviews the Installation Test results.

14.5 System Acceptance Tests

14.5.1 The Contractor shall carry out System Acceptance Tests after the completion of the Installation Test. System Acceptance test shall include the functional test of all equipment from the SM panel.

14.5.2 System Acceptance Tests shall be carried out on individual Subsystem as well as whole System to verify the functional, operational performance, electrical performance and services coverage at the stage:

a) after successful completion of the Installation Tests;

b) after the Subsystems have been configured with correct settings and parameters;

c) properly connected to the power supply and can be switched on for System Acceptance Tests; and

d) before the equipment of different locations are ready for Integrated Testing & Commissioning.

14.5.3 The Contractor shall develop System Acceptance Tests procedures for each Subsystem and System as a whole and submit to the Engineer for review.

14.5.4 The System Acceptance Tests procedures shall include:

a) objectives of the System Acceptance Tests for all subsystems;

b) objectives of the System Acceptance Tests for system as a whole;

c) list of specifications and standards, reviewed design documentation for reference;

d) step-by-step test instructions;

e) list of test instrument and special tools;

f) test record forms; and

g) pass or fail criteria.

14.5.5 Where performance across interfaces to other System within this Contract is required to be verified during the System Acceptance Tests, the Contractor shall include a list of other systems and the interface test procedures in the System Acceptance Tests procedures for the relevant Subsystem.

14.5.6 Where performance across interfaces to Project Contractors or to other parties is required to be verified during the System Acceptance Tests, the Contractor shall include a list of Project Contractors and the interface test procedures agreed with the relevant Project Contractors in the System Acceptance Tests procedures for the relevant Subsystem.

14.5.7 The functional, electrical and timing performances of the Subsystems as well as System as a whole shall be verified against the requirements and relevant international standards.

14.5.8 The Contractor shall conduct end-to-end circuit test to verify the circuit integrity and electrical performance for all circuits including spare.

14.5.9 All local alarms, control and monitoring functions shall be verified.

14.5.10 All equipment settings and parameters shall be verified and recorded in the reviewed test record forms.

14.5.11 All protection mechanisms such as hot-standby, parallel redundancy, automatic switchover, etc., built into the system and individual Subsystems shall be verified.

14.5.12 The system response time of relevant Subsystems and the System shall be tested and measured.

14.5.13 The Contractor shall carry out load test on each Subsystem to verify the designed system capacity and performance in accordance with the requirements given in the Particular Specification under full load condition.

14.5.14 The Contractor shall carry out tests on the operation of the System in accordance with the normal operation procedures and emergency operation procedures, which has been reviewed without objection by the Engineer.

14.5.15 The System Acceptance Tests are considered completed only if the Engineer without objection reviews the System Acceptance Test results.

14.5.16 Upon completion of the System Acceptance Test, the individual Subsystem shall be operational and ready to be connected to other Subsystems and interfacing systems for testing.

14.6 Integrated Testing and Commissioning

14.6.1 The Contractor shall carry out Integrated Testing and Commissioning after the completion of the System Acceptance Tests. This test shall include the test of equipment from the IMD/ control centre of the project.

14.6.2 The Contractor shall co-ordinate with the Engineer and with all the interfacing Project Contractors/Parties to ensure all the interface test activities are completed in accordancewith the program on Completion Plan.

14.6.3 The Contractor shall provide all necessary supports, conduct investigation and provide

corrective actions, if necessary, to ensure all matters related to interfacing are properly resolved.

14.6.4 Within one week upon completion of all interface test activities, the Contractor shall submit the test results to the Engineer for review.

14.6.5 After the test results of all interface test activities have been reviewed by the Engineer without objection, the Contractor shall start the Reliability Demonstration Test in accordance with the reviewed Reliability Demonstration Test Plan.

14.6.6 The Contractor shall advise the Engineer in writing the commencement date of the Reliability Demonstration Test.

14.6.7 The Contractor shall submit a Reliability Demonstration Test Plan to the Engineer for review at least three months before the test.

14.6.8 The Contractor shall include the following in the Reliability Demonstration Test Plan as a minimum:

a) calculation of the maximum allowable number of failures of equipment, Subsystems and System during the reliability demonstration period in accordance with requirements on reliability performance of the equipment, Subsystems and System given in the Particular Specification

b) definition of relevant failures

c) pass and fail criteria

d) sample of fault logs

14.6.9 During the reliability demonstration test period, the Contractor shall record details of all faults in a fault log which shall include:

a) the date and time the fault occurs

b) the date and time the Contractor's staff arrive on site

c) the date and time the fault is cleared and the normal operation is restored

d) the description of the fault

e) the cause of the fault

f) equipment or component replaced

14.6.10 All fault logs shall be submitted to the Engineer for review.

14.6.11 The reliability demonstration test is considered a failure if:

a) the actual number of relevant failures exceeds the maximum allowable number of failures for any equipment, Subsystems or System identified in the Reliability Demonstration Test Plan

b) any fault resulting from the Design omission or commission of error requires Design modification in order to fix the fault

14.6.12 If the reliability demonstration test fails, the Contractor shall provide all the necessary corrective actions and rectify the fault to the satisfaction of the Engineer.

14.6.13 The reliability demonstration test shall be repeated on the affected Subsystem or Subsystems for another three months until the test is successfully completed.

14.6.14 Within two weeks upon completion of the reliability demonstration test, the Contractor shall

submit the test results for the Engineer to review.

14.6.15 The Integrated Testing and Commissioning is considered completed only if all the test results of the Integrated Testing and Commissioning have been reviewed by the Engineer without objection.

14.7 Service Trials

14.7.1 The Contractor shall provide all necessary support and attendance to the Engineer during the Service Trials period.

14.7.2 The Contractor shall provide on-Site supports to the Engineer in all aspects related to the operation of the System. The Contractor shall also conduct investigation and provide corrective actions for any problems related to the System or the interfaces with the System.

14.7.3 The Contractor shall assign competent staff to support the Service Trials as required by the Engineer. The persons shall be the technical staff who shall have sufficient skills and knowledge of the System and shall have been involved in the Design, installation or commissioning of the System.

14.7.4 The Contractor shall submit a Manpower Plan to the Engineer for review at least 1 month before the commencement of the Service Trials.

14.7.5 The manpower plan shall include the organisation chart of the Contractor's Service Trials supporting group, individual person's role and responsibility and 24-hour contacts for emergency cases.

(End of Chapter-12)

CHAPTER 15 - SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

15.1 Spares

15.1.1 General

The Contractor shall provide his own spares during Installation & Commissioning Period as well as during the Defects Notification Period. The Contractor shall also provide separate spares for the Employer to enable the Employer to operate and maintain the System.

1) Contractor's Own Spares

i) The Contractor shall keep and maintain sufficient stock of his own Installation & Commissioning Spares and Defects Liability Spares. In addition, in determining the list of spare parts for the Installation & Commissioning Spares and Defects Liability Spares, the Contractor shall provide calculation to support the proposed spares and quantities with the following taken into account:

- the expected failure rate of the parts;
- population of the parts in the System;
- criticality of the parts in the System;
- availability figures of the System;
- spare delivery lead time; and
- workshop repair turnaround time.

ii) The Contractor shall submit the list of Installation & Commissioning Spares, with the types and quantities of spares, the Contractor intends to hold, at least three months before the commencement of installation activity to the Engineer for review.

iii) The Contractor shall submit the list of Defects Liability Spares, with the types and quantities of spares, the Contractor intends to hold, at least six months before the commencement of the Defects Notification Period to the Engineer for review.

iv) The Contractor shall include details of the stock of the Contractor's own spares in the Monthly Progress Report. The status of the spares, either in store or under workshop repair, shall also be included.

2) Contract Spares for Employer's Operational and Maintenance Requirements

i) The Contract Spares, to be supplied by Contractor to Employer for Employer's Operational and Maintenance Requirements, shall include spare modules, sub-assemblies, special components, cables, connectors, fuses etc. The Contract Spares to be supplied shall be as per the following list.

SN	Item	Total Quantity
1	SDH Node complete with all tributary cards andfull hardware redundancy and LER and LSR complete with all cards and	1 of each type

	compatible SFP	
2	2 Mb Mux complete with all channel cards andfull hardware redundancy	2 of each type
3	All type of PCB cards including mother board ,Optical line termination Card,E1 Tributary cardand power supply card for STM- Mux	10% of the total populationfor each type
4	All type of PCB cards including mother board, 2MB card ,VF card, E&M Card ,Data card and power supply card for 2 MB Mux	10% of the total populationfor each type
5	Notebook computer loaded with OFC NMS software	2
6	Layer-3 Switch	10% of the total populationfor each type
7	Layer-2 Switch	10% of the total populationfor each type
8	PBX Subscriber Line Cards	10% of the total populationfor each type
9	PBX Junction Line Cards	10% of the total populationfor each type
10	PBX Switch Cards	10% of the total populationfor each type
11	PBX System Control Cards and Power SupplyCard	10% of the total populationfor each type
12	Digital Telephone Instruments	10% of the total populationfor each type
13	Analogue Telephone Instruments	10% of the total populationfor each type
14	Media Gateway	10% of the total populationfor each type
15	Way-Station Equipment of ControlCommunication Equipment	10% of the total populationfor each type

17	IP phone	10% of the total populationfor each type
18	Notebook Computer loaded with PBX NMS Software	1
19	Replaceable/Plug-In Cards for Master Clock	1 Card of each type
20	Station Sub-Master Clock Complete	10% of the total populationfor each type
21	Digital Clock Units	10% of the total populationfor each type
22	Analogue Clocks	10% of the total populationfor each type
23	25 Watt VHF Transceivers along with Antennae, Associated Voice Recording Equipment and other associated Hardware/Accessories.	1
24	SMPS Based Power supply system (48 V DC)	1
25	All type of Replaceable/Plug-In Cards/Modulesfor SMPS Based Float Cum Boost Charger	10% of the total populationfor each type
26	Maintenance Free Batteries	10% of the total populationfor each type
27	Fuses of all types	10% of the total populationfor each type
28	Terminals of all types	10% of the total populationfor each type
29	Transient/Surge Protection Device	10% of the total populationfor each type
30	Optical Distribution Frame	10% of the total populationfor each type
31	Telephone Cable Termination frame	10% of the total populationfor each type
32	Copper Cable Jointing Kits for all sizes ofcables	10% of the total populationfor each type
33	Splicing Kits for OFC	10% of the total

		populationfor each type
34	Optical Fibre Cable	10 km for each type
35	Optical Fibre Splice Box & remake loops	10% of the total populationfor each type.
36	Optical Pigtail Cables of	10% of the total populationfor each type.
37	Outdoor Telephone Cable	10% of the total population(km) for each type.
38	Indoor Telephone Cable	10% of the total population(km) for each type.
39	6 QUAD CABLE	10% of the total population(km) for each type.
40	Cable jointing kits	10% of the total population(km) for each type.
41	All type of Connectors/Dummy Loads	10% of the total population for each type.
42	Emergency Socket	20% of the total population for each type.
43	Portable Emergency Telephone Set	5 NOS.

NOTE: The Quantity shall be rounded to nearest decimal natural number with minimum1(one).

ii) The Contractor shall submit list the of Contract Spares along with quantities at least 6 months before start of 'Defects Notification Period', based on approved tentative BOQ which shall be adjusted on approval of As-Built BOQ.

iii) The list of Contract Spares shall include information such as brand name, model number, serial number (if applicable), rating(if applicable), description, part number(if applicable), drawing number, shelf life, bar-coded (as directed by the Employer) etc. of each item of Contract Spares.

iv) The Contractor shall indicate the sources of supply of each item of Contract Spares and shall guarantee their availability during the service life of the system.

v) All Contract Spares shall be tested as per reviewed factory acceptance testing procedures before delivery to the Employer. The delivery to the Employer shall be completed by the start of 'Defects Notification Period'.

vi) Any item not included as Contract Spare and subsequently found to be necessary during Defects Notification Period, shall be supplied by the Contractor in required quantities as variation to Contract under direction of Engineer.

3) Coding and Tagging of Spare Parts and Special Tools and Test Equipment-

All Spares/Spare Parts and Special Tools and Test Equipment to be delivered to the Employer shall each carry a tag suitably marked, bar-coded (as directed by the Engineer) and numbered. The numbers on the tags shall correspond with those on the coding system developed by the Contractor for all Telecom components, parts and equipment's.

15.2 Special Tools and Test Equipment

15.2.1 The Contractor shall provide his own test equipment and tools during the Installation & Commissioning Periods and Defects Notification Period.

15.2.2 The following Special Tools & Test Equipment shall be suitably packed and supplied to the Employer.

SN	Item	Unit	Total Quantity
1	E1 Analyser	Nos.	1
2	Auto fusion splicing machine complete.	Nos.	1
3	SDH Analyser	Nos.	1
4	OTDR mini	Nos.	1
5	OTDR main frames	Nos.	1

6	Optical fibre tool box Impairment (TIMS)	Nos.	1
7	Transmission measuring set	Nos.	1
8	Digital multi-meter	Nos.	4
9	Earth tester	Nos.	1
10	Megger 500 Volts	Nos.	2
11	Mega OHM meter	Nos.	1
12	Optical Power Meter with Laser Source (2 in 1)	Nos.	4
13	Optical Variable Attenuator	Nos.	1
14	PCM channel analyzer with printer	Nos.	1
15	Cable tool kit	Nos.	1
16	Cable Route Locator	Nos.	1
17	Portable Generator 1.5 KVA	Nos.	1
18	Emergency light	Nos.	1
19	Ethernet Analyser	Nos.	1
20	General purpose telecom tool kit.	Nos.	2
21	Power supply (Variable) 0 to 60 Volt DC	Nos.	1
22	Vacuum Cleaner	Nos.	4
23	Maintenance Vehicle (Semi Utility Vehicle Type)	Nos.	1
24	Drilling machine with hammer action capable of working on wood, metal, concrete complete with chuck drill bits	Nos.	1
25	VHF Power Meter with all accessories	Nos.	1
26	Fibre Microscope	Nos.	1

15.2.3 The Contractor shall submit the technical specifications, datasheets and operational manual of each type of Special Tool & Test Equipment at least six months before the start of Defects Notification Period to the Engineer for review.

15.2.4 All Special Tools & Test Equipment shall be supplied together with all cords and connectors, operation manuals, complete diagrams, schematics, assembly and connection drawings, maintenance instructions and calibration certificates.

15.2.5 None of the Special Tools & Test Equipment provided for the Employer shall be used on site prior to delivery to the Employer.

15.2.6 The supply of Special Tool & Test Equipment shall be completed by the start of Defect Notification Period.

15.2.7 All tools and test equipment required in the field for restoration of the network shall be suitably fixed in the maintenance vehicle (Mobile Telecommunication maintenance vehicle), so that in case of failures, the mobilisation time is minimised and complete equipment required for repair are carried by the maintenance vehicle.

(End of Chapter-15)

CHAPTER 16 — TRAINING

16.1 General

16.1.1 The Contractor shall provide comprehensive training to the Employer's Personnel in respect of design, system engineering, construction/ installation, assembly, configuration, operations, fault diagnosis and maintenance of the systems/sub-systems, provided under the Contract. The Contractor shall arrange Training at Manufacturing facilities as well as at site, as per the approved Training Plan.

16.1.2 All the training courses at manufacturing facilities shall be conducted during design period and completed before the commencement of installation.

16.1.3 The training at manufacturing facilities has the potential of imparting maximum benefit and shall cover all Signalling and Telecommunication equipment provided under the contract.

16.1.4 All the training courses at site shall be conducted during installation period and completed before the commencement of testing and commissioning.

16.1.5 The Contractor shall also arrange training at site for Employer's maintenance and Operating personnel and Key Instructors. The Contractor shall set up training class rooms near to site, where he shall provide competent training instructors, training manuals, all necessary aids and materials as required for all the training courses. The training courses shall cover working principles, installation, operation, fault diagnosis & maintenance of all major equipment and works engineered by the Contractor.

16.1.6 The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields. The training instructors shall be either the system designer or engineering staff of the Contractor, the Contractor's subcontractors or the equipment manufacturers. No Training instructor shall be deployed without prior approval of the Engineer. The training shall be in English and Hindi languages as required. The Training abroad shall, however be in English language only. All training material shall be provided in English. If requested by the Engineer, the training material shall be provided in Hindi also.

16.1.7 The Employer intend to create some 'Experts' of each sub-system/equipment who need to be intensively trained by the Contractor in all aspects (design, installation, testing and commissioning, fault finding etc.) of each sub-system/equipment, and train them to the level that they can even undertake customization of the sub system as required by the Employer from time to time in future. The Employer will nominate up to 5 persons for training in each sub-system.

16.1.8 The Training Program shall enable the basic staff to operate service, enhance, maintain and interact with the hardware, software and firmware such that the systems and associated equipment will perform in accordance with the specifications of this contract.

16.1.9 The training courses and/or sessions shall include system performance requirements and all major equipment and works engineered by the Contractor.

16.1.10 The Contractor shall submit assessment reports on the performance of individual trainees to the Engineer. Training evaluation shall be required at regular intervals to monitor the progress and suitability of the training program. Items that require further information or tasks that require additional training or practice will be discussed between Engineer and the contractor at the evaluation meetings. Such items or tasks

must be appended to the training program,

16.1.11 The Contractor shall bear all the training costs except for allowances, hotel and travel expenses of the Employer's trainees.

16.1.12 Throughout training program, the Engineer/Employer shall have free access to all training sessions to monitor the progress of the trainees and the Contractor's training instructors.

16.1.13 If required by the Employer, any one or more of training courses may be repeated during currency of the contract to train additional batches of staff.

16.1.14 The Contractor shall provide full-time management, co-ordination and supervision of the entire training Program to ensure the continuity of classes and proper distribution of training materials and be responsible for interfacing with the instructors.

16.2 Scope of Training

16.2.1 Objective of Training is as follows:

a) To enable the Employer's maintenance personnel to maintain the commissioned Signalling and Telecommunication systems;

b) To enable the Employer's Operating personnel to become competent in operating the various systems/sub-systems at work site; and

c) To enable the Employer's Key Instructors to become competent to deliver future courses to other employees of the Employer;

d) The Training shall be imparted on various Sub-systems. Aspects covered shall include, but not be limited to the following:

(i)Operating features and functional principles of the relevant Systems.

(ii)System engineering aspects including design standards, design criteria and parameters, short-circuit and other calculations, insulation and protection co- ordination.

(iii)Details of major equipment and components used in the System.

(iv)System operating and maintenance management procedures and

(v)Control and monitoring systems for each System.

e) The Training shall be in India and abroad, including training at manufacturing facilitiesas appropriate.

16.3 Training Plan

16.3.1 Within six months after the Commencement Date of the Works, the Contractor shall submit a Training Plan to the Engineer for review.

16.3.2 The Training Plan shall include, but not be limited to, the following:

(1) the program of the training courses at site and at manufacturing facilities;

(2) overview and description of objectives of each training course;

(3) the location where the training courses to be conducted;

(4) submission schedule of the training materials;

(5) set ups for practical exercises;

(6) the Contractor's training organisation chart, including the role and responsibilities of

individual key persons;

(7) the qualifications and experience of the training instructors;

16.4 Training Courses for Signalling and Telecommunication Sub- systems

16.4.1 General

1) The Contractor shall provide Training Courses on all facilities, systems, equipment, hardware, firmware and software. Each Course shall be specific and shall consist of classroom, hands-on and/or field training as necessary to accomplish the Course Objectives specified in the Training Program Plan. The Contractor shall develop detailed training modules based on information in the Operating and Maintenance manuals.

2) The technical training courses to the Employer's staff shall be programmed in phases with the progress of manufacture and installation to ensure that trainees are present during all stages of the manufacture, installation and commissioning of the equipment which is the subject of the training. The Contractor shall ensure that the courses fully encompass all aspects of the basic design, manufacture, installation, commissioning and maintenance of the Equipment with maximum effort being directed at instruction in the maintenance of the installations.

3) Training at site shall include operation courses and maintenance courses. The class will be of maximum of 30 trainees. The Contractor in consultation with Engineer and Employer shall determine the number of classes for each type of training course, within the provisions available in respective Particular Specification, to ensure the objectives of the course can be met.

16.4.2 Training Courses for Operating Staff

1) The Training courses for Operating personnel on Signalling and Telecommunication systems/sub-systems shall be developed to provide all necessary knowledge and skills that enable them to operate the system under normal and emergency situations and recovery from minor or simple faults. In particular, the Training course shall include the following as minimum:

2) Overview of the system/sub-system;

3) Brief description the operational principles of the system/sub-systems;

4) Operational features and functions;

5) Familiarisation and use of all man-machine interfaces involved;

6) Reading and interpretation of system status and alarm messages or indications;

7) Normal operating procedures;

8) Operating procedures under emergency situations; and

9) Procedures for recovery from minor or simple faults.

10) A comprehensive list of Dos and Don'ts shall be prepared and explained to the Operating personnel and also shall be prominently displayed at the stations.

16.4.3 Training Courses for Maintenance Staff

The Training courses for maintenance staff at site shall, as a minimum, impart the following techniques to maintenance staff of Employer of the appropriate grades:

(1) Planned maintenance and overhaul of all the railway systems/subsystems supplied,installed or modified under the Contract;

(2) Fault diagnosis and rectification techniques for the systems/subsystems including equipment supplied, installed or modified under the Contract. These shall be developed from the Contractor's previous experience with similar equipment and also from the fault tree analysis and other analysis carried out as part of the reliability engineering studies undertaken by the Contractor;

(3) Normal and degraded modes of operation of the S&T systems/subsystems including equipment supplied, installed or modified under the Contract;

(4) All rules, regulations, practices and procedures necessary for the safe and efficient operation of the S&T systems/subsystems supplied, installed or modified under the Contract; and

(5) All contingency plans necessary to recover speedily and safely from any mishaps or emergencies that may arise with the S&T systems/subsystems supplied, installed or modified under the Contract.

(6) The Training in Operation and Maintenance shall enable trainees to obtain competence, including obtaining Competency Certificate from the competent authority.

(7) The training courses for system engineers at manufacturing facilities shall be developed to provide all necessary knowledge and skills to perform system engineering management including system parameter configuration, enhancement, expansion and provision of new circuits.

(8) The Contractor shall determine the content of the system engineering courses, however the courses shall include the following as minimum:

(1) Overview of the S&T systems/subsystems;

(2) Brief description of the operation principles of the Subsystems and background theory;

(3) System/ operational features and functions;

(4) Description of system components and equipment down to card or module level;

(5) Test and commissioning procedures;

(6) Use of test equipment and special tools;

(7) Reading and interpretation of alarm indications, messages and print-outs;

(8) Preventive maintenance procedures;

(9) Fault diagnosis, troubleshooting and corrective maintenance procedures;

(10) Equipment settings and parameters configuration;

(11) Use of Equipment manuals, Operation and Maintenance manuals, circuit

diagramsand wiring schematics;

(12) Methods and procedures to provide new circuits, system expansion and enhancement;

(13) Data, software backup and loading;

(14) Use of software such as peripheral control and configuration, utility, databasestructure, generation and modification;

(15) Periodical Maintenance schedules and impacts;

(16) Familiarisation and use of all man-machine interfaces involved;

(17) Normal operating procedures;

(18) Operating procedures under emergency situations; and

(19) Procedures for recovery from faults

(9) During the Defects Notification Period, when the Contractor is responsible for fault finding and repair, he shall provide practical hands on training to Employer's maintenance staff to facilitate successful handing over of the works.

(10) Training Courses for Telecom Sub Systems

The Maintenance & Troubleshooting courses shall be developed to provide all necessary knowledge and skills for maintenance staff of the Employer to perform full maintenance, including both preventive and corrective maintenance and fault diagnosis in case of failure.

The Contractor shall provide training courses for each of the telecommunication sub-systems including but not limited to:

(1) Optical Fiber Cable communication system including SDH, PDH and IP-MPLS system;

(2) OFC cable Splicing and Testing.

(3) IP based Telephone Exchanges and associated sub-systems;

(4) VHF system;

(5) Master Clock/GPS clock system

(6) Earthing and Surge Protection Systems;

(7) Power Supply System

(8) DTMF Control Communication System

The Employer's Key Instructors shall attend all types of training courses so that they shall be able to subsequently train the Employer's staff in future in all aspects of operation and maintenance of the System.

16.5 Training material and Equipment

16.5.1 The Contractor shall provide such written or printed matter, functional equipment, samples, models, cutaway equipment, slides, films and other instructional material, as may be necessary for training. Such equipment and material shall remain the property of the Employer and shall be sufficient both for the persons trained by the Contractor and for those to be subsequently trained by Employer Training Instructors.

16.5.2 The Contractor shall arrange all training material including tables, chairs, white boards,

and so on. If available, the Contractor may however, use the training rooms of the Employer.

16.5.3 With the prior approval of the Engineer, the Contractor may use the Works being erected, tested or commissioned for the training of Employer's Personnel.

16.5.4 The Contractor shall prepare a Trainer's guide for each training course. The Trainer's guide shall include the course agenda, objectives, list of resources and facilities required, detailed lesson plans, presentation notes, discussion guides, training aids and job aids, test papers, criteria and methodology for testing and assessment, and all other things that will enable Employer's Training Instructors to carry out repeat or refresher courses in the future.

16.5.5 At the commencement of the training course, the Contractor shall, distribute two sets of Trainer's guides and one set of Training manual for each trainee and two sets of Trainer's guides and three additional sets of Training manual to the Engineer

16.5.6 Training course notes shall be compatible and where appropriate, cross-referenced to the Manuals supplied by the Contractor as part of the Operation and Maintenance documentation.

16.5.7 The Training course notes and Trainer's guides shall be submitted to the Engineer for review six (06) months prior to the commencement of the first training session of the course. Course notes and Trainer's guides shall be in a standard format as decided by the Engineer and in a form that allows for easy reproduction. At least two months before the commencement of the training course, the Contractor shall submit all the training materials including the trainer's guides, training manual for trainees, training aids and presentation materials to the Engineer for review. The training materials shall be prepared in a form allow easy future reproduction.

16.6 Test and Assessment

1) The Contractor shall develop a system of assessment and certification of trainees at the end of each course. The system of assessment shall test the knowledge, understanding and proficiency of the trainees.

2) The assessment and certification procedures shall be submitted by the Contractor for approval of the Engineer.

3) At the end of the training period, the Contractor shall issue Training certificate to the trainees who pass the assessment.

4) Training sessions, tests, and certification processes may be witnessed by the Engineer and the Employer.

5) The Contractor in consultation with the Engineer, shall develop a system of Feedback after each Training course. The Feedback forms shall measure the Trainee's level of satisfaction with the course content. The Feedback form shall be submitted to the Engineer for review four weeks before the commencement of the Training course.

16.7 Training Records

1) The Contractor shall keep attendance records of trainees.

2) The Contractor shall issue appropriate training certificate to the trainees who pass the assessment.

3) The Contractor shall, at the completion of each training course provide the Engineer a consolidated training records listing the training course title, date of

training, name of all trainees, training result and other relevant information.

4) After two weeks, the Contractor shall submit a Training report to the Engineer for review.

5) The Training report shall include a summary of the training course conducted, the results of trainees' assessment and the Feedback report.

(End of Chapter-16)

CHAPTER 17 — OPERATION & MAINTENANCE AND SERVICE LIFE SUPPORT

17.1 General

17.1.1 Operation and Maintenance is an important element in the execution of a project. It is essential to have a well-designed Operation & Maintenance Support Plan and Maintenance Plan before the system is made Operational. These plans shall be submitted to Engineer for review, at least six months before start of Defect Notification Period.

17.1.2 It shall be ensured that the resource requirement in terms of men and material as identified in the Plans is available before the system is made Operational.

17.1.3 The Contractor shall repair and/or replace, in each case at no cost to the Employer, any part of the Works which is found to be defective by reason of faulty design, materials or workmanship or negligence or failure on the part of the Contractor to comply with any obligation expressed or implied under the Contract, during the DNP after the date of issue of the Taking Over Certificate of the Works. The Works shall include equipment being provided under this Contract Package and upgraded/augmented/reconfigured.

17.1.4 During the Defects Notification Period, as a result of an inspection made by or on behalf of the Employer at any time or times prior to its expiration, the Engineer shall have the right but not the obligation to instruct the Contractor in writing to execute all such work of repair, amendment, rectification and make good defects, imperfections or other faults in the Works and any part thereof, as the case may be.

17.2 Operation and Maintenance Support Plan

1) Operation and Maintenance Support Plan shall cover, but not limited to, the following items:

- Submission of Technical Manuals as required for both Signalling andTelecommunication;
- Submission of Operation & Maintenance Manuals and Warranty certificates for each item/unit/ equipment;
- Requirement of bare minimum Employer's Manpower for maintenance;
- Proposed Contractor's Manpower for supervision of Maintenance during one year Maintenance and Defect Notification Period;

2) Provision of Software support during one year Maintenance and Defect Notification Period;

3) Provision of Spares, Test Equipment, Tools, etc. for respective equipment and machines;

4) Requirement of periodic operation of equipment and machines which would otherwise deteriorate because of non-operation for extended periods.

17.3 Support during One year Maintenance and Defect Notification Period (DNP)

17.3.1 Support and Call-out Services

1) The Contractor shall provide the Support & Call-out-services for maintenance of the system. The maintenance will be done by the Employer with the support of the Contractor. The Support and Call-out services shall be available 24 hours per day

and 7 days per week.

2) The Contractor shall deploy adequate, committed and competent resources for providing desired level Support and Call-out-services. As a minimum, the expert of each sub-system of Signalling and Telecommunication shall be provided by the contractor at Manesar Station. All the resources shall be trained before deployment.

3) The resource deployment shall be as per Operation and Maintenance Support Plan approved by the Engineer. The Contractor shall provide a list of staff together with the contact landline/mobile telephone numbers who can be contacted for Support and Call-out-services. Any change in the staff or his call-out number shall be notified to the Engineer at least two weeks before such change becomes effective.

4) The Contractor's response Time for Support & Call-Out-Services shall not exceed three hours for Signalling and Telecommunication both. The Response Time is defined as the time that elapses between the reporting of a fault and the Contractor's Call out personnel arriving at site where the faulty equipment is located.

5) In case of any abnormal System behavior like intermittent faults, interference, frequent repeated faults, etc. occur or the performance is found to deviate from the specified tolerances, the Contractor shall conduct investigations and report the findings to the Engineer along with the recommendations and proceed after the recommendation has been reviewed without objection by the Engineer. The Contractor shall take every precaution to protect existing equipment from damage and make good any damage caused.

17.3.2 ~~Workshop~~ Repair

1. The Contractor shall provide ~~Workshop~~ repair services for all defective and faulty items of the System and shall collect and repair defective parts that are removed from the System during corrective and predictive maintenance.
2. The Contractor shall perform all necessary adjustments or alignments as required to the repaired parts. The repair of defective parts can only be considered as completed and returned to stock or back to the System if the parts are tested and verified fit for use in the System.
3. The Contractor shall use only components of equal or better specification than the original components in his repair activities. The performance of the defective parts after repair shall not be degraded or deteriorated due to repairs.
4. The maximum turnaround time for ~~workshop~~ repair shall be less than 28 calendar days. The turnaround time count shall start from the time the defective parts are removed from the System and shall continue till the parts are repaired and returned to stock or to the System. Any extension of workshop repair time shall be agreed with the Employer.

17.4 RAMS Targets Failures

In case of failure of the Contractor to achieve the RAMS Targets specified in the Employer's Requirement:

- The Defects Notification Period shall stand extended for a further period corresponding to period of failure;
- The Performance Guarantee shall stand extended for a period corresponding

to the extension of the Defects Notification Period; and

- All work required to be carried out by the Contractor for the rectification of defects, shall be carried out at the Contractor's own expense.

17.4 Operation and Maintenance Manuals

17.5.1 In addition to the various existing Codes and Manuals applicable to Indian Railways for operation and maintenance of systems, the Contractor shall produce manuals covering the additional provisions, over and above the various existing Codes and Manuals of Indian Railways in respect of the Operation and Maintenance requirements of various assets created under the Contract.

17.5.2 With reference to the requirements as above, the Contractor shall produce manuals for all equipment and manufactured items and sub-systems, supplied and created under the Contract, for their efficient operations and maintenance. These shall include, but not be limited to, the following equipment/sub-systems:

1) Maintenance of Telecommunication Equipment: Maintenance of following Telecommunication equipment but not limited to shall be carried out:

   - Optic Fiber Cable Communication System including PDH/SDH/IP-MPLS equipment.
   - Telephone Exchanges and associated sub-systems;
   - Master/GPS Clock system
   - VHF Communication System
   - Earthing, Lightning and Surge Protection System
   - Emergency Communication System
   - Train control communication equipment
   - Power Supply System for Telecommunication
   - IP based Passanger Information System
   - Public address System

2) System/Sub-System Manuals- A comprehensive description of all system principles at block diagram level.

3) Operating/User Manuals - broken into as many sub-sections as necessary and providing sufficient information to enable non-technical staff to exploit fully the facilities of each system. The Operating Manual of EI shall contain detailed description of all the operations of the SM's Control terminal with coloured illustrations.

4) Workshop Manuals - Installation and circuit descriptions, full schematics, circuits, wiring diagrams, mechanical construction/installation drawings and itemized parts list to enable all maintenance rectification and setting-up to be carried out.

5) Software System Manual - for each software package and each piece of

equipment which incorporates Programmable Device(s), licensed copies of CD/DVD of application and peripheral software along with write up on software features, instructions for configuration, working of software and procedures for taking out report and data in the form of instruction manual/guide.

17.6 Maintenance Plan

17.6.1 While Operation & Maintenance Support Plan take care of day to day operation and maintenance of the systems/sub-systems, the Maintenance Plan is designed to put the maintenance practices on sound footing for proper upkeep of the systems. The Maintenance Plan shall be prepared by the Contractor and submitted to the Engineer for review at least 3 months before start of Defect Notification Period.

17.6.2 The Maintenance Plan shall describe, but not limited to, the following:

1) Maintenance philosophy and approach,
2) All necessary tasks for first line, second line, third line and corrective maintenance,
3) Frequency of each maintenance task,
4) Employer's and Contractor's proposed maintenance regime for maintenance,
5) Maintenance Schedules (Daily, Weekly, Monthly as recommended by OEM) detailing maintenance task for each maintenance team member;

17.6.3 The Maintenance Plan shall be aligned with the Employer's maintenance policy.

17.6.4 Maintenance Management system (MIS)

The system described in PS/Signalling Clause 10.7 shall be provided to cater for Telecommunication System maintenance also.

17.7 Maintenance Schedules

17.7.1 The Contractor shall prepare the Maintenance schedule for each item/equipment required to be maintained. The schedule should give the details such as the frequency of maintenance, the items to be maintained, the tolerances permitted and the safety checks to be performed. The Contractor shall submit the Maintenance Schedule to the Engineer for review.

17.7.2 In addition to the above, the Contractor shall include in the Maintenance Schedule the following information:

a) The equipment, sub-systems covered in the task,
b) Step by step procedure to carry out the task,
c) Tools and test equipment required for each task,
d) Diagrams and flowcharts by illustration, if applicable,
e) Adjustment procedures for all field adjustable units,
f) Recovery procedures, if applicable,
g) Precautions including Safety to be followed by maintenance personnel and
h) Estimated duration and manpower required;

17.8 Maintenance Manual

The maintenance manual shall contain the following, but not limited to:

a) Technical description of each system and sub-system of equipment installed to ensurethat the Employer's technical staff fully understand the scope and facilities provided.

b) Diagrammatic drawings of each system indicating principal components and items of equipment

c) Name, addresses, telephone, e-mail and fax numbers of the manufacturer of every item of equipment.

d) Manufacturer's service manual for each major item of equipment, assembled specifically for the project including detailed drawings, illustrations, circuit details, operating and maintenance instructions, modes of operation, control provisions, sequences and interlocks and preventative maintenance Program.

e) Procedures for fault location and isolation.

f) Maintenance procedures and their periodicity. The contractor must give list of Items to be checked, adjustments to be made, safety checks to be performed and frequency of maintenance for each item of the sub-system/equipment. These maintenance Schedules should be compiled in the form of a register and shall be kept at stations for recording of the maintenance done by Signal maintainer. It should lead to computerization of the maintenance activities.

g) Tools and Plant needed for maintenance of different Equipment provided in the Works.

h) Configuration Manual for all equipment, wherever required.

- All test results conducted on the relevant equipment whether at the manufacturer's place or at site; and
- Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items, which may involve extended deliveries.

i) The Contractor shall submit all the Manuals for review by the Engineer prior to Factory Acceptance Tests which shall be submitted not later than 112 days before the targeted date of start of Trial Running for the Engineer's consent.

j) The Contractor shall provide sufficient copies of all Manuals along with electronic version for use of the Employer's Staff/Engineer.

k) The Contractor shall maintain all Manuals in an up-to-date condition throughout the Contract Period, wherever applicable.

17.9 Software Support

17.9.1 The Contractor shall submit a Software Support Plan at least ninety (90) days before commencement of Software installation. This plan shall require the Contractor to provide all changes, bug fixes, updates, modifications, amendments and new versions of the program as required by the Engineer.

17.9.2 The changes and modifications of the software shall not degrade the performance or have adverse impact on the system. The Contractor shall maintain backup copies of all software developed or delivered for the System.

17.9.3 The Contractor shall ensure that all new versions are fully tested and validated and reviewed without objection by the Engineer prior to loading into the system.

17.9.4 The Contractor shall provide training to the Employer's staff for use of new version, as and when incorporated.

17.9.5 The Contractor shall provide full support to the Employer and Engineer for all computer programs provided by the Contractor under the Contract.

17.9.6 The Contractor shall provide all tools, equipment, manuals, configuration and customization data and training necessary for the Employer's staff to maintain and re-configure all the software provided under the Contract. This shall include supply of any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers.

17.9.7 The Contractor shall submit all new versions to the Engineer for review at least two (02) weeks prior to their installation. New Versions of any program shall not result in any non-conformance with the Specification or degrade the performance or have adverse impact on the System. The Contractor shall:

a) ensure that all new versions are fully tested and validated on the simulation and development system prior to installation;

b) ensure that all new versions are fully tested and commissioned once installed on thesite; and deliver to the Employer any new version, together with the updated Operation andMaintenance Manuals.

c) All new version of software shall be accompanied by a release note containing the following details:

- Version number
- modifications made to the previous version;
- check sum

17.9.8 The Engineer shall not be obliged to use any new version that shall not relieve the Contractor of any of its obligations. Any effect upon the performance or operation of the computer-controlled system that may be caused by a new version shall be brought to the Engineer attention including updating the files to suit new version.

17.10 Security obligations

Within fourteen (14) days of the installation of any software, which is developed or modified for this Contract, into the permanent works by the Contractor, the Contractor shall submit to the Engineer for retention by the Employer two (2) backup copies of the software, which shall include, without limitation:

(1) All source and executable code including all data configuration tables.

(2) All design documentation relating to the software;

(3) Any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers, and

(4) All licenses in favour of the Employer for their perpetual use by HRIDC for the

entire life of the systems.

17.11 Monthly Maintenance Meeting

The Contractor shall attend the Monthly Maintenance Meeting with the Engineer to discuss the maintenance matters during the Defect Notification Period. The dates and agenda of the meeting shall be agreed with the Engineer.

17.12 Service Life support

1) The Contractor shall ensure availability of full support to the Employer during the Service life of the project, for operation, maintenance, customization and upgradation of system/sub-system supplied and installed by him as part of the Contract. Wherever the equipment provided under this Contract Package are being upgraded/augmented/reconfigured, this support during service life for operation, maintenance, customization and upgradation shall be available for these equipment.

2) The contractor shall ensure that the OEM should either provide support as above on his own or sign an MOU with suitable Indian companies or company having proven track record and are working in related areas for all systems/subsystems. The copy of the MOU shall be submitted to the Employer as a proof of continuous support.

3) The Contractor/OEM of the system/subsystem may be required to undertake comprehensive Annual Repair Contract (ARC) at the end of Defect Notification Period. The comprehensive ARC may include supply of cards/modules for repairs/replacement of the sub system/system. However, this ARC will be a separate contract and will not be part of this Contract.

4) The Contractor must ensure the following, but not limited to:

- Availability/Establishment of repair/servicing facility in India. The Local Service Centre shall have test and repair facility with simulation test set-up, fault diagnostic system, test jigs, software for testing of cards/modules along with required test instruments and tools.
- Availability/Establishment of Organization in India that can enter into Annual Maintenance/Repair Contract (AMC/ARC) with the Employer.
- Availability/Establishment of Customization facility to add/modify/re-engineer hardware/software of the subsystem as required by the Employer during the lifetime of the equipment for adding facilities/features with future ~~yard modification/signalling equipment~~ up gradation etc.
- Supply of Spares for entire Service life of the equipment.
- Supply additional equipment required for replacement or expansion of the network in future.
- Training of Employer's Personnel in Operation and maintenance of existing and new/modified equipment/sub-systems.

(End of Chapter-17)

Section VII-12: Tender drawings and documents

List of Drawings for Package C-2			
S.No	**TITLE**	**DRAWING No.**	**SHEET No.**
ESP/ YARD PLAN			
1.	PATLI	GC-HRIDC-C2-DRW-ALN-ESP-001_A0 (SMC/HRIDC/PS/ESP/2 (N.RLY DRAWING NO. Y-4/PT/DLI/ 2022)	1 OF 1
2.	NEW PATLI	GC-HRIDC-C2-DRW-ALN-ESP-002_A0 (AA/RLY/2245/HRIDC/ESP/REV-02)	1 of 1
3.	SULTANPUR	GC-HRIDC-C2-DRW-ALN-ESP-003_A0 (AA/2245/ESP/REV-02)	1 of 1
L- Section:			
1.	CH: 55-60	AA/2245/AL/DR/P&P	13 of 26
2.	CH 60-65	AA/2245/AL/DR/P&P	14 of 26
3.	New- Patli to Patli Connectivity	AA/Rly/2245/HRIDC/PLAN&LS/Rev	1 of 1
4.	New- Patli to Farukhnagar (Sultanpur) Connectivity	AA/Rly/2245/HRIDC/PLAN&LS/Rev	1 of 1
Station Building			
1.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING OF NEW PATLI SATATION	GC-HRIDC-C2-STN1-SAD-001_A0	1 of 2 & 2 of 2
2.	SULTANPUR STATION	GC-HRIDC-C2-STN2-SAD-001_A0	1 of 1
A - MINOR BRIDGES			
MAIN LINE			
1.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO 137 SPAN 1.0X2.0X2.0 RCC AT CH: 56118.344	GC-HRIDC-C2-DRG-BRD-GAD-137_A0	1 of 1
2.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO 138 SPAN 1.0X5.0X3.0 RCC AT CH:56291.578	GC-HRIDC-C2-DRG-BRD-GAD-138_A0	1 of 1
3.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO 139 SPAN 1.0X2.0X2.0 RCC BOX AT CH: 56465.954	GC-HRIDC-C2-DRG-BRD-GAD-139_A0	1 of 1
4.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO 140 SPAN 1.0X2.0X2.0 RCC BOX AT CH: 56755.960	GC-HRIDC-C2-DRG-BRD-GAD-140_A0	1 of 1
5.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO 141, 1X5X3+ 1X2X2 RCC BOX+PIPE AT CH. 57168.916	GC-HRIDC-C2-DRG-BRD-GAD-141_A0	1 of 1
6.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO 142, 1X2.0X2.0m RCC BOX AT CH.57546.948	GC-HRIDC-C2-DRG-BRD-GAD-142_A0	1 of 1
7.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO 143, 2X7.0X5.0m RCC BOX AT CH. 57671.734	GC-HRIDC-C2-DRG-BRD-GAD-143_A0	1 of 1

List of Drawings for Package C-2			
8.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD BALANCING CULVERT BRIDGE NO 144, 1X2.0X2.0m RCC BOX AT CH. 57987.971m	GC-HRIDC-C2-DRG-BRD-GAD-144_A0	1 of 1
9.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO 145, 1X5.0X3.0m RCC BOX AT CH. 58204.074m	GC-HRIDC-C2-DRG-BRD-GAD-145_A0	1 of 1
10.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO 146, 1x2.0x2.0m RCC BOX AT CH. 58565.918m	GC-HRIDC-C2-DRG-BRD-GAD-146_A0	1 of 1
11.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO 149, 1X10.0X5.0m RCC BOX AT CH. 59885.880m	GC-HRIDC-C2-DRG-BRD-GAD-149_A0	1 of 1
12.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD+BALANCING CULVERT BRIDGE NO 150, 1X5X3+ 1X2X2 RCC BOX AT CH. 60162.268m	GC-HRIDC-C2-DRG-BRD-GAD-150_A0	1 of 1
13.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO 151, RCC BOX AT CH. 60602.923m	GC-HRIDC-C2-DRG-BRD-GAD-151_A0	1 of 1
14.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO 152, 1X2.0X2.0 RCC BOX AT CH. 61164.432	GC-HRIDC-C2-DRG-BRD-GAD-152_A0	1 of 1
CONNECTING LINE			
S.No	**TITLE**	**DRAWING No.**	**SHEET No.**
NEW PATLI TO PATLI			
1.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO. 3-1X5.0X3.0m RCC BOX AT CH. 898.787m (CONNECTING LINE NEW PATLI TO PATLI)	GC-HRIDC-C2-DRG-BRD-GAD_NP-P-3_A0	1 of 1
2.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO. 4-1X2.0X2.0m RCC BOX AT CH. 1153.187m (CONNECTING LINE NEW PATLI TO PATLI)	GC-HRIDC-C2-DRG-BRD-GAD_NP-P-4_A0	1 of 1
3.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO. 5 -1X4.0X2.5m RCC BOX AT CH. 1858.919m (CONNECTING LINE NEW PATLI TO PATLI)	GC-HRIDC-C2-DRG-BRD-GAD_NP-P-5_A0	1 of 1
4.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO. 6 – 1X5.0X5.0m RCC BOX AT CH. 2391.105m (CONNECTING LINE PATLI TO NEW PATLI)	GC-HRIDC-C2-DRG-BRD-GAD_NP-P-6_A0	1 of 1
5.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT NO. 7 +1X2.5X3.0m RCC BOX AT CH. 2560.493 AND EXIST BOX SIZE-1X2.5X3.0 (CONNECTING LINE NEW PATLI TO PATLI)	GC-HRIDC-C2-DRG-BRD-GAD_NP-P-7_A0	1 of 1
CONNECTING LINE			
S.No	**TITLE**	**DRAWING No.**	**SHEET No.**
NEW PATLI TO FARUKHNAGAR(SULTANPUR)			
1.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO. 1-1X2.0X2.0m	GC-HRIDC-C2-DRG-BRD-GAD_NP-F-1_A0	1 of 1

List of Drawings for Package C-2			
	RCC BOX AT CH. 1698.053m (CONNECTING LINE NEW PATLI TO FARUKHNAGAR)		
2.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO. 2- 1X5.0X3.0M RCC BOX AT CH. 1912.700M (CONNECTING LINE NEW PATLI TO FARUKHNAGAR)	GC-HRIDC-C2-DRG-BRD-GAD_NP-F-2_A0	1 of 1
3.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO.3, -1X2.0X2.0m RCC BOX AT CH. 2807.817m (CONNECTING LINE NEW PATLI TO FARUKHNAGAR)	GC-HRIDC-C2-DRG-BRD-GAD_NP-F-3_A0	1 of 1
4.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO. 4-1X5.0X4.0m RCC BOX AT CH. 2972.708m (CONNECTING LINE NEW PATLI TO FARUKHNAGAR)	GC-HRIDC-C2-DRG-BRD-GAD_NP-F-4_A0	1 of 1
B - MAJOR BRIDGES			
MAIN LINE			
S.No	**TITLE**	**DRAWING NO.**	**SHEET NO.**
1.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR PROPOSED MAJOR ROR BRIDGE NO. 136 AT CH: 55724.752m 24.4+76.2+24.4 OPEN WEB GRIDER	GC-HRIDC-C2-DRG-BRD-GAD-136_A0	1 of 1
2.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR PROPOSED MAJOR RUB NO. 147 AT CH: 59107.010m 1X45.7m, OPEN WEB GRIDER	GC-HRIDC-C2-DRG-BRD-GAD-147_A0	1 of 2 & 2 of 2
CONNECTING LINE (NEW PATLI TO FARUKNAGAR)			
3.	CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR PROPOSED MAJOR RUB NO.147(A) AT CH:1200.000 m 1 x 45.7m,OPEN WEB GIRDER(CONNECTING LINE NEW PATLI TO FARUKHNAGAR)	GC-HRIDC-C2-DRG-BRD-GAD-147(A)_A0	1 of 2 & 2 of 2
Miscellaneous Drawings (Conceptual Plan)			
1.	MINI PLATFORM SHELTER	GC-HRIDC-C2-DRG-SAD-GMD-001_A0	1 of 1
2.	S&T HUT	GC-HRIDC-C2-DRG-SAD-GMD-002_A0	1 of 1
3.	BARBED WIRE FENCING	RDSO/WKS/2019/2	1 of 1
4.	R.C. PRE-CAST FENCING FOR END PLATFORM	GC-HRIDC-C2-DRG-SAD-GMD-004_A0	1 of 1
5.	STATION NAME BOARD (M.S. STEEL BOARD)	GC-HRIDC-C2-DRG-SAD-GMD-005_A0	1 of 1
6.	PROPOSED TOILET BLOCK ON ISLAND PLATFORMS	GC-HRIDC-C2-DRG-SAD-GMD-006_A0	1 of 1
7.	PROPOSED TOILET BLOCK ON MAIN PLATFORMS	GC-HRIDC-C2-DRG-SAD-GMD-007_A0	1 of 1
8.	DRAINS FOR FORMATION	GC-HRIDC-C2-DRG-DRN-GMD-008_A0	1 of 1
9.	STEEL BARRICADE	GC-HRIDC-C2-DRG-SAD-GMD-9_A0	1 of 1

List of Drawings for Package C-2			
10.	WATER BOOTH WITH ONE SIDE TAPS ARRANGEMENT (END PLATFORM)	GC-HRIDC-C2-DRG-SAD-GMD-010_A0	1 of 1
11.	WATER BOOTH WITH BOTH SIDE TAPS ARRANGEMENT (ISLAND PLATFORM)	GC-HRIDC-C2-DRG-SAD-GMD-011_A0	1 of 1
12.	INTERFACING LOCATION BANK BENCHING	GC-HRIDC-C2-DRG-SAD-GMD-012_A0	1 of 1
13.	TICKET COUNTER	GC-HRIDC-C2-DRG-SAD-GMD-013_A0	1 of 1
14.	DRAINAGE ARRANGEMENT (NEW PATLI)	GC-HRIDC-C2-DRG-SAD-GMD-014_A0	1 of 1
15.	TYPICAL DETAILS OF PROTECTION WORK	GC-HRIDC-C2-BRD-GMD-0015_A0	1 of 1
16.	DRAINAGE ARRANGEMENT (SULTANPUR)	GC-HRIDC-C2-DRG-SAD-GMD-016_A0	1 of 1
17.	TYPE PLAN POWDERTOILET FOR DIVYANGS	N.R.H.Q.E PLAN NO. HQ/20/11-2021	1 of 1

List of Documents for Package C-2			
S.No.	**TITLE**		
1.	LIST OF CURVE AND GRADIENT		
2.	LIST OF TBM		
3.	LIST OF UTILITIES		
4.	GT REPORT		
5.	LIST OF APPROVED VENDORS		

LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- EXPRESSWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND

F/CSB-FROM CENTER LINE OF STN BLDG	RH - RIGHT HANDED
TP1 & TP2 - TANGENT POINT	LH - LEFT HANDED
R - RADIUS	FM - FOULING MARK
CCL - CIRCULAR CURVE LENGTH	SRJ - STOCK RAIL JOINT
TL - TANGENT LENGTH	TS - TRAP SWITCH
TR - TRANSITION LENGTH	DE - DEAD END
SE - SUPERELEVATION	Rr - RESULTANT RADIUS
Δ - DEFLECTION ANGLE	D - DEGREE OF CURVE
CSR - CLEAR STANDING ROOM	RH - RELAY HUT
SSP - SUB SECTIONING & PARALLING POST	

NOTE:

1. ALL DIMENSIONS ARE SHOWN IN METRES.
2. CH:0.00 IS RECKONED FOR C.L OF STATION BUILDING.
3. EXISTING WORK SHOWN IN BLACK.
4. PROPOSED WORK SHOWN IN RED.
6. ISOLATION WILL BE PROVIDED AS PER STD .IIR.
7. STD IIR ELECTRONIC INTERLOCKING WITH MACL SIGNALLING WILL BE PROVIDED.
8. ALL POINTS AND CROSSINGS ARE TO BE PROVIDED WITH FAN SHAPED CURVED SWITCHES ON CONCRETE SLEEPER .
9. CHAINAGES ARE RECKONED FROM C.L OF PIRTHALA STATION
10. RULING GRADIENT FOR THIS SECTION IS 1 IN 150 COMPENSATED

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

CSR DETAILS FOR NEW PATLI YARD

LINE NO	LINE NOTATION	START (F/CSB)		END (F/CSB)		TOTAL LENGTH OF CSR (m)
LINE NO-1	LOOP LINE	FM	428.8000	SRJ	419.7030	826.2610
LINE NO-2	LOOP LINE	SRJ	389.5240	FM	448.9070	826.2610
LINE NO-3	DN MAIN LINE	FM	580.8420	FM	550.8730	1119.5220
LINE NO-4	UP MAIN LINE	FM	478.8890	FM	512.7160	991.6050
LINE NO-5	LOOP LINE	SRJ	461.8640	SRJ	495.6690	957.5330

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD	[signature]	SHIV OM DWIVEDI CPM/HRIDC	[signature]
SUDHIR AGRAWAL DPD/CIVIL	[signature]	UMA.M.RAO DGM/C-1	[signature]
AJAY VIJAYVARGIYA DPD/EST		DGM/S&T	
KRISHAN CHAND SAINSI CRE/CIVIL	[signature]	DGM/Elect.	
AMARNATH SINGH CRE/S&T	[signature]		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE — SMEC

GC DRG.NO. GC-HRID-C2-DRW-ALN-ESP-002_A0

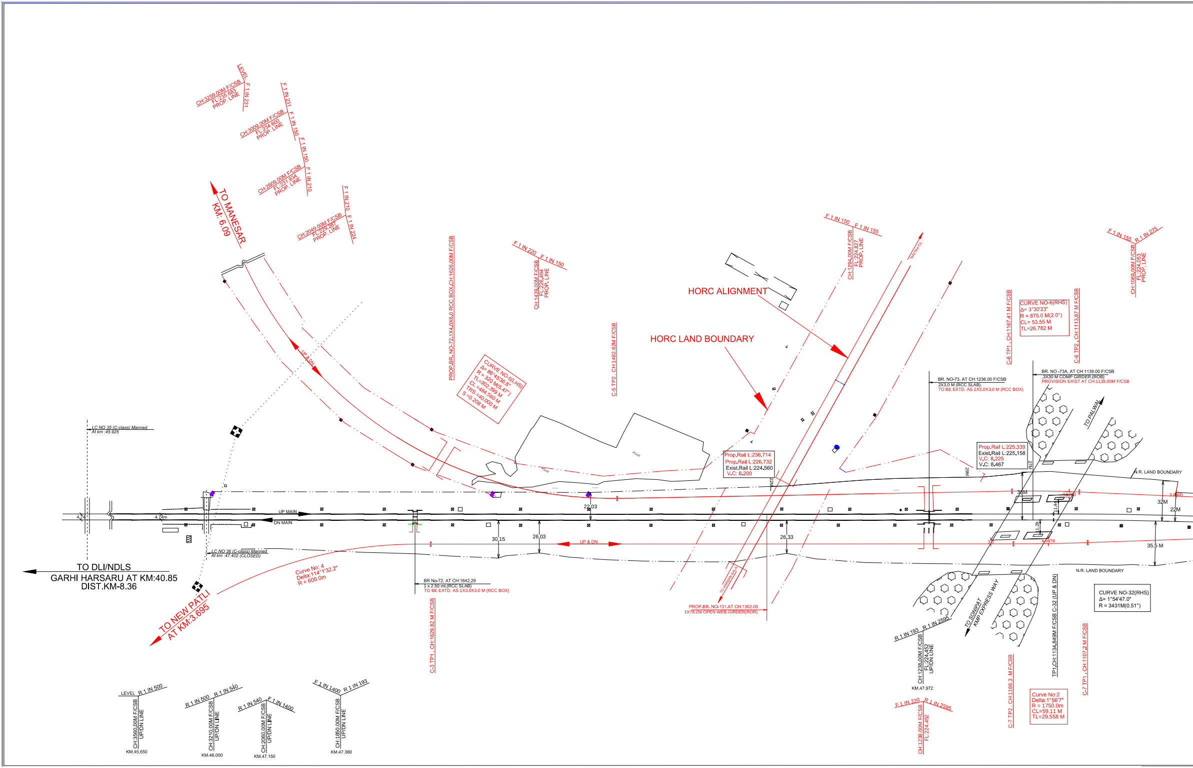
TITLE : ENGINEERING SCALE PLAN
NEW PATLI JUNCTION
CH:58136.439m F/PIRTHALA

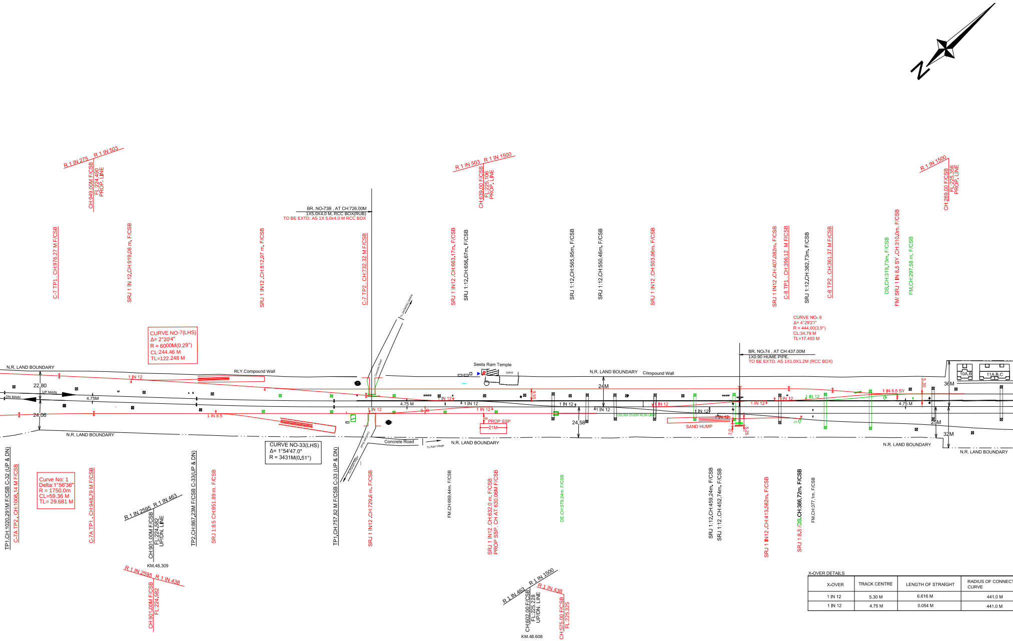
CONSULTANTS : aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

MANISHA (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

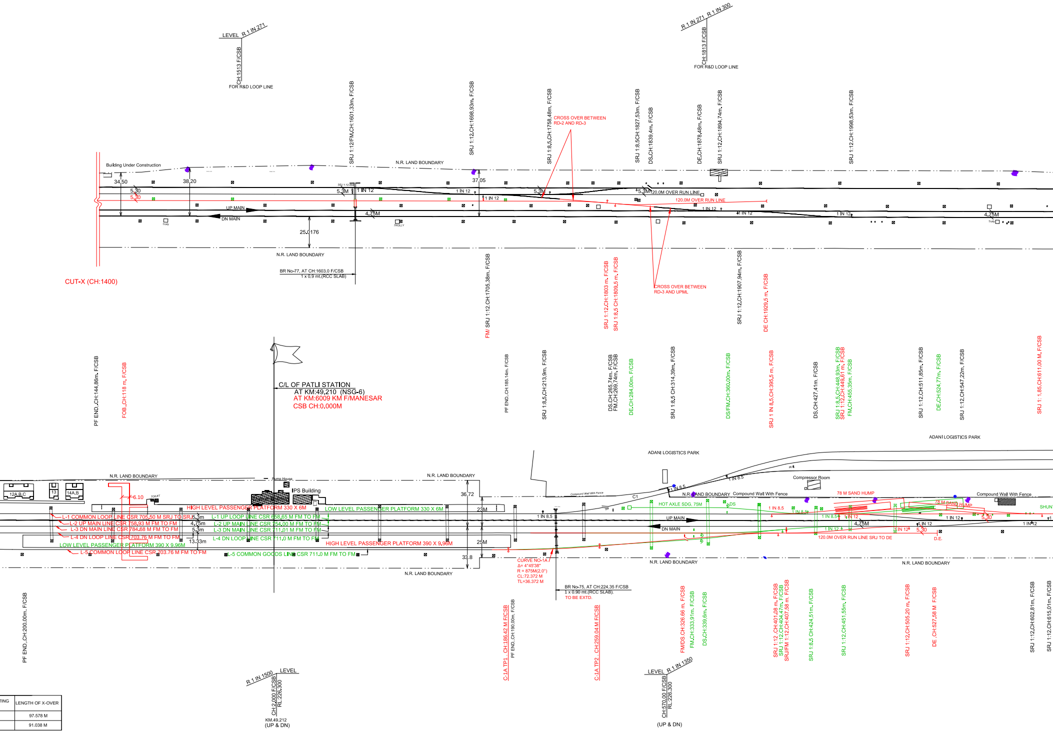
DRG.NO.AA/RLY/2245/HRIDC/ESP-06/REV-3 — SHEET No. 1
SCALE : 1:1000 — ISSUED Dt: 26.11.2019 — REV Dt: 25-06-2022


LEVEL
F 1 IN 231
CH:3259.00M F/CSB
FL:235.683
PROP. LINE
F 1 IN 231
F 1 IN 150
CH:3009.00M F/CSB
FL:234.600
PROP. LINE
F 1 IN 150
F 1 IN 210
CH:2609.00M F/CSB
FL:231.934
PROP. LINE
F 1 IN 210
F 1 IN 224
CH:2049.00M F/CSB
FL:229.267
PROP. LINE
TO MANESAR
KM: 6.09
UP & DN
PROP.BR. NO-72.1X4.0X6.0 RCC BOX.CH:1626.00M F/CSB
CURVE NO-5(LHS)
Δ= 86°45'36.8"
R = 320 M(5.47°)
TL=302.399 M
CL =484.560 M
TRS =40.000 M
S =0.208 M
F 1 IN 220
F 1 IN 150
CH:1439.00M F/CSB
FL:226.494
PROP. LINE
C-5 TP2 . CH:1482.62M F/CSB
HORC ALIGNMENT
HORC LAND BOUNDARY
F 1 IN 150
F 1 IN 155
CH:1294.00M F/CSB
FL:224.827
PROP. LINE
TO PALWAL
F 1 IN 155
R 1 IN 275
CH:1069.00M F/CSB
FL:224.053
PROP. LINE
C-6 TP1 . CH:1167.41 M F/CSB
CURVE NO-6(RHS)
Δ= 3°30'23"
R = 875.0 M(2.0°)
CL= 53.55 M
TL=26.782 M
C-6 TP2 . CH:1113.87 M F/CSB
BR. NO-73, AT CH:1236.00 F/CSB
2X3.0 M (RCC SLAB).
TO BE EXTD. AS 2X3.0X3.0 M (RCC BOX)
BR. NO -73A, AT CH:1139.00 F/CSB
,3X30 M COMP GIRDER.(ROB)
PROVISION EXIST AT CH:1139.00M F/CSB
TO PALWAL
LC NO 35 (C-class) Manned
At km :45.925
Prop.Rail L:236.714
Prop.Rail L:226.732
Exist.Rail L:224.560
V.C: 8.200
22M
29M
Prop.Rail L:225.339
Exist.Rail L:225.158
V.C: 8.225
V.C: 8.467
27M
N.R. LAND BOUNDARY
4.74
4.74m
UP MAIN
DN MAIN
22.03
33M
4.5760
3.0000
32M
22M
11.44
1.29
30.15
26.03
UP & DN
26.33
3.0
4.0476
35.5 M
LC NO 36 (C-class) Manned
At km :47.402 (CLOSED)
N.R. LAND BOUNDARY
TO DLI/NDLS
GARHI HARSARU AT KM:40.85
DIST.KM-8.36
Curve No: 4
Delta:114°1'32.2"
R = 600.0m
BR No-72, AT CH:1642.29
1 x 2.50 mt.(RCC SLAB)
TO BE EXTD. AS 1X3.0X3.0 M (RCC BOX)
TO HARSAN KALA
PROP.BR. NO-131.AT CH:1362.00
1X76.2M OPEN WEB GIRDER(ROR)
CURVE NO-32(RHS)
Δ= 1°54'47.0"
R = 3431M(0.51°)
TO NEW PATLI
AT KM:3.695
C-3 TP1 . CH:1629.82 M F/CSB
R 1 IN 193
R 1 IN 2595
CH:1238.00M F/CSB
FL:224.452
UP/DN LINE
KM.47.972
TO SONIPAT
KMP EXPRESS WAY
TP1.CH:1134.849M F/CSB C-32 (UP & DN)
C-7 TP1 . CH:1107.2 M F/CSB
C-7 TP2 . CH:1166.3 M F/CSB
Curve No:2
Delta:1°56'7"
R = 1750.0m
CL=59.11 M
TL=29.558 M
F 1 IN 220
R 1 IN 2595
CH:1238.00M F/CSB
FL:224.452
LEVEL
R 1 IN 500
CH:3560.00M F/CSB
UP/DN LINE
KM.45.650
R 1 IN 500
R 1 IN 540
CH:3210.00M F/CSB
UP/DN LINE
KM.46.000
R 1 IN 540
F 1 IN 1400
CH:2060.00M F/CSB
UP/DN LINE
KM.47.150
F 1 IN 1400
R 1 IN 193
CH:1850.00M F/CSB
UP/DN LINE
KM.47.360

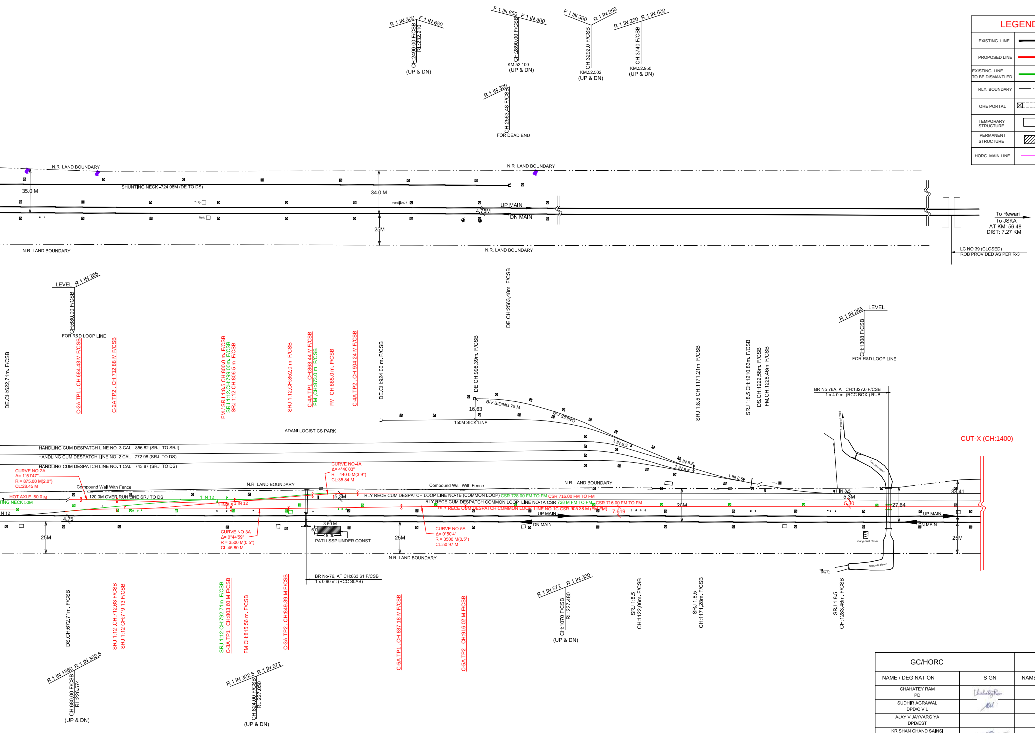

R 1 IN 275 R 1 IN 503
CH:949.00M F/CSB
FL:224.490
PROP. LINE
R 1 IN 503 R 1 IN 1500
CH:639.00 F/CSB
FL:225.106
PROP. LINE
R 1 IN 1500
CH:269.00 F/CSB
FL:225.356
PROP. LINE
BR. NO-73B , AT CH:726.00M
1X5.0X4.0 M, RCC BOX(RUB)
TO BE EXTD. AS 1X 5.0x4.0 M RCC BOX
C-7 TP1 . CH:976.27 M F/CSB
SRJ 1 IN 12,CH:919.08 m. F/CSB
SRJ 1 IN12 .CH:812.97 m. F/CSB
C-7 TP2 . CH:732.32 M F/CSB
SRJ 1 IN12 .CH:663.17m. F/CSB
SRJ 1:12,CH:656.67m. F/CSB
SRJ 1:12,CH:565.95m. F/CSB
SRJ 1:12,CH:550.46m. F/CSB
SRJ 1 IN12 .CH:503.96m. F/CSB
SRJ 1 IN12 .CH:407.082m. F/CSB
C-8 TP1 . CH:396.12 M F/CSB
SRJ 1:12,CH:382.73m. F/CSB
C-8 TP2 . CH:361.37 M F/CSB
DS,CH:319.73m. F/CSB
FM/ SRJ 1 IN 8.5 SY .CH:310.0m. F/CSB
FM,CH:297.58 m. F/CSB
CURVE NO- 8
Δ= 4°29'21"
R = 444.00(3.9°)
CL:34.79 M
TL=17.403 M
CURVE NO-7(LHS)
Δ= 2°20'4"
R = 6000M(0.29°)
CL:244.46 M
TL=122.248 M
To Jhansi Gate
Concrete Road
Seeta Ram Temple
SHED
BR. NO-74 , AT CH:437.00M
1X0.90 HUME PIPE.
TO BE EXTD. AS 1X1.0X1.2M (RCC BOX)
N.R. LAND BOUNDARY
RLY.Compound Wall
N.R. LAND BOUNDARY
Compound Wall
10A,B
11A,B,C
22.80
UP MAIN
DN MAIN
4.75M
24.06
1 IN 12
1 IN 8.5
4.75 M
5.30
1 IN 12
PROP SSP
21M
9.55
24M
24.58
20.0M OVER RUN LINE
SAND HUMP
2.0
5.25
DS
1 IN 8.5 SY
5.30
36M
25M
32M
N.R. LAND BOUNDARY
Concrete Road
To Patti Village
To Fatehi Village
N.R. LAND BOUNDARY
N.R. LAND BOUNDARY
N.R. LAND BOUNDARY
CURVE NO-33(LHS)
Δ= 1°54'47.0"
R = 3431M(0.51°)
Curve No: 1
Delta:1°56'36"
R = 1750.0m
CL=59.36 M
TL= 29.681 M
TP1.CH:1020.291M F/CSB C-32 (UP & DN)
C-7A TP2 . CH:1008.14 M F/CSB
C-7A TP1 . CH:948.79 M F/CSB
R 1 IN 2595 R 1 IN 463
CH:901.00M F/CSB
FL:224.582
UP/DN. LINE
KM.48.309
R 1 IN 2595 R 1 IN 438
CH:901.00M F/CSB
FL:224.582
TP2.CH:867.23M F/CSB C-33(UP & DN)
SRJ 1:8.5 CH:851.89 m. F/CSB
TP1.CH:757.82 M F/CSB C-33 (UP & DN)
SRJ 1 IN12 .CH:729.6 m. F/CSB
FM.CH:669.44m. F/CSB
SRJ 1 IN12 .CH:632.0 m. F/CSB
PROP SSP. CH AT 630.06M F/CSB
DE.CH:579.24m. F/CSB
R 1 IN 463 R 1 IN 1500
CH:602.00 F/CSB
FL:225.228
UP/DN. LINE
KM.48.608
R 1 IN 438
CH:575.00 F/CSB
FL:225.325
SRJ 1:12,CH:459.24m. F/CSB
SRJ 1:12 .CH:452.74m. F/CSB
SRJ 1 IN12 .CH:413.582m. F/CSB
SRJ 1:8.5 /DS.CH:386.72m. F/CSB
FM.CH:377.1m. F/CSB
N

X-OVER DETAILS

X-OVER	TRACK CENTRE	LENGTH OF STRAIGHT	RADIUS OF CONNECT CURVE
1 IN 12	5.30 M	6.616 M	441.0 M
1 IN 12	4.75 M	0.054 M	441.0 M


LEVEL R 1 IN 271
CH:1513 F/CSB
FOR R&D LOOP LINE
R 1 IN 271 R 1 IN 300
CH:1813 F/CSB
FOR R&D LOOP LINE
SRJ 1:12/FM.CH:1601.33m. F/CSB
SRJ 1:12.CH:1698.93m. F/CSB
SRJ 1:8.5,CH:1758.48m. F/CSB
CROSS OVER BETWEEN RD-2 AND RD-3
SRJ 1:8.5CH:1827.53m. F/CSB
DS.CH:1839.4m. F/CSB
DE.CH:1878.48m. F/CSB
SRJ 1:12.CH:1894.74m. F/CSB
SRJ 1:12.CH:1998.53m. F/CSB
Building Under Construction
N.R. LAND BOUNDARY
34.50
38.20
37.05
5.30
5.30
5.3M
1 IN 12
1 IN 12
1 IN 12
5.3M
5.3M
120.0M OVER RUN LINE
120.0M OVER RUN LINE
1 IN 12
1 IN 12
1 IN 12
UP MAIN
DN MAIN
4.75M
4.75M
Trolly
TROLLY
25.0176
N.R. LAND BOUNDARY
BR No-77, AT CH:1603.0 F/CSB
1 x 0.9 mt.(RCC SLAB)
CUT-X (CH:1400)
FM/ SRJ 1:12.CH:1705.38m. F/CSB
SRJ 1:12.CH:1803 m. F/CSB
SRJ 1:8.5 CH:1809.5 m. F/CSB
CROSS OVER BETWEEN RD-3 AND UPML
SRJ 1:12.CH:1907.94m. F/CSB
DE CH:1929.5 m. F/CSB
C/L OF PATLI STATION
AT KM:49.210 (NSG-6)
AT KM:6009 KM F/MANESAR
CSB CH:0.000M
PF END.,CH:144.86m. F/CSB
FOB, CH:118 m. F/CSB
PF END.,CH:185.14m. F/CSB
SRJ 1:8.5,CH:213.9m. F/CSB
DS.CH:265.74m. F/CSB
FM.CH:269.74m. F/CSB
DE.CH:284.00m. F/CSB
SRJ 1:8.5 CH:314.39m. F/CSB
DS/FM.CH:360.00m. F/CSB
SRJ 1 IN 8.5 CH:395.5 m. F/CSB
DS.CH:427.41m. F/CSB
SRJ 1:8.5,CH:448.93m. F/CSB
SRJ 1:12,CH:449.61 m. F/CSB
FM.CH:455.35m. F/CSB
SRJ 1:12.CH:511.85m. F/CSB
DE.CH:524.77m. F/CSB
SRJ 1:12.CH:547.22m. F/CSB
SRJ 1: 1.85,CH:611.00 M. F/CSB
ADANI LOGISTICS PARK
ADANI LOGISTICS PARK
N.R. LAND BOUNDARY
Pump House
IPS Building
12A,B,C
13
14A,B
6.10
TOILET
HIGH LEVEL PASSENGER PLATFORM 330 X 6M
LOW LEVEL PASSENGER PLATFORM 330 X 6M
L-1 COMMON LOOP LINE CSR 705.50 M SRJ TO SRJ
L-2 UP MAIN LINE CSR 758.93 M FM TO FM
L-3 DN MAIN LINE CSR 784.68 M FM TO FM
L-4 DN LOOP LINE CSR 703.76 M FM TO FM
LOW LEVEL PASSENGER PLATFORM 390 X 9.96M
L-5 COMMON LOOP LINE CSR 703.76 M FM TO FM
5.3m
4.75m
5.3m
13.33m
L-1 UP LOOP LINE CSR 658.65 M FM TO FM
L-2 UP MAIN LINE CSR 754.00 M FM TO FM
L-3 DN MAIN LINE CSR 711.01 M FM TO FM
L-4 DN LOOP LINE CSR 711.0 M FM TO FM
HIGH LEVEL PASSENGER PLATFORM 390 X 9.96M
L-5 COMMON GOODS LINE CSR 711.0 M FM TO FM
N.R. LAND BOUNDARY
36.72
23M
25M
33.8
N.R. LAND BOUNDARY
Compound Wall With Fence
C1
1 IN 8.5
1 IN 8.5
Compressor Room
N.R. LAND BOUNDARY
Compound Wall With Fence
78 M SAND HUMP
78 M SAND HUMP
Compound Wall With Fence
HOT AXLE SDG. 75M
DS
1 IN 8.5
1 IN 8.5
1 IN 8.5
1 IN 8.5
1 IN 12
1 IN 12
1 IN 12
1 IN 12
1 IN 12
1 IN 12
SHUNT
UP MAIN
DN MAIN
4.75M
5.30
5.30
120.0M OVER RUN LINE SRJ TO DE
D.E.
CURVE NO-1A
Δ= 4°45'38"
R = 875M(2.0°)
CL:72.372 M
TL=36.372 M
BR No-75, AT CH:224.35 F/CSB
1 x 0.90 mt.(RCC SLAB).
TO BE EXTD.
N.R. LAND BOUNDARY
N.R. LAND BOUNDARY
PF END.,CH:200.00m. F/CSB
C-1A TP1 CH:186.42 M F/CSB
PF END.,CH:190.00m. F/CSB
C-1A TP2 CH:259.04 M F/CSB
FM/DS.CH:326.66 m. F/CSB
FM.CH:333.91m. F/CSB
DS.CH:339.6m. F/CSB
SRJ 1:12, CH:401.08 m. F/CSB
SRJ 1:12,CH:404.47m. F/CSB
SRJ/FM 1:12,CH:407.58 m. F/CSB
SRJ 1:8.5 CH:424.51m. F/CSB
SRJ 1:12,CH:451.55m. F/CSB
SRJ 1:12,CH:505.20 m. F/CSB
DE CH:527.58 M F/CSB
SRJ 1:12,CH:602.81m. F/CSB
SRJ 1:12,CH:615.01m. F/CSB
R 1 IN 1500 LEVEL
CH:2.000 F/CSB
RL:226.300
KM.49.212
(UP & DN)
LEVEL R 1 IN 1350
CH:570.00 F/CSB
RL:226.300
(UP & DN)

TING	LENGTH OF X-OVER
	97.578 M
	91.038 M


R 1 IN 300 F 1 IN 650
CH:2490.00 F/CSB
RL:232.210
(UP & DN)
F 1 IN 650 F 1 IN 300
CH:2890.00 F/CSB
KM.52.100
(UP & DN)
F 1 IN 300 R 1 IN 250
CH:3292.0 F/CSB
KM.52.502
(UP & DN)
R 1 IN 250 R 1 IN 500
CH:3740 F/CSB
KM.52.950
(UP & DN)
R 1 IN 300
CH:2563.48 F/CSB
FOR DEAD END
N.R. LAND BOUNDARY
SHUNTING NECK -724.08M (DE TO DS)
35.0 M
34.0 M
25M
4.75M
UP MAIN
DN MAIN
To Rewari
To JSKA
AT KM: 56.48
DIST: 7.27 KM
LC NO 39 (CLOSED)
ROB PROVIDED AS PER R-3
DE CH:2563.48m. F/CSB
LEVEL R 1 IN 265
CH:680.00 F/CSB
FOR R&D LOOP LINE
DE.CH:622.71m. F/CSB
C-2A TP1 . CH:684.43 M F/CSB
C-2A TP2 . CH:712.88 M F/CSB
FM / SRJ 1:8.5 CH:800.0 m. F/CSB
SRJ 1:12.CH:799.00m. F/CSB
SRJ 1:12.CH:806.5 m. F/CSB
SRJ 1:12.CH:852.0 m. F/CSB
C-4A TP1 . CH:868.44 M F/CSB
FM ,CH:873.0 m. F/CSB
FM ,CH:885.0 m. F/CSB
C-4A TP2 . CH:904.24 M F/CSB
DE.CH:924.00 m. F/CSB
DE.CH:998.39m. F/CSB
ADANI LOGISTICS PARK
16.63
B/V SIDING 75 M.
B/V SIDING
150M SICK LINE
1 IN 8.5
SRJ 1:8.5 CH:1171.21m. F/CSB
SRJ 1:8.5 CH:1210.83m. F/CSB
DS.CH:1222.58m. F/CSB
FM.CH:1228.46m. F/CSB
R 1 IN 265 LEVEL
CH:1308 F/CSB
FOR R&D LOOP LINE
BR No-76A, AT CH:1327.0 F/CSB
1 x 4.0 mt.(RCC BOX).RUB
To Rewari Road
Concrete Road
CUT-X (CH:1400)
HANDLING CUM DESPATCH LINE NO. 3 CAL - 856.82 (SRJ TO SRJ)
HANDLING CUM DESPATCH LINE NO. 2 CAL - 772.98 (SRJ TO DS)
HANDLING CUM DESPATCH LINE NO. 1 CAL - 743.87 (SRJ TO DS)
CURVE NO-2A
Δ= 1°51'47"
R = 875.00 M(2.0°)
CL:28.45 M
Compound Wall With Fence
HOT AXLE 50.0 M
TING NECK 50M
IN 12
120.0M OVER RUN LINE SRJ TO DS
1 IN 12
1 IN 8.5
1 IN 12
4.75
25M
CURVE NO-4A
Δ= 4°40'03"
R = 440.0 M(3.9°)
CL:35.84 M
5.3M
RLY RECE CUM DESPATCH LOOP LINE NO-1B (COMMON LOOP) CSR 728.00 FM TO FM CSR 716.00 FM TO FM
RLY RECE CUM DESPATCH COMMON LOOP LINE NO-1A CSR 728 M FM TO FM CSR 716.00 FM TO FM
RLY RECE CUM DESPATCH COMMON LOOP LINE NO-1C CSR 905.38 M (FM-FM)
7.619
26M
3.50 M
6.0
18.00
PATLI SSP UNDER CONST.
CURVE NO-3A
Δ= 0°44'59"
R = 3500 M(0.5°)
CL:45.80 M
CURVE NO-5A
Δ= 0°50'4"
R = 3500 M(0.5°)
CL:50.97 M
N.R. LAND BOUNDARY
1 IN 8.5
5.3M
5.30
27.64
33.41
25M
Gang Rest Room
BR No-76, AT CH:863.61 F/CSB
1 x 0.90 mt.(RCC SLAB).
DS.CH:672.71m. F/CSB
SRJ 1:12 .CH:712.63 F/CSB
SRJ 1:12 CH:719.13 F/CSB
SRJ 1:12.CH:792.71m. F/CSB
C-3A TP1 . CH:803.60 M F/CSB
FM CH:815.56 m. F/CSB
C-3A TP2 . CH:849.39 M F/CSB
C-5A TP1 . CH:887.18 M F/CSB
C-5A TP2 . CH:916.02 M F/CSB
R 1 IN 1350 R 1 IN 302.5
CH:680.00 F/CSB
RL:226.574
(UP & DN)
R 1 IN 302.5 R 1 IN 572
CH:824.00 F/CSB
RL:227.050
(UP & DN)
R 1 IN 572 R 1 IN 300
CH:1070 F/CSB
RL:227.480
(UP & DN)
SRJ 1:8.5 CH:1122.06m. F/CSB
SRJ 1:8.5 CH:1171.28m. F/CSB
SRJ 1:8.5 CH:1283.46m. F/CSB

LEGEND	
EXISTING LINE	━━━
PROPOSED LINE	🟥
EXISTING LINE TO BE DISMANTLED	🟩
RLY. BOUNDARY	── · ──
OHE PORTAL	☒- - - -☒
TEMPORARY STRUCTURE	☐
PERMANENT STRUCTURE	▨
HORC MAIN LINE	─

LEGEND	
NAME BOARD	I
TP	⧗ ⧗
PT	⚲ ⚲
HAND PUMP(H.P)	↑
WIRE FENCE	─•─•─
DS, DE	⚲ [
OHE	☒
LAND TO BE REQUIRED	▨

NOTES :-

1. ALL CHAINAGES ARE TAKEN FROM C.L OF PATLI STATION BUILDING AS 0.00 M .
2. ALL CHAINAGES AND LEVELS ARE IN METRES.
3. THIS DRAWING IS PREPARED BASED ON DATA COLLECTED FROM SITE & WILL SUPERCEDE DRG. NO N.R.H.Q.E PLAN NO DLI/14/03-2007/R-3 (APPROVED ON 21.12.2018).ALL EXISTING DETAILS ARE AS PER EXISTING SITE FEATURES AND CONDITIONS.REQUIREMENT OF CON-DONATION FROM CRS FOR GRADIENT LESS THAN 1 IN 400 HAS BEEN MENTIONED ON NOTE NO 16 OF EARLIER APPROVED ESP AND GRADIENTS ARE NOT BEING CHANGED.
4. TRACK CIRCUIT FIT FOR PSC SLEEPERS SHALL BE PROVIDED THROUGH OUT THE YARD INCLUDING 400 M FROM OUTER MOST PT ON EITHER END WITH GLUED INSULATED JOINTS AS REQUIRED BY THE S&T DEPT.
5. RULLING GRADIENT OF EXISTING IR LINE IS 1 IN 200 AND HORC LINE IS 1 IN 150.
6. STAGGERED GLUED JOINTS ARE TO BE PROVIDED FOR TOKEN LESS BLOCK WORKING SYSTEM.
7. LONG PSC SLEEPERS ARE TO BE PROVIDED FOR P&C TO FIX PT MACHINE.
8. TRACK STRUCTURE OF ALL NEW / REPLACEMENT OF LINES SHALL BE OF 60 KG RAILS ON 60 KG PSC SLEEPERS AND WITH SLEEPER DENSITY FOR MAIN LINE 1660 Nos/Km.BALLAST CUSHION 350 MM & FOR LOOP LINE 1540 Nos/Km. BALLAST CUSHION 250 MM.
9. PRECAUTION OF OFC / SIGNALING CABLES SHOULD BE TAKEN DURING EXECUTION OF WORK.
10. OHE MASTS SHALL NOT BE LOCATED IN BETWEEN TRACKS WHEREVER TRACK CENTER IS LESS THAN 5.30 M .
11. EXISTING PASSENGER AMENITIES ARE TO BE MAINTAINED.
12. ALL EXISTING BRIDGES LEVEL CROSSINGS & OTHER STRUCTURES ARE EXACTLY AS PER FIELD SURVEY & ACCORDINGLY CHAINAGES ARE CORRECTED FROM CENTRE OF STATION BUILDING.
13. ALL LT/HT OVER HEAD/UNDERGROUND POWER LINE CROSSINGS ARE TO BE MODIFIED AS PER THE REGULATION FOR ELECT.TRACK CROSSING - 1987 WHERE EVER REQUIRED.
14. THIS MODIFICATION IN REVISION -3 IS DONE DUE TO CONSTRUCTION OF HORC TWO CONNECTING LINES AT DELHI END IS PROPOSED WHICH WILL BE CONECTED TO HORC LINE AT MANESAR & NEW PATLI STATION OF HORC.
15. RAILWAY BOUNDARY SHOWN IN THE ESP SHOULD NOT BE REFERRED FOR ISSUE / DISPUTES RELATED TO LAND.N.R BOUNDARY IS AS PER LAND PLAN WITH RESTORATION LABLE IS ***DD01262 AND DD01263.***
16. THERE IS REQUIREMENT OF EXTENSION OF BRIDGES FALLING IN THIS YARD.
17. ONE HOT AXLE SIDING IS THERE IN LINE NO1 (COMMON LOOP) AND ITS RELOCATION & MERGING WITH SHUNTING NECK IS PROPOSED TO INCREASE CSR OF LINE NO 1.
18. NOMENCLATURE OF COMMON GOODS LINE TO BE CHANGED AS COMMON LOOP LINE.
19. LEVEL CROSSING NO. 35 AND 36 CLOSED DUE TO CONSTRUCTION OF LHS AT KM 45.925 AND 47.402 RESPECTIVELY.
20. ***WORK SANCTIONED VIDE RAILWAY BOARD LETTER NO.2019/JV-CELL/HARYANA/PROJECT/06 DATED, 21.10.2020 & LETTER EVEN NO DATED.29.10.2020. (***PINK BOOK 2022-23 ITEM NO.1194)
21. ***PROVISION OF 6.1 M WIDE FOB(ref: SHORTLISTED DELHI DIVISION ESTIMATE NO.53),RAISING OF PLATFORM TO HIGH LEVEL (ref:PROPOSED DELHI DIVISION PLAN HEAD 53),SAND HUMP& OVERRUN ISOLATION FOR LINE NO 4&5 AT DLI &RE END RESPECTIVELY AND 3rd R&D LINE WILL BE EXECUTED BY DIVISION'S.***
22. TRACK MACHINE SIDING IS PROVIDED AT MANESAR STATION ON HORC LINE AT ABOUT 6.0 KM AWAY.

NORTHERN RAILWAY	
DRM-DLI	
ADRM-INFRA-DLI	
SRDEN-CO-DLI	
SRDOM- DLI	
SRDSTE-DLI	
SRDEE-TRD-DLI	
SRDEN-5-DLI	
ADEN-DEE	
SSE-PWAY-GGN	
SSE-W-GGN	

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
AJAY VIJAYVARGIYA DPD/EST		DGM/S&T	
KRISHAN CHAND SAINSI CRE/CIVIL		DGM/Elect.	
AMARNATH SINGH CRE/S&T			

NORTHERN RAILWAY
DELHI DIVISION

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

SIGN

RITES THE INFRASTRUCTURE PEOPLE

SMEC Member of the Surbana Jurong Group

GC/HORC DRG. NO:-	GC-HRIDC-C2-DRW-ALN-ESP-001-A0
DRAWING NAME	ESP OF PATLI STATION
N.R.H.Q.E.(P) PLAN NO:	
DIVISION PLAN NO :	Y-4/PT/DLI/2022
SCALE	1:1000 1MM:1METRE
SMC DRG. NO:-	SMC/HRIDC/PS/ESP/2 (R-5)
CONSULTANT:	S.M. CONSULTANTS An ISO 9001 Company Bhubaneswar / Balasore / Secunderabad / South Andaman / New Delhi Web : www.smcindia.com , E-Mail : support@smcindia.com
DRAWN BY:- R.DAS	CHECKED BY:- A. A SAMANT

S. M. CONSULTANTS BHUBANESWAR

A. A. SAMANT
PROJECT INCHARGE

RELEASED FOR ☐ PRELIMINARY FOR APPROVAL ☑ TENDER ☐ CONSTRUCTION

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	PROW PROW
EXPRESSWAY BOUNDARY	ROW ROW
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	

F/CSB-FROM CENTER LINE OF STN BLDG	RH - RIGHT HANDED
TP1 & TP2 - TANGENT POINT	LH - LEFT HANDED
R - RADIUS	FM - FOULING MARK
CCL - CIRCULAR CURVE LENGTH	SRJ - STOCK RAIL JOINT
TL - TANGENT LENGTH	TS - TRAP SWITCH
TR - TRANSITION LENGTH	DE - DEAD END
SE - SUPERELEVATION	Rr - RESULTANT RADIUS
Δ - DEFLECTION ANGLE	D - DEGREE OF CURVE
CSR - CLEAR STANDING ROOM	RH - RELAY HUT
SSP - SUB SECTIONING & PARALLING POST	

NOTE:

1. ALL DIMENSIONS ARE SHOWN IN METRES.
2. CH:0.00 IS RECKONED FOR C.L OF STATION BUILDING.
3. EXISTING WORK SHOWN IN BLACK.
4. PROPOSED WORK SHOWN IN RED.
6. ISOLATION WILL BE PROVIDED AS PER STD .IIR.
7. STD IIR ELECTRONIC INTERLOCKING WITH MACL SIGNALLING WILL BE PROVIDED.
8. ALL POINTS AND CROSSINGS ARE TO BE PROVIDED WITH FAN SHAPED CURVED SWITCHES ON CONCRETE SLEEPER .
9. CHAINAGES ARE RECKONED FROM C.L OF PIRTHALA STATION
10. RULING GRADIENT FOR THIS SECTION IS 1 IN 150 COMPENSATED

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

NORTHERN RAILWAY	
DRM-DLI	
ADRM-INFRA-DLI	
SRDEN-CO-DLI	
SRDOM- DLI	
SRDSTE-DLI	
SRDEE-TRD-DLI	
SRDEN-5-DLI	
ADEN-DEE	
SSE-PWAY-GGN	
SSE-W-GGN	
NR.DIVL FILE NO.	
NR.DIVL PLAN NO.	
NRHQ CASE NO.	
NRHQ PLAN NO.	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

CSR DETAILS FOR SULTANPUR KALIAWAS YARD						
LINE NO	LINE NOTATION	START (F/CSB)		END (F/CSB)		TOTAL LENGTH OF CSR (m)
LINE NO-1	LOOP LINE	SRJ	320.2170	SRJ	419.7030	826.2610
LINE NO-2	MAIN LINE	FM	320.2170	FM	419.7830	826.2610

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD	[signature]	SHIV OM DWIVEDI CPM/HRIDC	[signature]
SUDHIR AGRAWAL DPD/CIVIL	[signature]	UMA.M.RAO DGM/C-1	[signature]
AJAY VIJAYVARGIYA DPD/EST		DGM/S&T	
KRISHAN CHAND SAINSI CRE/CIVIL	[signature]	DGM/Elect.	
AMARNATH SINGH CRE/S&T	[signature]		

GC DRG.NO. GC-HRID-C2-DRW-ALN-ESP-003_A0

TITLE : ENGINEERING SCALE PLAN
SULTANPUR KALIAWAS JUNCTION
CH:3674.74m F/BADSA KM:6/375

CONSULTANTS : aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
MANISHA (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/RLY/2245/HRIDC/ESP-07/REV-3	SHEET No. 1	
SCALE : 1:1000	ISSUED Dt: 26.11.2019	REV Dt: 25-06-2022

ANNEXURE-VII(D2)

RHS			
From Ch	To Ch	Height of Retaining wall(m)	Length (m)
55720.00	56160.00	6.75	440.00
56160.00	56920.00	6.00	760.00
56920.00	57300.00	3.75	380.00
59940.00	60102.00	2.25	162.00
60264.00	60462.00	3.00	198.00
60482.00	60665.00	3.75	183.00
60665.00	61178.00	5.75	513.00

LEGEND:

- EXISTING RAILWAY TRACK.
- PROPOSED UP & DN LINE DETAILS
- DISMANTLING WORKS
- DFCC PROPOSALS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- FENCE
- DFCC RAILWAY BOUNDARY
- PRO.HORC BOUNDARY
- TUNNEL VAIDUCT BOUNDARY
- EXPRESSWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND

LEGEND FOR PROFILE :

- PROPOSED RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 6.00m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed

- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

A P P R O V E D

DRM/NR/DLI		CGE/NR/DLI	
SR. DEN/(CO.ORD.)/NR/DLI.		CTPM/NR/DLI	
SR. DEN/NR/DLI		CE/P&D/NR/DLI	
SR. DSTE/NR/DLI		CEE/TRD/NR/DLI	
SR.DEE/TRD/NR/DLI		CEE/G/NR/DLI	
SR.DEE/G/NR/DLI		CSTE/NR/DLI	
SR.DCM/NR/DLI		CCM/NR/DLI	
DIVN. OFFICER'S APPROVAL		H.Q. OFFICER'S APPROVAL	

DIVN. DWG.No.
भाग आरेख संख्या

H.Q. DWG.No.
मुख्यालय आरेख संख्या

M/s.HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

M/S. AARVEE ASSOCIATES ARCHITECTS ENGINEERS & CONSULTANTS PVT LTD

CONNECTING RAILWAY : संयोजक रेल्वे — NORTHERN RAILWAY उत्तरी रेल्वे

HEAD QUARTERS: NEW DELHI नई दिल्ली

CLIENT : मुख्य कर्ता : HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED. हरयाणा रेल इन्फ्रास्ट्रक्चर विकास निगम लिमिटेड

PROJECT : परियोजना : HARYANA ORBITAL RAIL CORRIDOR CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI–PATLI–SULTANPUR–ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

हरयाणा रेल कॉरडोर कनेक्टगि पलवल लकि द्वारा दलि्ली क्षेत्र का चयन करने के लिए असौटी-पटली-सुल्तानपुर-असौद नए वद्यिुतीकरण द्वारा बीजी डबल लाइन

TITLE : शीर्षक : PLAN & LONGITUDINAL SECTION (55.0km TO 60.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

DRG.NO. AA/2245/AL/DR/P&P		SHEET No. 13 OF 26	
SCALE : H-5000 , V-500		ISSUED Dt: 22.06.2019	REV Dt : 19.03.2022
DRAWN BY:	V.SUNITHA (AM CAD)		
DESIGNED BY:	E.SANTHOSH REDDY(AM)		
APPROVED BY:	N.J .RAO (VP)		

ANNEXURE-VII(D2)

RHS			
From Ch	To Ch	Height of Retaining wall(m)	Length (m)
61178.00	61246.00	2.25	68.00
61472.00	61586.00	3.25	114.00
61586.00	61780.00	8.00	194.00
63562.00	63592	1.10	30.00

LEGEND:

EXISTING RAILWAY TRACK.	
PROPOSED UP & DN LINE DETAILS	
DISMANTLING WORKS	
DFCC PROPOSALS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
FENCE	
DFCC RAILWAY BOUNDARY	
PRO.HORC BOUNDARY	
TUNNEL VAIDUCT BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

NOTE:-
1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 6.00m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-
1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

A P P R O V E D

DRM/NR/DLI		CGE/NR/DLI	
SR. DEN/(CO.ORD.)/NR/DLI.		CTPM/NR/DLI	
SR. DEN/NR/DLI		CE/P&D/NR/DLI	
SR. DSTE/NR/DLI		CEE/TRD/NR/DLI	
SR.DEE/TRD/NR/DLI		CEE/G/NR/DLI	
SR.DEE/G/NR/DLI		CSTE/NR/DLI	
SR.DCM/NR/DLI		CCM/NR/DLI	
DIVN. OFFICER'S APPROVAL		H.Q. OFFICER'S APPROVAL	

DIVN. DWG.No.
भाग आरेख संख्या
H.Q. DWG.No.
मुख्यालय आरेख संख्या

M/s.HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

M/S. AARVEE ASSOCIATES ARCHITECTS ENGINEERS & CONSULTANTS PVT LTD

CONNECTING RAILWAY : संयोजक रेल्वे — NORTHERN RAILWAY उत्तरी रेल्वे

HEAD QUARTERS: NEW DELHI नई दिल्ली

CLIENT : मुख्य कर्ता : HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED. हरयाणा रेल इन्फ्रास्ट्रक्चर विकास निगम लिमिटेड

PROJECT : परियोजना : HARYANA ORBITAL RAIL CORRIDOR CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI–PATLI–SULTANPUR–ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

हरयाणा रेल कॉरडोर कनेक्टगि पलवल लकि दुवारा दलि्ली क्षेत्र का चयन करने के लए असौटी-पटली-सुल्तानपुर-असौद नए वदि्युतीकरण दुवारा बीजी डबल लाइन

TITLE : शीर्षक : PLAN & LONGITUDINAL SECTION (60.0km TO 65.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

DRG.NO. AA/2245/AL/DR/P&P		SHEET No. 14 OF 26	
SCALE : H-5000 , V-500		ISSUED Dt: 22.06.2019	REV Dt : 19.03.2022
DRAWN BY:	V.SUNITHA (AM CAD)		
DESIGNED BY:	E.SANTHOSH REDDY(AM)		
APPROVED BY:	N.J .RAO (VP)		

LEGEND:

- EXISTING RAILWAY TRACK.
- PROPOSED UP & DN LINE DETAILS
- EXISTING DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- FENCE
- EXISTING RAILWAY BOUNDARY
- PROPOSED RAILWAY BOUNDARY
- TUNNEL VAIDUCT BOUNDARY
- EXPRESSWAY BOUNDARY
- PROPOSED RETAINING WALL.
- PROPOSED TOE LINE
- PROPOSED FORMATION
- HT LINE / LT LINE
- STREAM / CANAL / DRAIN
- WELL
- POND

NOTE:-

1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE STATED
2. .CH:0.00 FOR CONNECTIVITY LINE IS RECKONED FROM NEW PATLI STATION
3. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
4. TRACK CENTER BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD

I. FOR RAIL CORRIDOR: 160KMPH Speed
- TRACK = 60KG RAILS
- SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- BALLAST CUSHION : 350mm
- ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

A P P R O V E D

DRM/NR/DLI		CGE/NR/DLI	
SR. DEN/(CO.ORD.)/NR/DLI.		CTPM/NR/DLI	
SR. DEN/NR/DLI		CE/P&D/NR/DLI	
SR. DSTE/NR/DLI		CEE/TRD/NR/DLI	
SR.DEE/TRD/NR/DLI		CEE/G/NR/DLI	
SR.DEE/G/NR/DLI		CSTE/NR/DLI	
SR.DCM/NR/DLI		CCM/NR/DLI	
DIVN. OFFICER'S APPROVAL		H.Q. OFFICER'S APPROVAL	

DIVN. DWG.No.
भाग आरेख संख्या

H.Q. DWG.No.
मुख्यालय आरेख संख्या

M/s.HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

M/S. AARVEE ASSOCIATES ARCHITECTS ENGINEERS & CONSULTANTS PVT LTD

CONNECTING RAILWAY : संयोजक रेल्वे
NORTHERN RAILWAY
दक्षिण पुर्व मध्य रेलवे

HEAD QUARTERS:
NEW DELHI
बिलासपुर

CLIENT : मुख्य कर्ता :
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.
छत्तीसगढत्र रेल्वे प्राधिकरण लिमिटेड

PROJECT : परियोजना :
HARYANA ORBITAL RAIL CORRIDOR CONNECING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI–PATLI–SULTANPUR–ASAUDH BY NEW ELECTRIFIED BG DOUBLE LINE

छत्तीसगढ़ राज्य मे, खरसिया से दूर्ग के मध्य नया ब्राड गेज
इलेक्ट्रीफाई रेल्वे लाईन का निर्माण
(एस.ई.सी न्यायिक अधिकार क्षेत्र के अंतर्गत)

TITLE : शीर्षक :
PLAN
CONNECTIVITY TOWARDS FARUKH NAGAR

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: +91-40-23737633; Fax: +91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

DRG.NO.AA/Rly/2245/HRIDC/PLAN&LS/Rev-0	SHEET No. 1 OF 1
SCALE : H-5000 , V-500	ISSUED Dt: 07.07.2021

ANNEXURE-VII(D2)

LONGITUDINAL PROFILE

HORIZONTAL-1:5000, VERTICAL-1:500

LEGEND:

- EXISTING RAILWAY TRACK.
- PROPOSED UP & DN LINE DETAILS
- EXISTING DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- FENCE
- EXISTING RAILWAY BOUNDARY
- PROPOSED RAILWAY BOUNDARY
- TUNNEL VAIDUCT BOUNDARY
- EXPRESSWAY BOUNDARY
- PROPOSED RETAINING WALL.
- PROPOSED TOE LINE
- PROPOSED FORMATION
- HT LINE / LT LINE
- STREAM / CANAL / DRAIN
- WELL
- POND

LEGEND FOR PROFILE :

- EXISTING RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

NOTE:-

1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE STATED
2. .CH:0.00 FOR CONNECTIVITY LINE IS RECKONED FROM NEW PATLI STATION
3. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
4. TRACK CENTER BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD

I. FOR RAIL CORRIDOR: 160KMPH Speed
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- * BALLAST CUSHION : 350mm
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ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

A P P R O V E D

DRM/NR/DLI		CGE/NR/DLI	
SR. DEN/(CO.ORD.)/NR/DLI.		CTPM/NR/DLI	
SR. DEN/NR/DLI		CE/P&D/NR/DLI	
SR. DSTE/NR/DLI		CEE/TRD/NR/DLI	
SR.DEE/TRD/NR/DLI		CEE/G/NR/DLI	
SR.DEE/G/NR/DLI		CSTE/NR/DLI	
SR.DCM/NR/DLI		CCM/NR/DLI	
DIVN. OFFICER'S APPROVAL		H.Q. OFFICER'S APPROVAL	

DIVN. DWG.No.
भाग आरेख संख्या

H.Q. DWG.No.
मुख्यालय आरेख संख्या

M/s.HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. | M/S. AARVEE ASSOCIATES ARCHITECTS ENGINEERS & CONSULTANTS PVT LTD

CONNECTING RAILWAY : संयोजक रेल्वे — *NORTHERN RAILWAY* उत्तरी रेल्वे

HEAD QUARTERS: NEW DELHI नई दिल्ली

CLIENT : मुख्य कर्ता : *HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.* हरयाणा रेल इन्फ्रास्ट्रक्चर विकास निगम लिमिटेड

PROJECT : परियोजना : *HARYANA ORBITAL RAIL CORRIDOR CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI–PATLI–SULTANPUR–ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE*

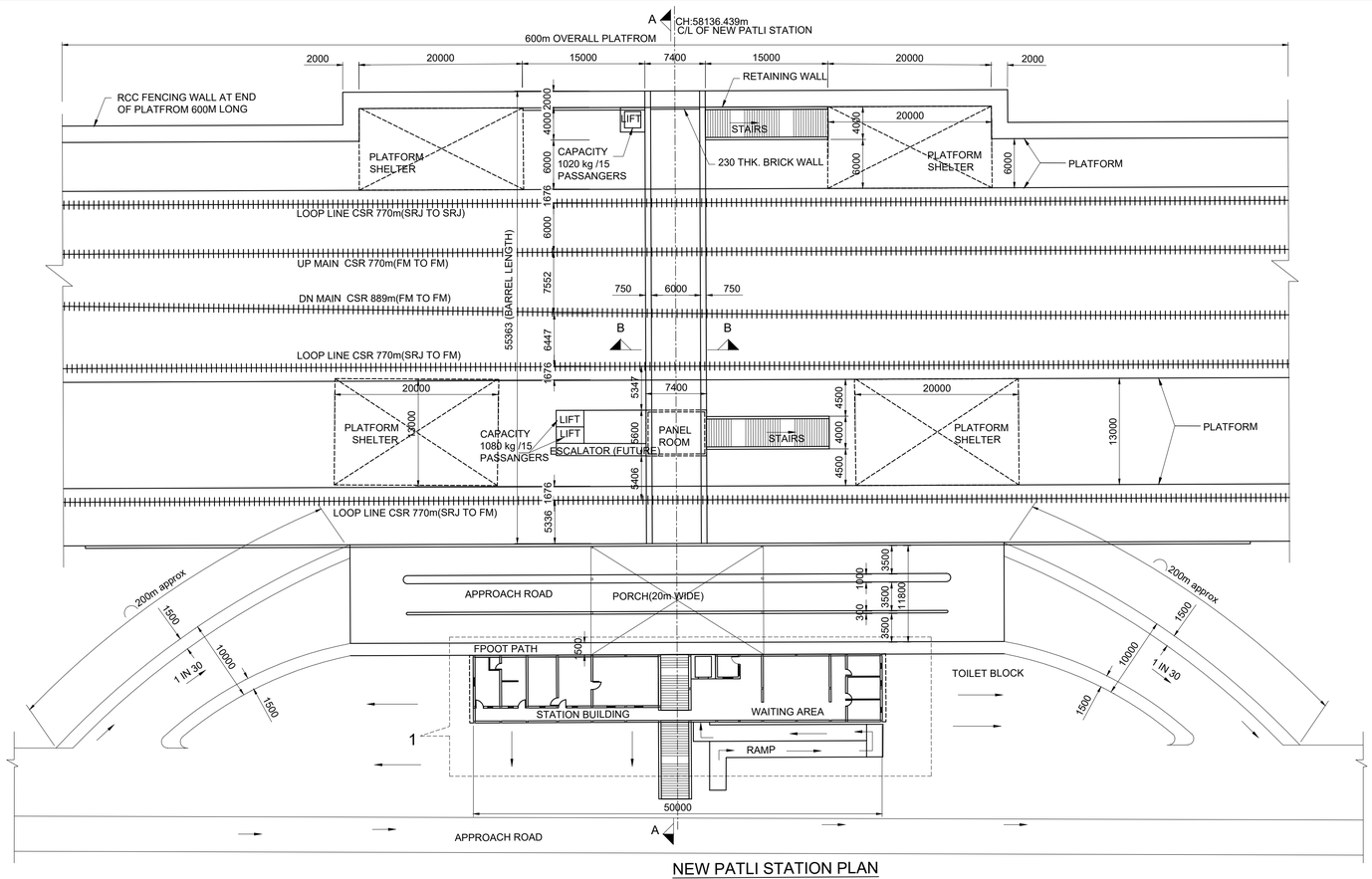
हरयाणा रेल कॉरडोर कनेक्टगि पलवल लकि द्वारा दलि्ली क्षेत्र का चयन करने के लिए असौटी-पटली-सुल्तानपुर-असौंद नए वद्युितीकरण द्वारा बीजी डबल लाइन

TITLE : शीर्षक : *PLAN & LONGITUDINAL SECTION FOR PATLI TO NEW PATLI CONNECTIVITY*

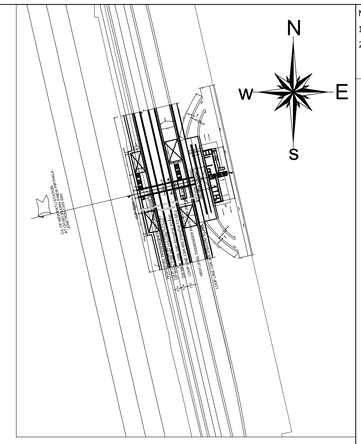
CONSULTANTS : aarvee associates architects engineers & consultants pvt. ltd.

DRG.NO.AA/Rly/2245/HRIDC/PLAN&LS/Rev-0 | SHEET No.3 OF 3

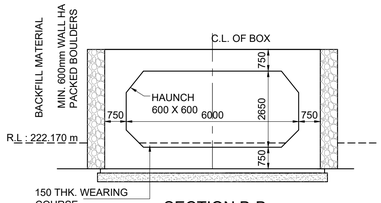
SCALE : H-5000 , V-500 | ISSUED Dt: 22.06.2019



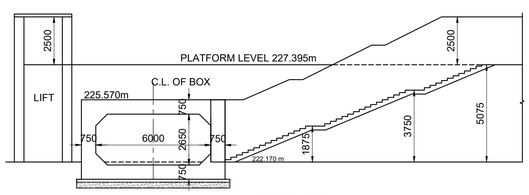
NEW PATLI STATION PLAN
(SCALE 1:350)



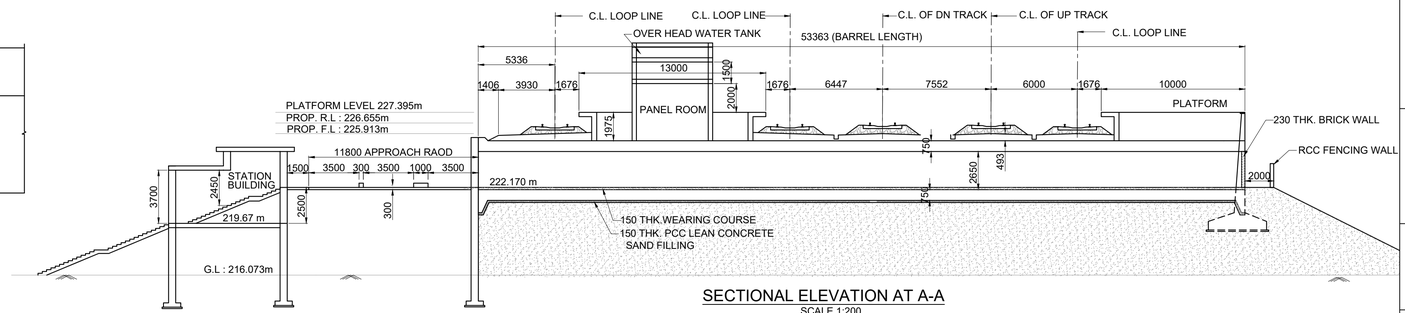
KEY PLAN
SCALE 1:NTS



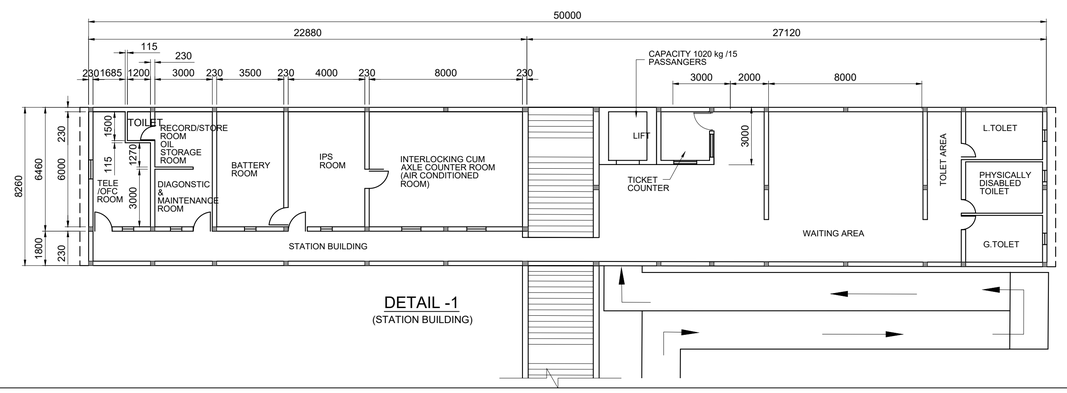
SECTION B-B
SCALE 1:100



SECTION C- C
SCALE 1:150



SECTIONAL ELEVATION AT A-A
SCALE 1:200



DETAIL -1
(STATION BUILDING)

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL LEVEL ARE IN METERS.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		JYOTI SANGWAN DGM/ELECT.	
AMARNATH SINGH CRE/S&T		UMA.M.RAO DGM/C-1	
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

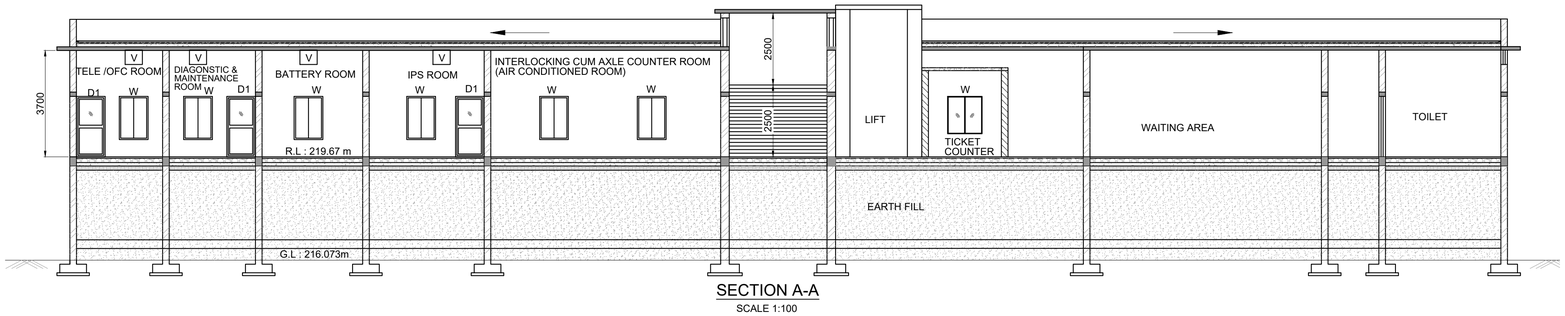
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.
RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

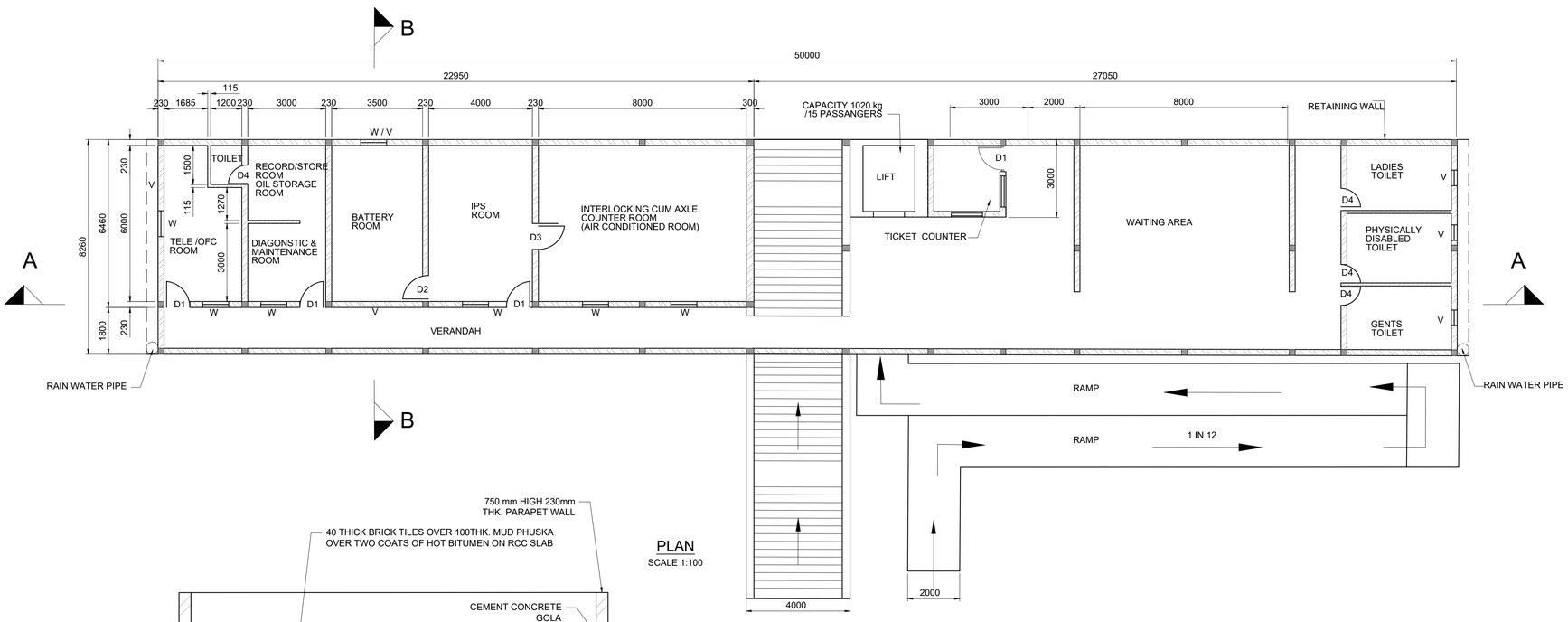
TITLE:-
CONCEPTUALGENERAL ARRANGEMENT DRAWING OF NEW PATLI STATION

DRG. NO.	SHEET NO.
GC-HRIDC-C2-STN1-SAD-001_A0	1 OF 2

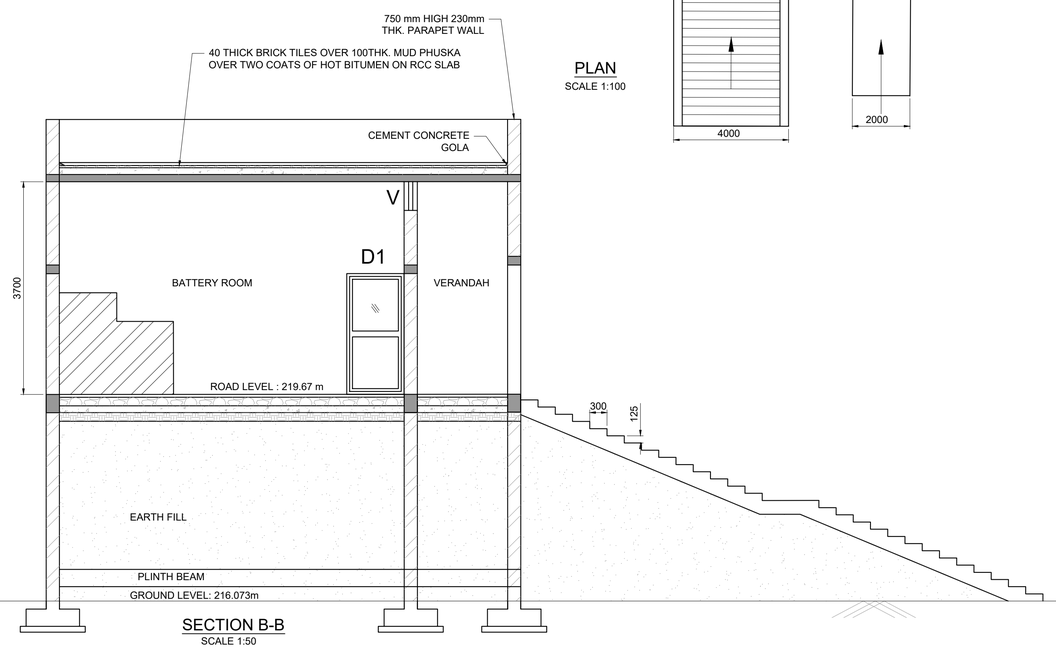
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



SECTION A-A
SCALE 1:100



PLAN
SCALE 1:100



SECTION B-B
SCALE 1:50

SCHEDULE DOOR

D1	1000x2100	FLUSH DOOR WITH MOSQUITO NET
D2	1000x2100	FLUSH DOOR
D3	1000x2100	HALF GLASS SINGLE DOOR WITH DOUBLE LOCKING ARRANGE MENT
D4	750x2100	FLUSH DOOR

SCHEDULE WINDOW

W	1000x1500	GLAZED WITH MOSQUITO NET
V	600X500	

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. ALL WALLS ARE OF 230MM THICK & PARTITION WALLS ARE OF 115MM.
3. ALL INTERNAL & EXTERNAL WALLS SHOULD BE PLASTERED AS PER TECHNICAL SPECIFICATIONS.
4. THE PROPOSED BUILDING PLAN IS BASED OF RDSO DRAWING NO. "SDO/S&T SERVICE BUILDING/001 AMDIT 1".
5. THE LOCATION OF THE BUILDING SHALL BE AS CLOSE TO CENTER OF YARD AS POSSIBLE. THE EXACT LOCATION OF THE BUILDING SHALL BE DECIDED BY CONCERNED ENGINEER .
6. THE FLOOR LEVEL SHALL BE AT LEAST 500 MM ABOVE THE LEVEL OF THE PLATFORM OF THE STATION.
7. THE FLOOR SHALL BE PROVIDED WITH VITRIFIED TILES IN ALL THE ROOMS AND VERANDAH UNLESS OTHERWISE SPECIFIED.
8. THE INTERIOR WALLS AND CEILING SHALL BE COATED WITH PREMIUM ENAMEL PAINT WITH A GLOSSY, DURABLE AND WASHABLE FINISH AS PER CONSTRUCTION SPECIFICATION.
9. FOUNDATIONS TO BE DESIGNED FOR G+1 FLOORS.
10. ASSUME BEARING CAPACITY OF SOIL; 10T/SQ M.
11. R.C.C. PLINTH BAND & LINTEL BAND TO BE PROVIDED IN ALL WALLS.
12. FOR ANY FURTHER DETAIL OF S&T SERVICE BUILDING REFER NR TYPE PLAN NO. O-99/2021 SHEET NO. 1 TO 5.
13. FOR PHYSICALLY HANDICAPPED TOILET REFER DRAWING NO. O-104/2021 SHEET 1 OF 1.
14. SUITABLE ARRANGEMENT FOR SEPTIC TANK & SOAK PIT TO BE PROVIDED FOR DRAINAGE DISCHARGE AND FOR EFFLUENT DISCHARGE REFER SEPARATE DRAINAGE PLAN.
15. TICKET COUNTER REFER DRAWING NO. GC-HRIDC-C2-DRG-SAD-GMD-013_A0 SHEET 1 OF 1.
16. ANY DETAIL WHICH IS NOT COVERED UNDER THE DRAWING REFER THE TECHNICAL SPECIFICATION/ DECIDED BY ENGINEER.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		JYOTI SANGWAN DGM/ELECT.	
AMARNATH SINGH CRE/S&T		UMA.M.RAO DGM/C-1	
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

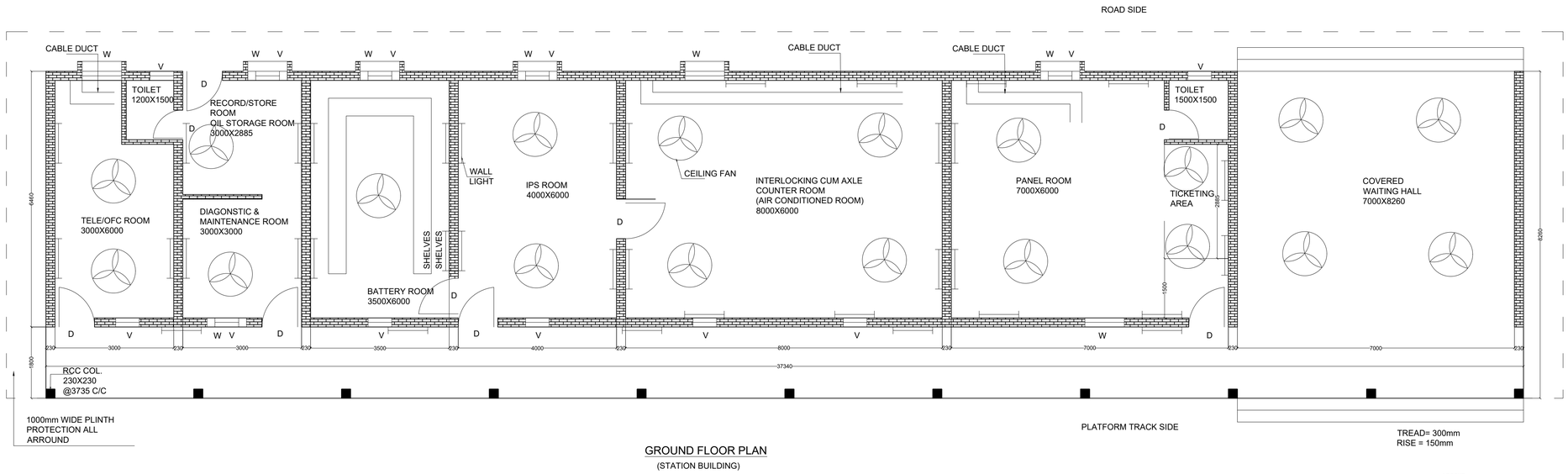
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:-
CONCEPTUALGENERAL ARRANGEMENT DRAWING OF NEW PATLI STATION BUILDING

DRG. NO.	SHEET NO.
GC-HRIDC-C2-STN1-SAD-001_A0	2 OF 2

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



GROUND FLOOR PLAN
(STATION BUILDING)

LEGEND

D- PANELED DOOR
W- WINDOW
V- VENTILATOR

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOR OTHER DETAIL REFER NORTHERN RAILWAY DRAWING S & T SERVICE BUILDING DWG.NO N.R.H.Q.E.PLAN NO.HQ/02/02-2021. SH. 1 OF 5 TO 5 OF 5.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		JYOTI SANGWAN DGM/ELECT.	
AMARNATH SINGH CRE/S&T		UMA.M.RAO DGM/C-1	
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

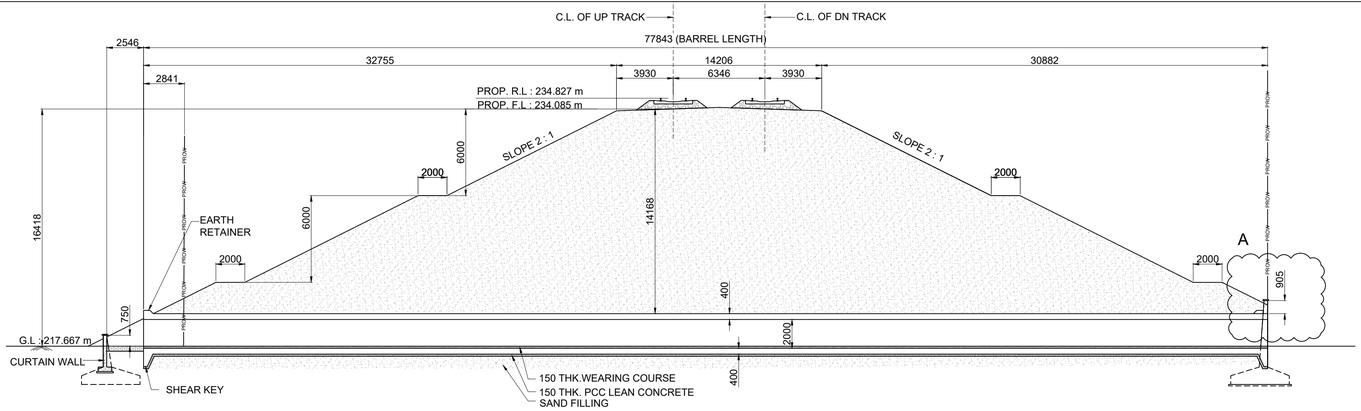
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

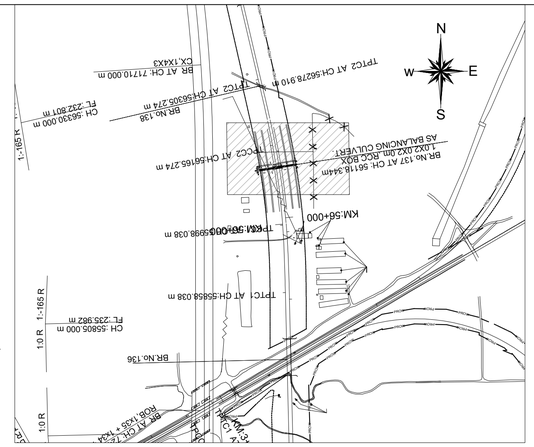
TITLE:-
CONCEPTUALGENERAL ARRANGEMENT DRAWING OF
SULTANPUR STATION BUILDING

DRG. NO.	SHEET NO.
GC-HRIDC-C2-STN2-SAD-001_A0	1 OF 2

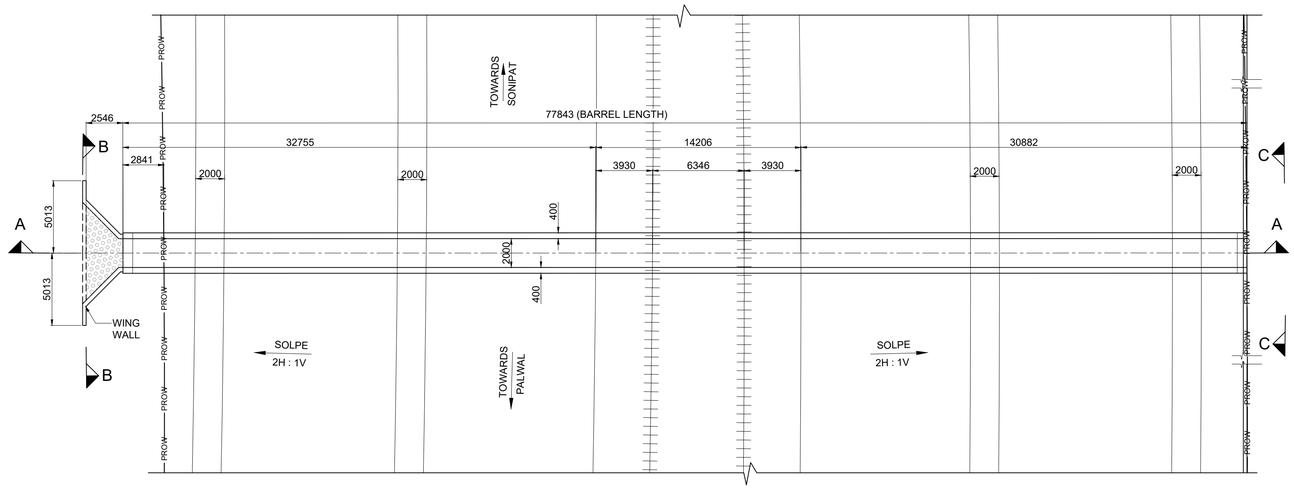
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



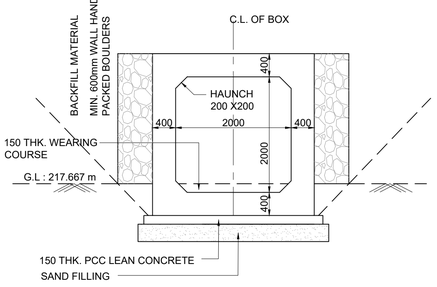
SECTIONAL ELEVATION AT A-A
SCALE 1:200



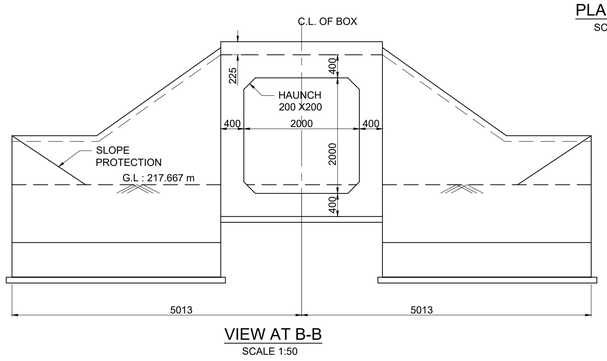
SCALE 1:NTS



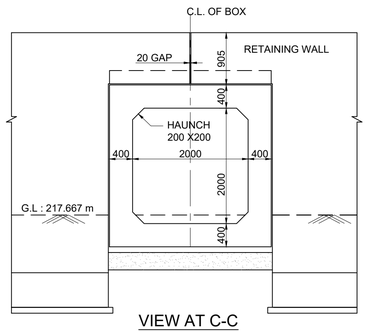
PLAN AT TOP
SCALE 1:200



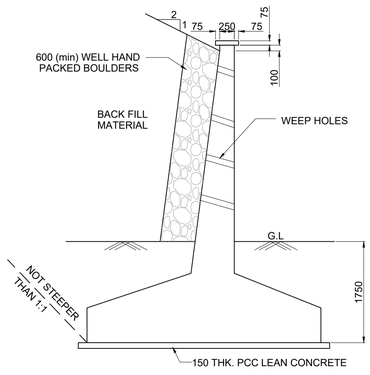
ELEVATION
SCALE 1:50



VIEW AT B-B
SCALE 1:50

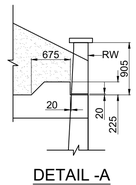


VIEW AT C-C
SCALE 1:50

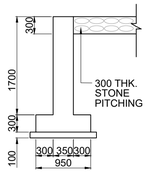


WING WALL (TO BE DESIGN AS PER SITE CONDITION)

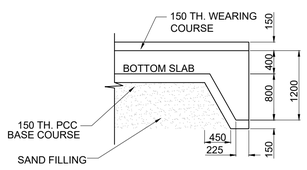
TYPICAL DETAIL OF RETURN WALL / WING WALL
SCALE 1:50



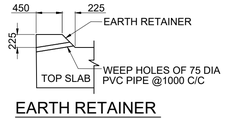
DETAIL -A
SCALE 1:50



DROP / CURTAIN WALL DETAILS
SCALE 1:50



SHEAR KEY
SCALE 1:50



EARTH RETAINER
SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

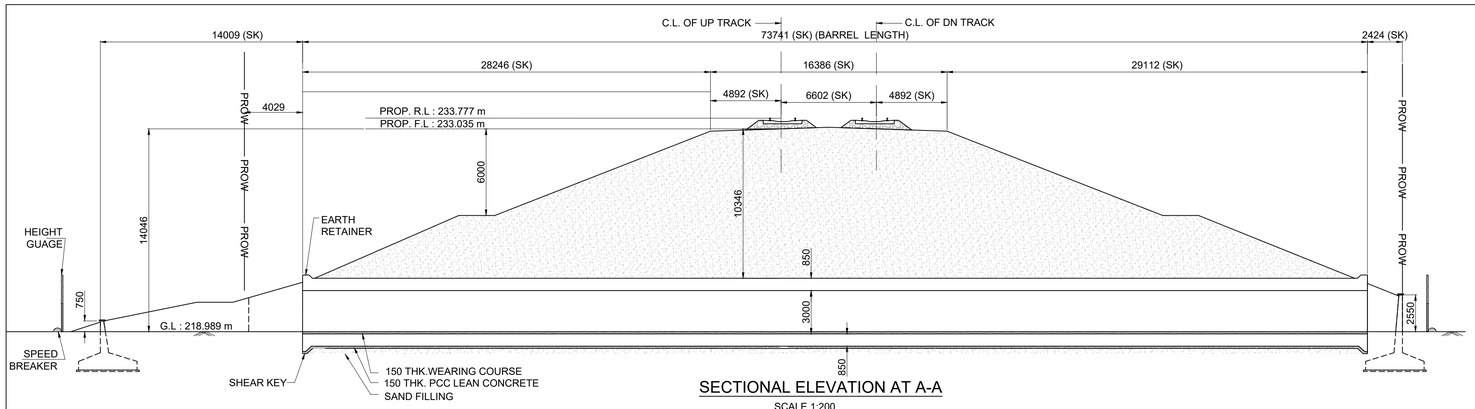
CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING
FOR BALANCING CULVERT BRIDGE NO 137
SPAN 1.0X2.0X2.0 RCC BOX AT CH: 56118.344

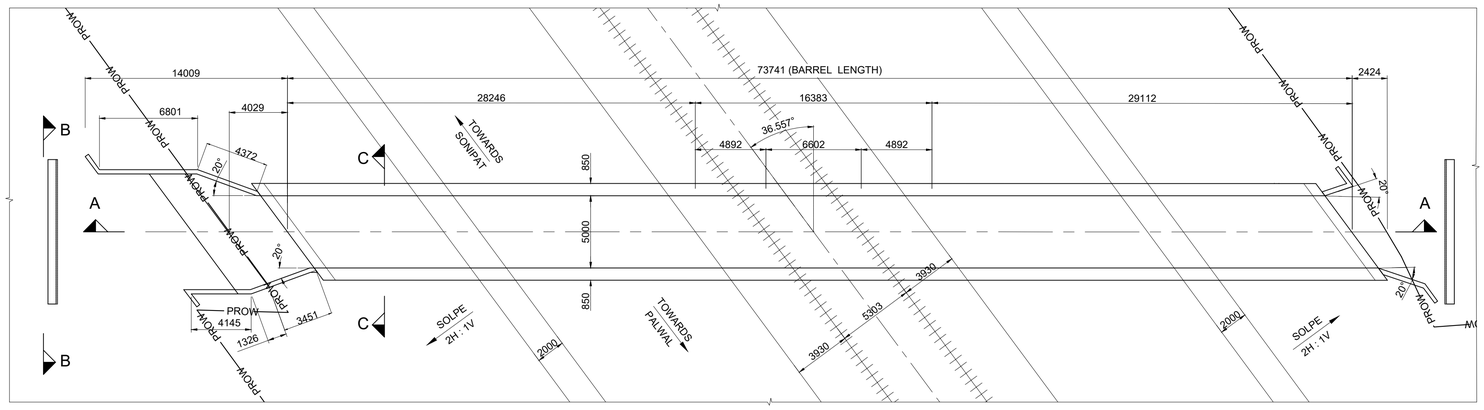
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-137_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



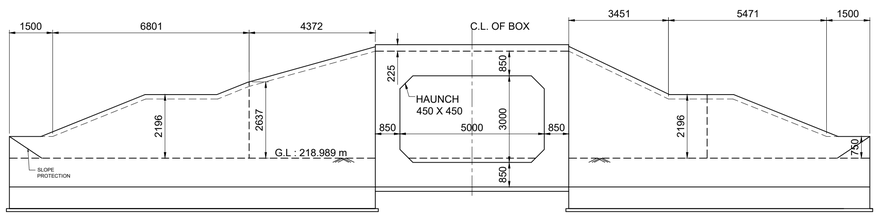
SECTIONAL ELEVATION AT A-A

SCALE 1:200



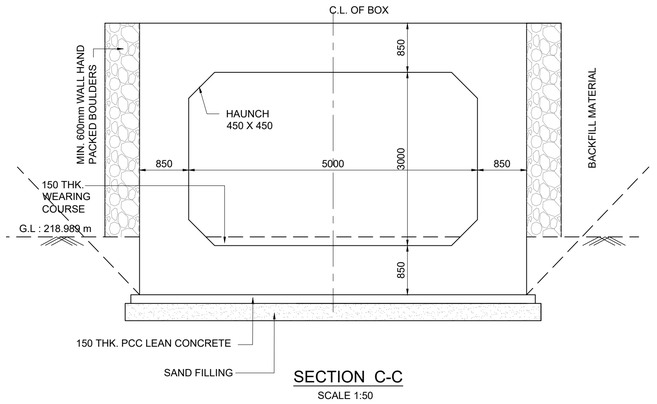
PLAN AT TOP

SCALE 1:200



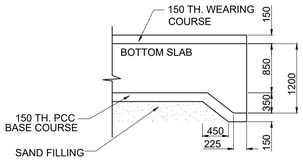
VIEW AT B-B

SCALE 1:50



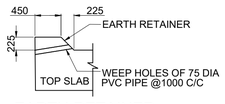
SECTION C-C

SCALE 1:50



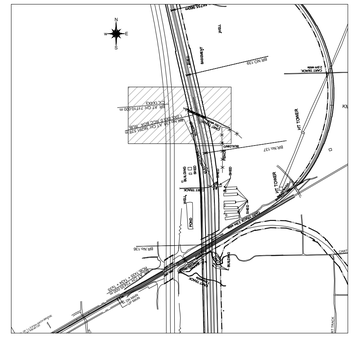
SHEAR KEY

SCALE 1:50



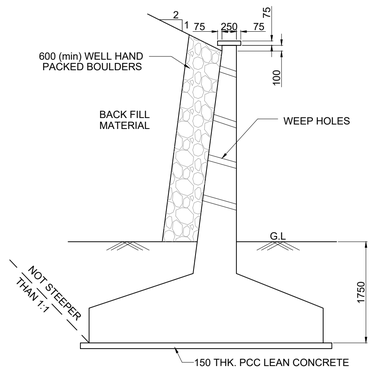
EARTH RETAINER

SCALE 1:50



KEY PLAN

SCALE 1:NTS



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD.
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

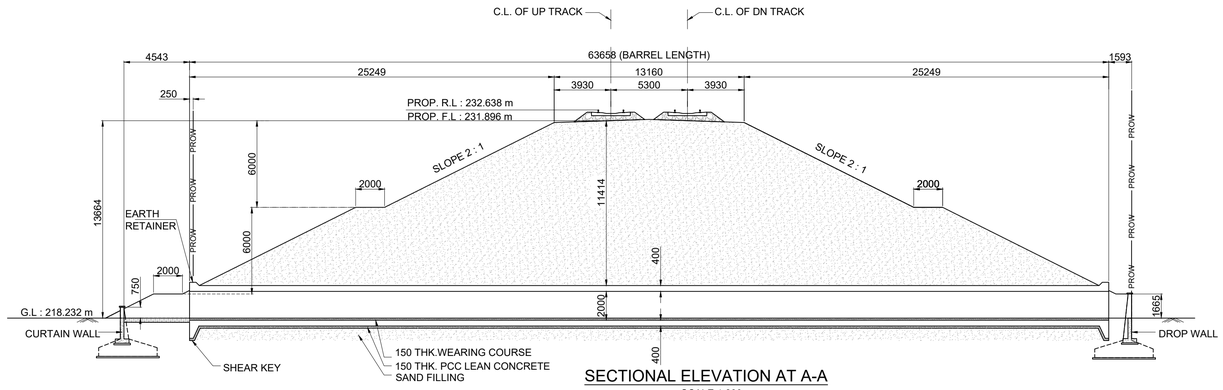
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING
FOR ROAD UNDER BRIDGE NO 138
SPAN 1.0X5.0X3.0 RCC BOX AT CH: 56291.578

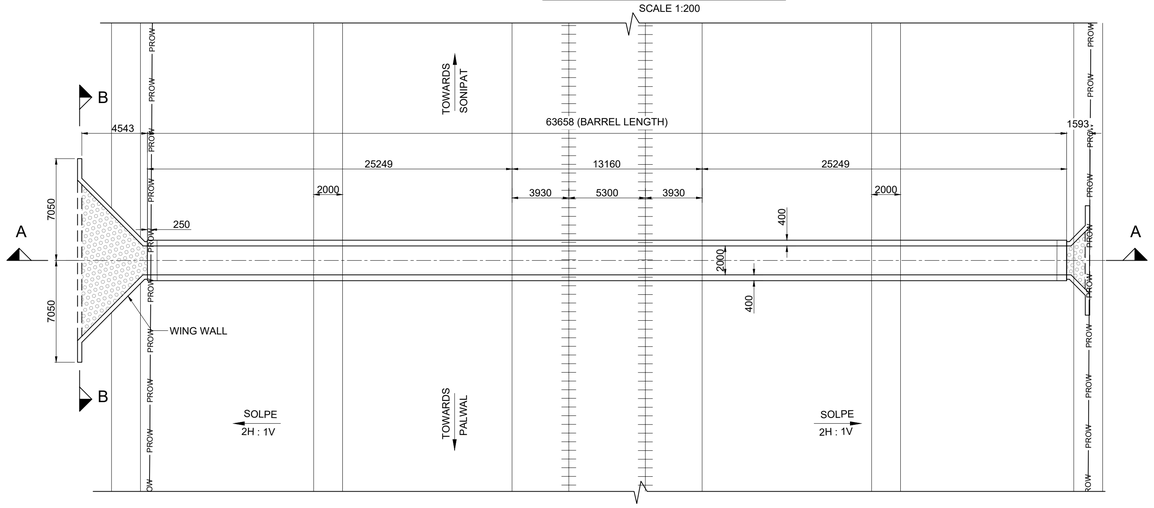
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-138_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



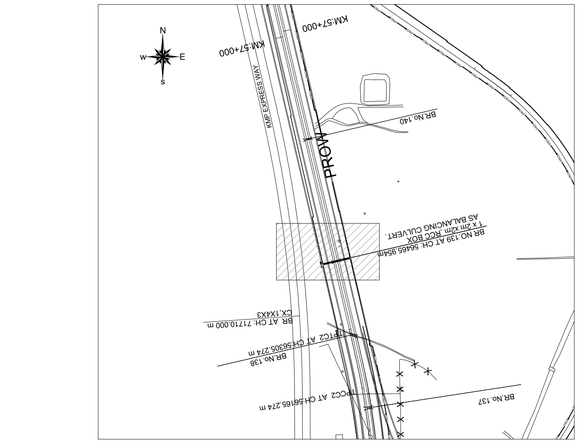
SECTIONAL ELEVATION AT A-A

SCALE 1:200



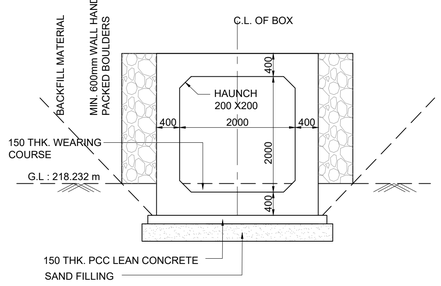
PLAN AT TOP

SCALE 1:200



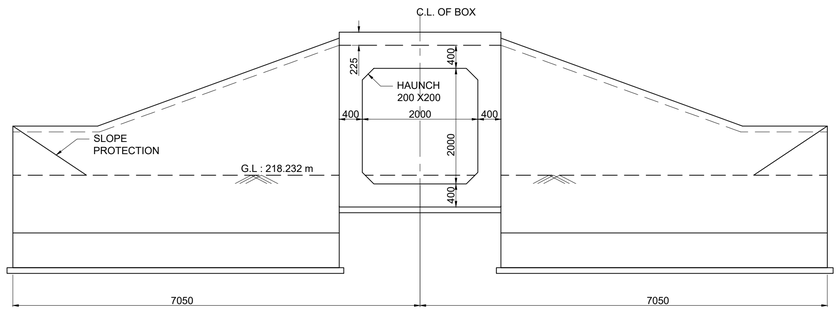
KEY PLAN

SCALE 1:NTS



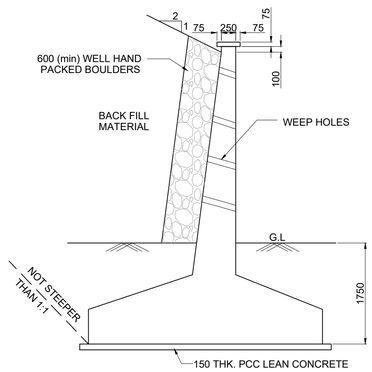
ELEVATION

SCALE 1:50



VIEW AT B-B

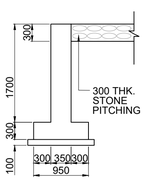
SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

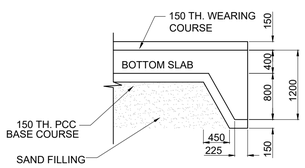
TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50



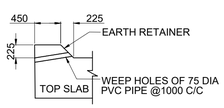
DROP / CURTAIN WALL DETAILS

SCALE 1:50



SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

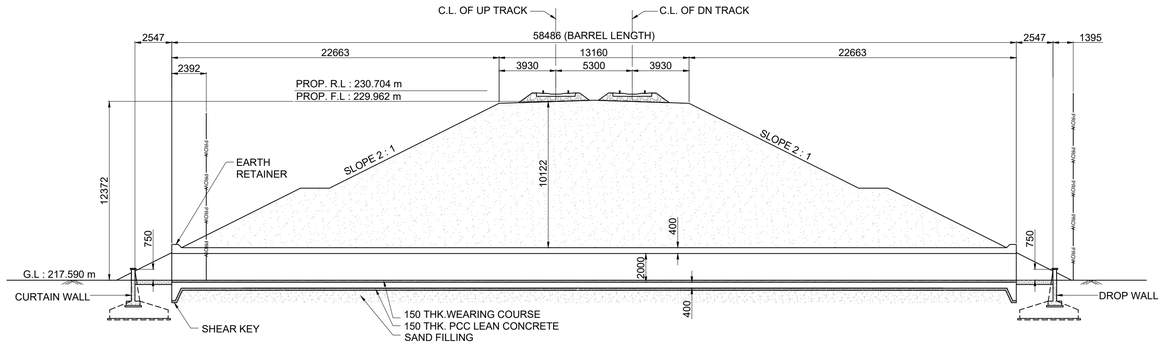
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

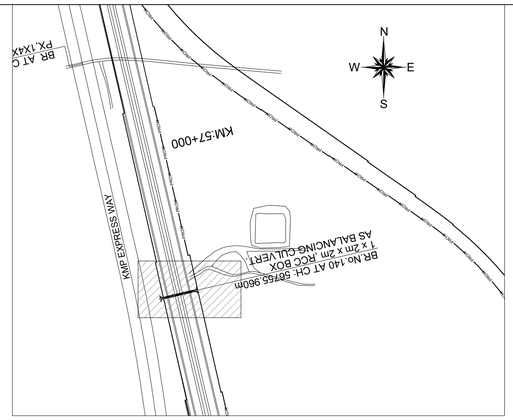
TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING
FOR BALANCING CULVERT BRIDGE NO 139
SPAN 1.0X2.0X2.0 RCC BOX AT CH: 56465.954

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-139_A0	1 OF 1

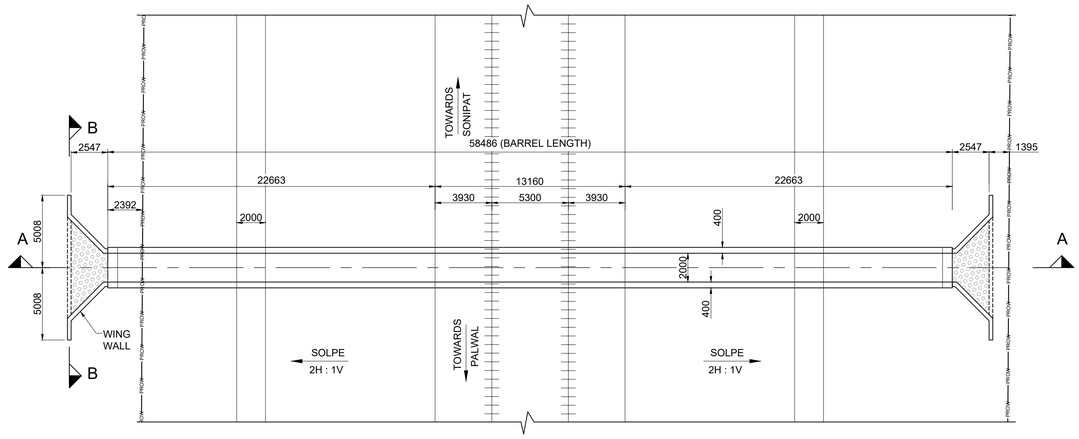
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



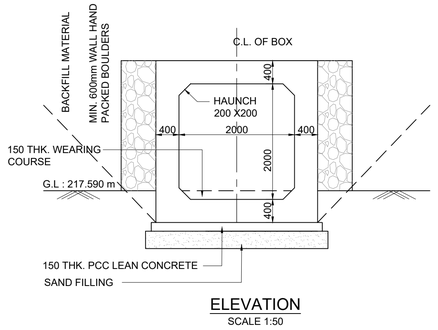
SECTIONAL ELEVATION AT A-A
SCALE 1:200



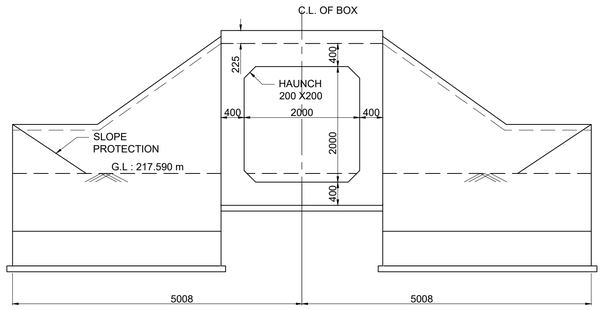
KEY PLAN
SCALE 1:NTS



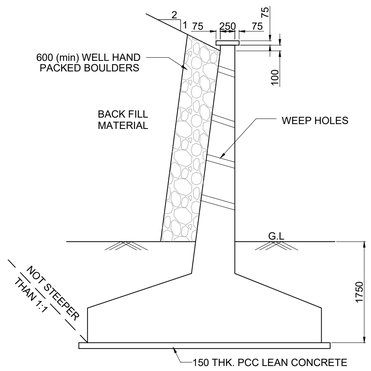
PLAN AT TOP
SCALE 1:200



ELEVATION
SCALE 1:50

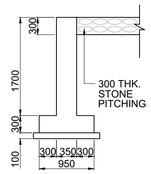


VIEW AT B-B
SCALE 1:50

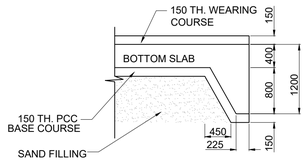


WING WALL (TO BE DESIGN AS PER SITE CONDITION)

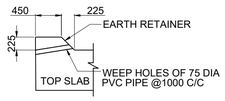
TYPICAL DETAIL OF RETURN WALL / WING WALL
SCALE 1:50



DROP / CURTAIN WALL DETAILS
SCALE 1:50



SHEAR KEY
SCALE 1:50



EARTH RETAINER
SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
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   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
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12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
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LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

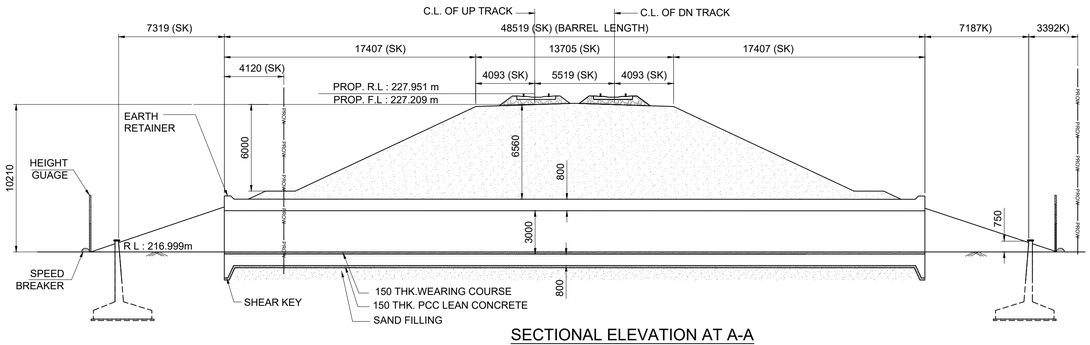
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING
FOR BALANCING CULVERT BRIDGE NO 140
SPAN 1.0X2.0X2.0 RCC BOX AT CH: 56755.960

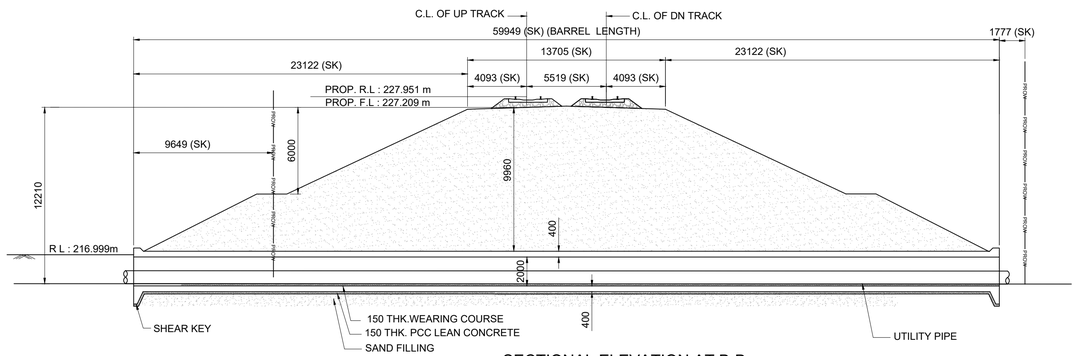
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD-140_A0
SHEET NO. 1 OF 1

SCALE : AS SHOWN
ISSUE DATE
REVISED DATE



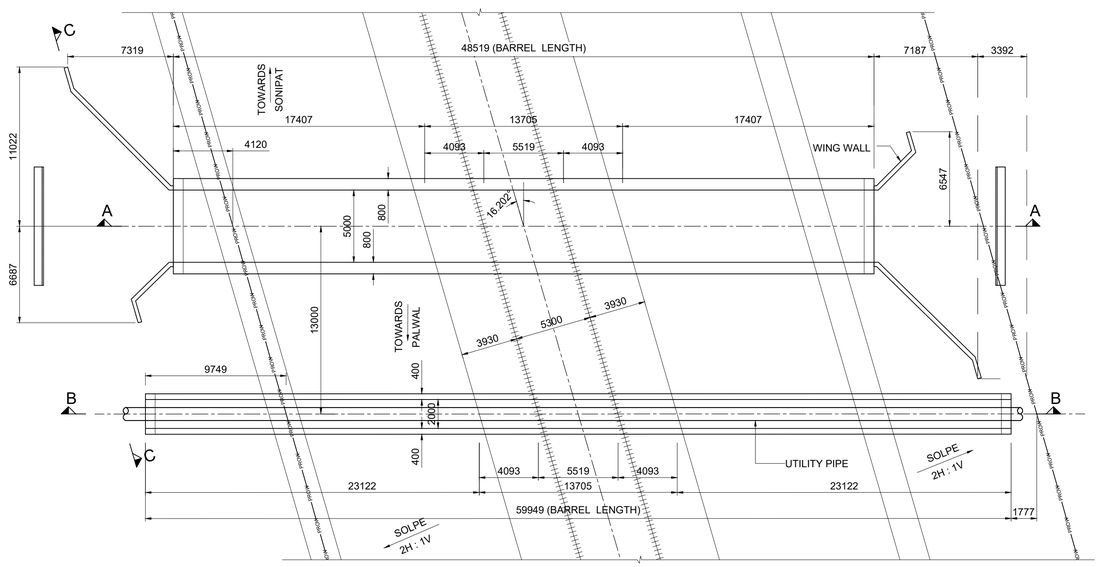
SECTIONAL ELEVATION AT A-A

SCALE 1:200



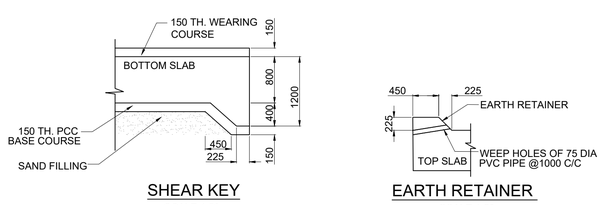
SECTIONAL ELEVATION AT B-B

SCALE 1:200



PLAN AT TOP

SCALE 1:200

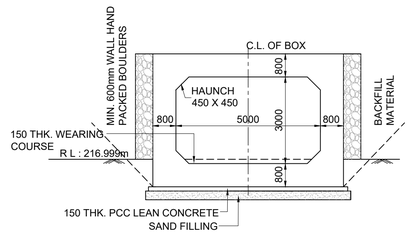


SHEAR KEY

SCALE 1:50

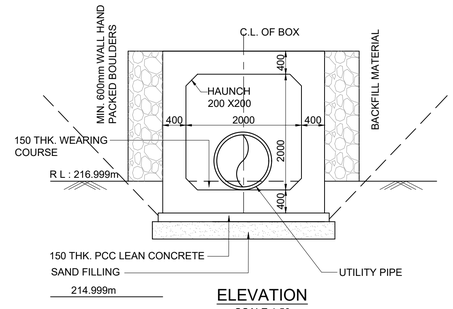
EARTH RETAINER

SCALE 1:50



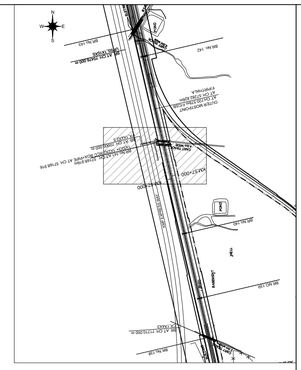
ELEVATION

SCALE 1:100

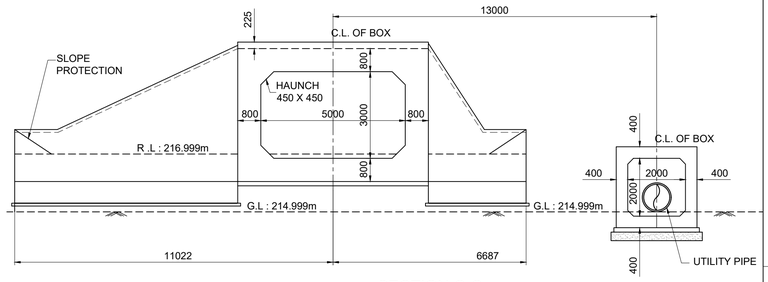


ELEVATION

SCALE 1:50

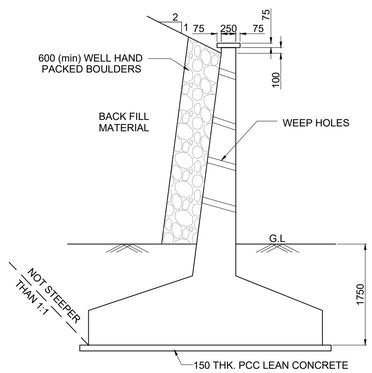


SCALE 1:NTS



SECTION C-C

SCALE 1:100



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
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7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
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11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
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7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
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12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
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15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

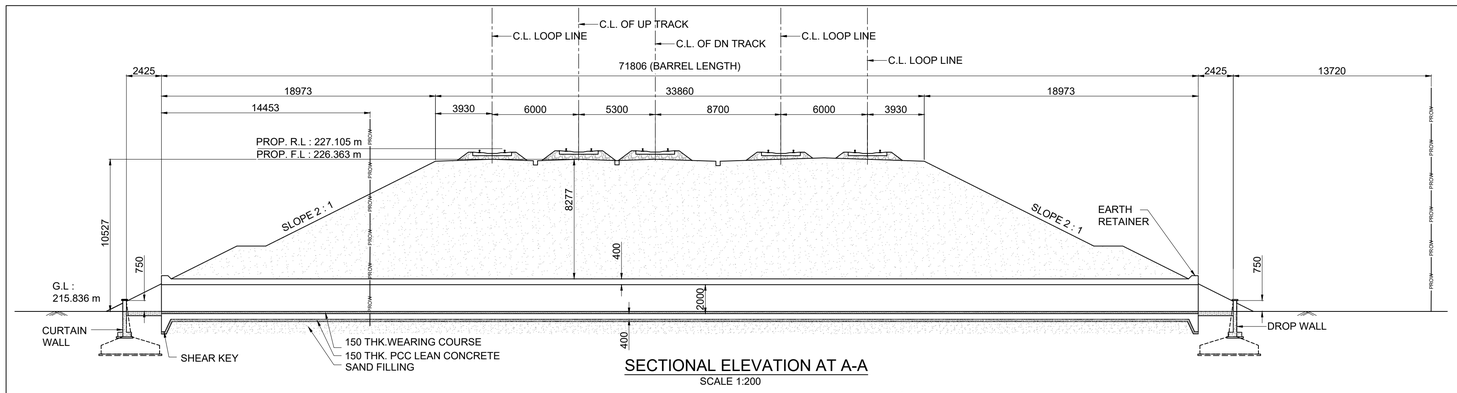
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO 141, 1X5X3+ 1X2X2 RCC BOX+PIPE AT CH. 57168.916

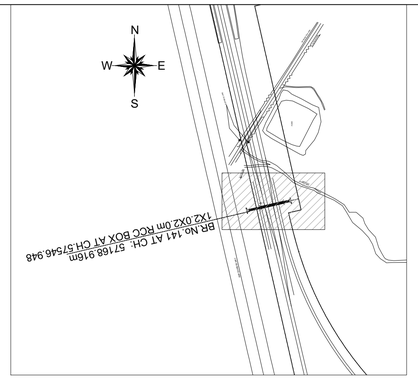
GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-141_A0	1 OF 1

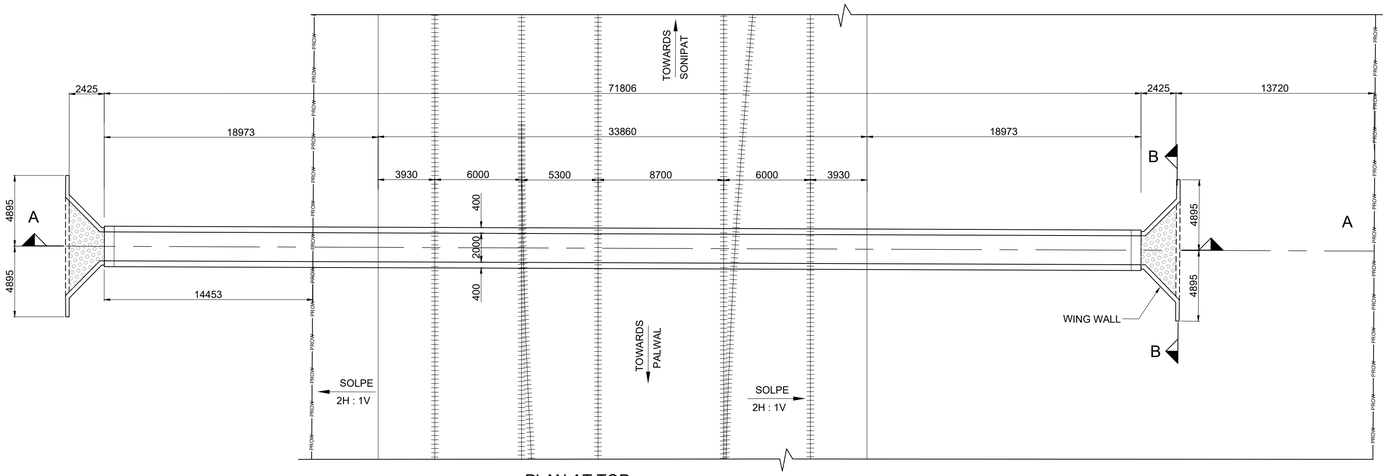
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



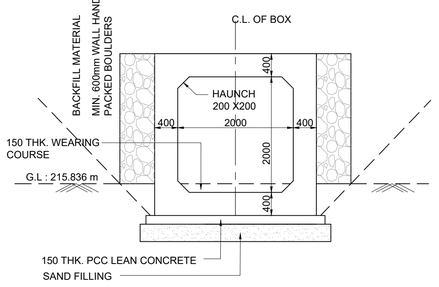
SECTIONAL ELEVATION AT A-A
SCALE 1:200



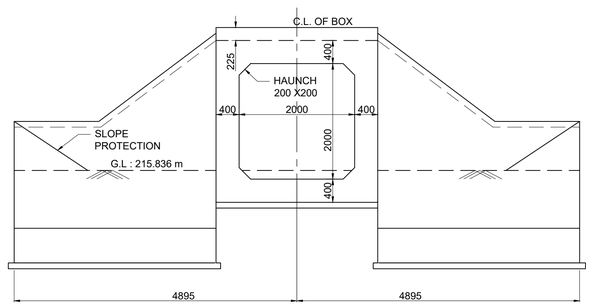
KEY PLAN
SCALE 1:NTS



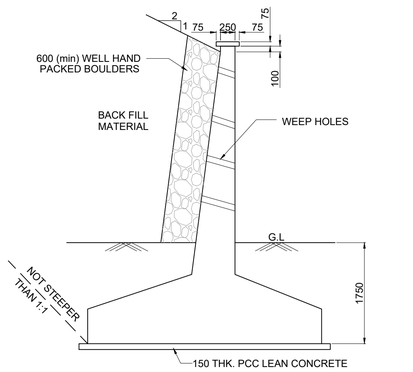
PLAN AT TOP
SCALE 1:200



ELEVATION
SCALE 1:50

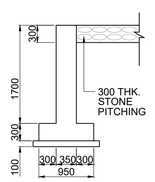


VIEW AT B-B
SCALE 1:50

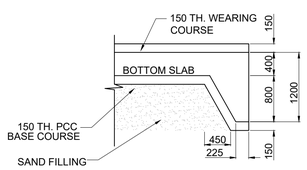


WING WALL (TO BE DESIGN AS PER SITE CONDITION)

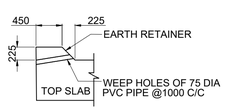
TYPICAL DETAIL OF RETURN WALL / WING WALL
SCALE 1:50



DROP / CURTAIN WALL DETAILS
SCALE 1:50



SHEAR KEY
SCALE 1:50



EARTH RETAINER
SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD.
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO 142 1X2.0X2.0m RCC BOX AT CH.57546.948

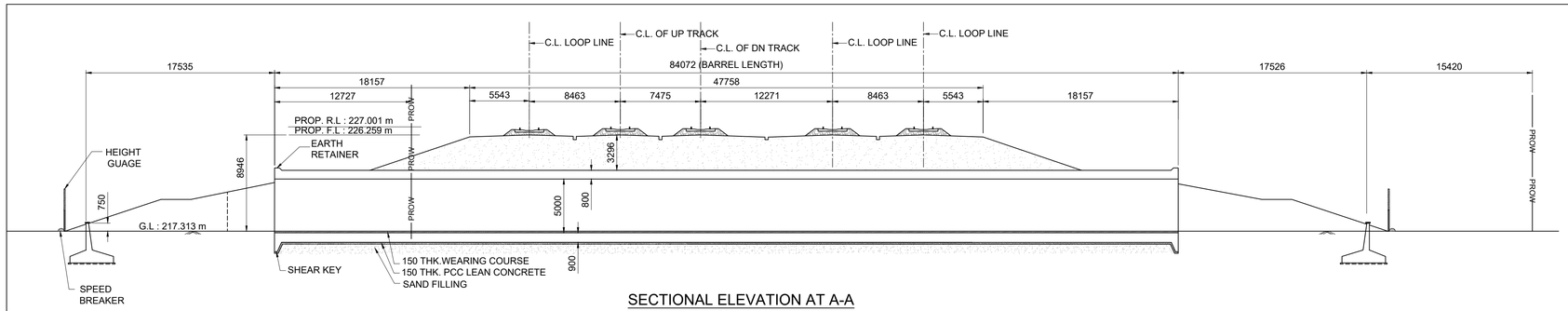
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD-142_A0

SHEET NO. 1 OF 1

SCALE : AS SHOWN

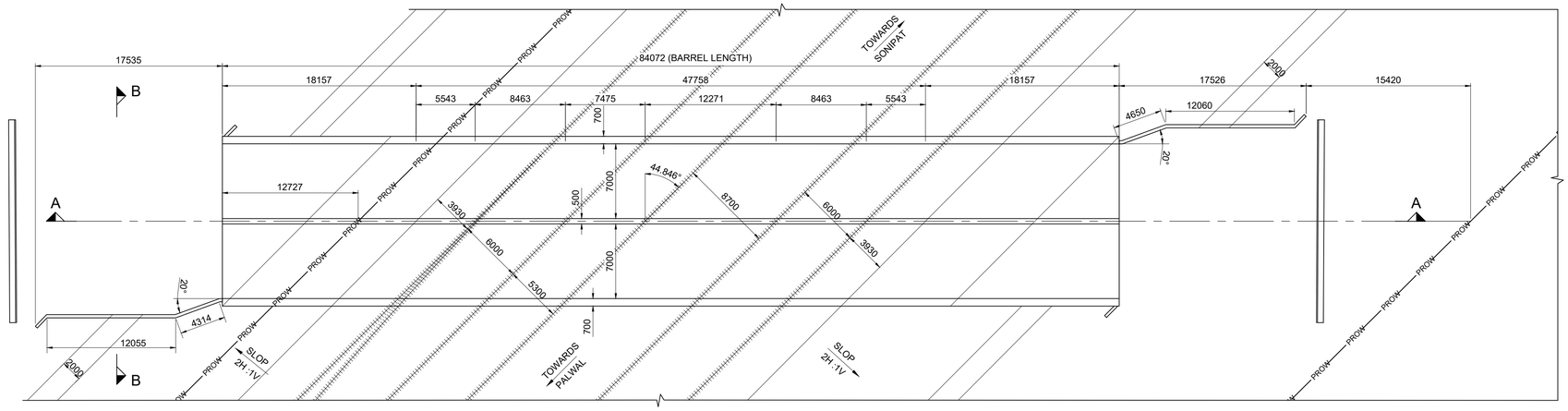
ISSUE DATE

REVISED DATE



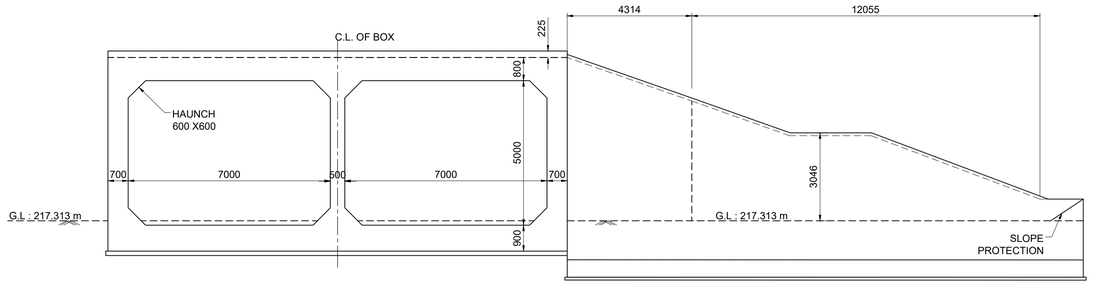
SECTIONAL ELEVATION AT A-A

SCALE 1:250



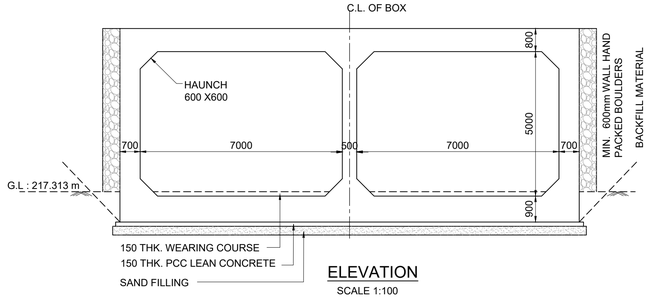
PLAN AT TOP

SCALE 1:250



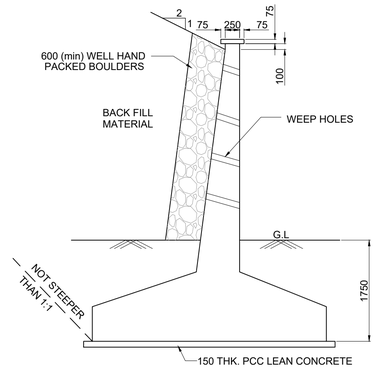
SECTION B-B

SCALE 1:100



ELEVATION

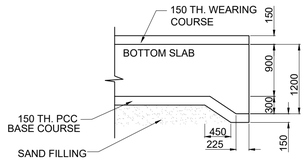
SCALE 1:100



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

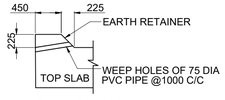
TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50



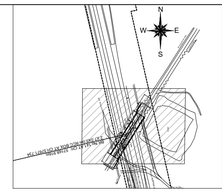
SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50



KEY PLAN

SCALE 1:NTS

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
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9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

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15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

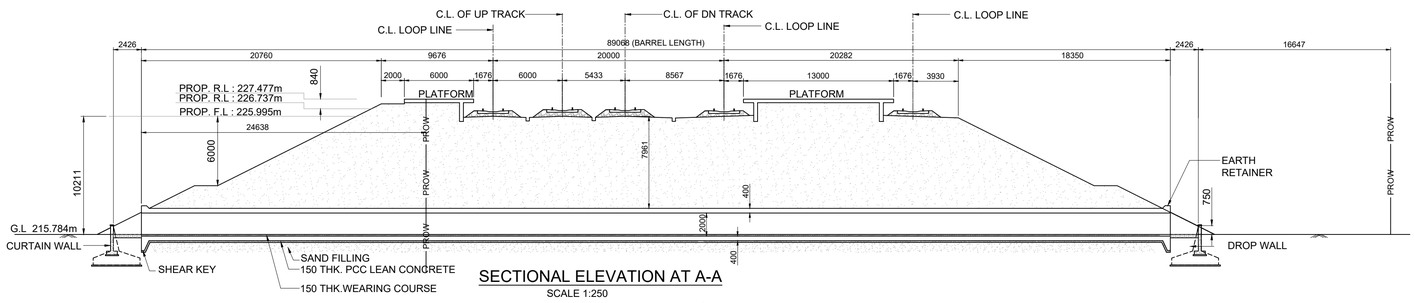
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO 143
2 X7.0X5.0m RCC BOX AT CH.57671.734

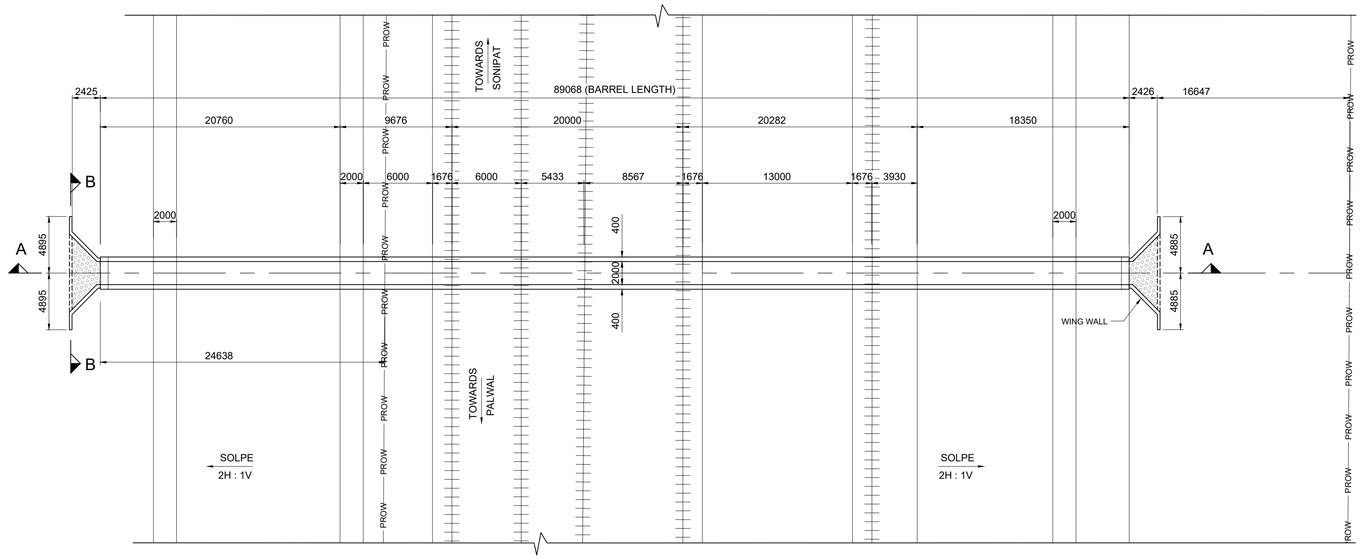
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-143_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



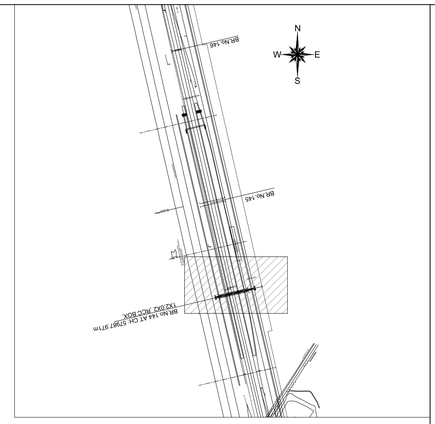
SECTIONAL ELEVATION AT A-A

SCALE 1:250



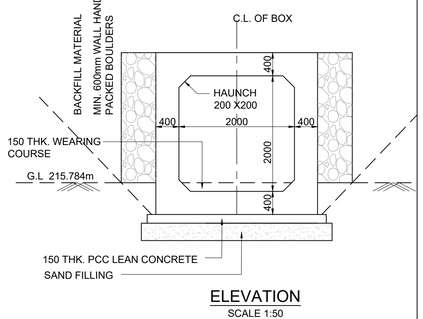
PLAN AT TOP

SCALE 1:250



KEY PLAN

SCALE 1:NTS



ELEVATION

SCALE 1:50

NOTES :

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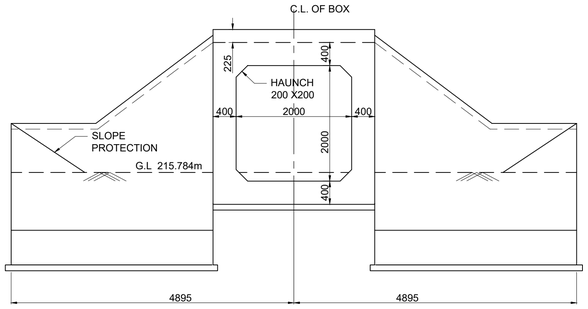
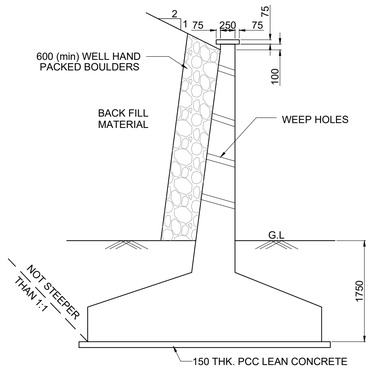


VIEW AT B-B

SCALE 1:50



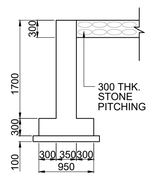
WING WALL (TO BE DESIGN AS PER SITE CONDITION)

TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50

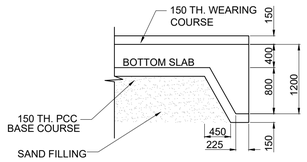
LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL



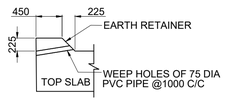
DROP / CURTAIN WALL DETAILS

SCALE 1:50



SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

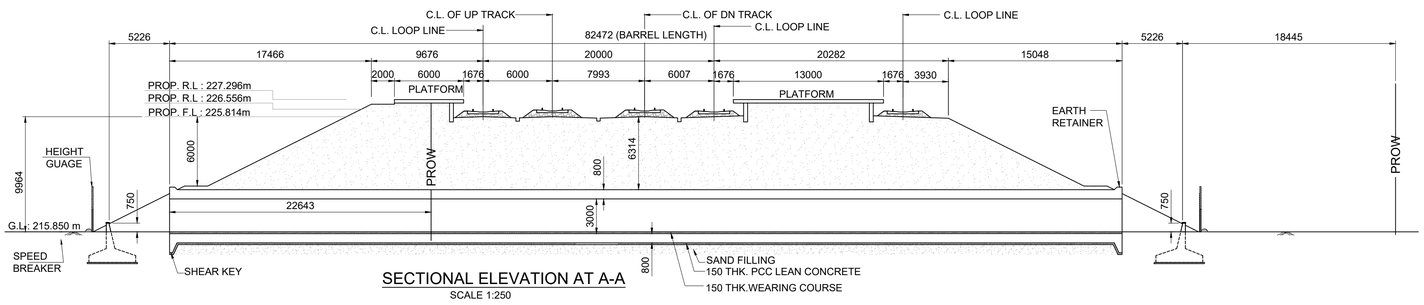
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING

FOR ROADBLANCING CULVERT BRIDGE NO 144
1X2.0X2.0m RCC BOX AT CH. 57987.971 m

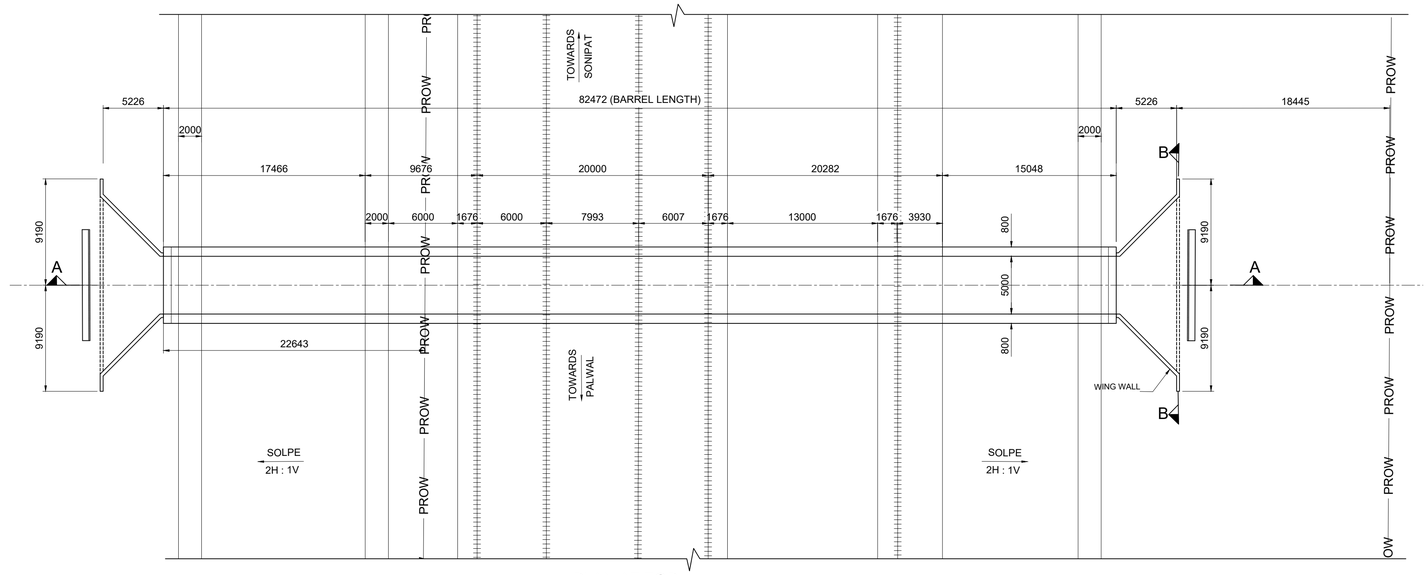
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-144_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



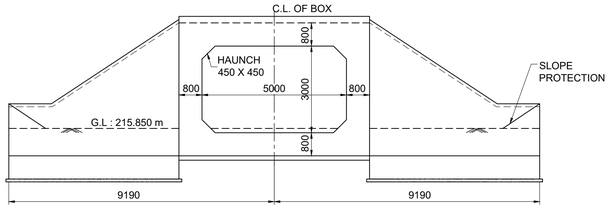
SECTIONAL ELEVATION AT A-A

SCALE 1:250



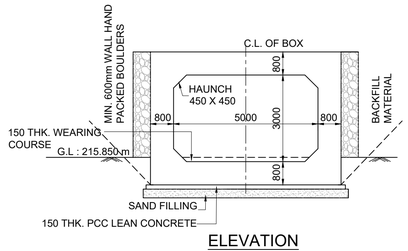
PLAN AT TOP

SCALE 1:250



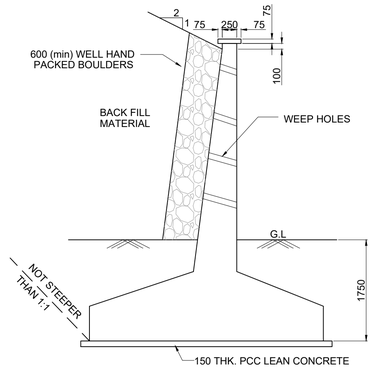
SECTION B-B

SCALE 1:100



ELEVATION

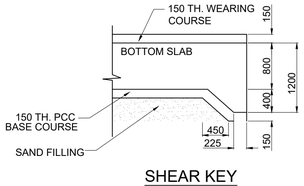
SCALE 1:100



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

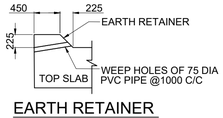
TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50



SHEAR KEY

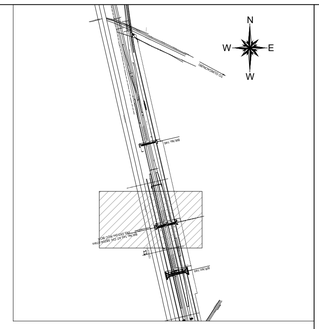
SCALE 1:50



EARTH RETAINER

SCALE 1:50

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			



KEY PLAN

SCALE 1:NTS

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

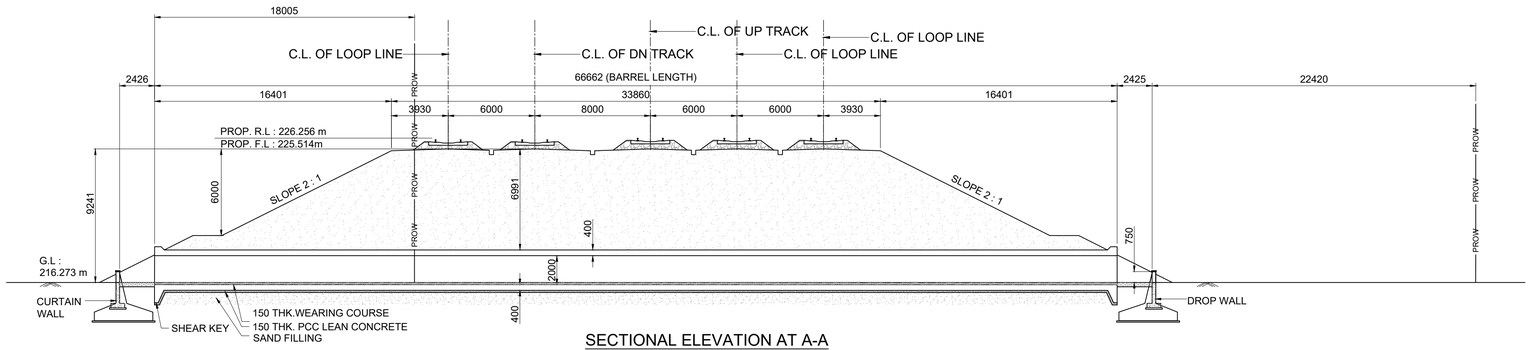
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING

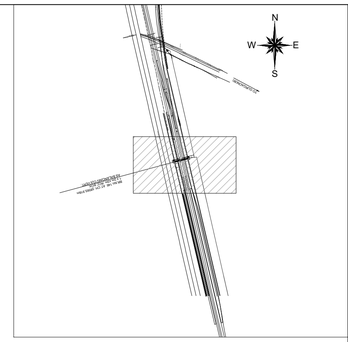
FOR ROAD UNDER BRIDGE NO 145
1X5.0X3.0m RCC BOX AT CH. 58204.074m

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-145_A0	1 OF 1

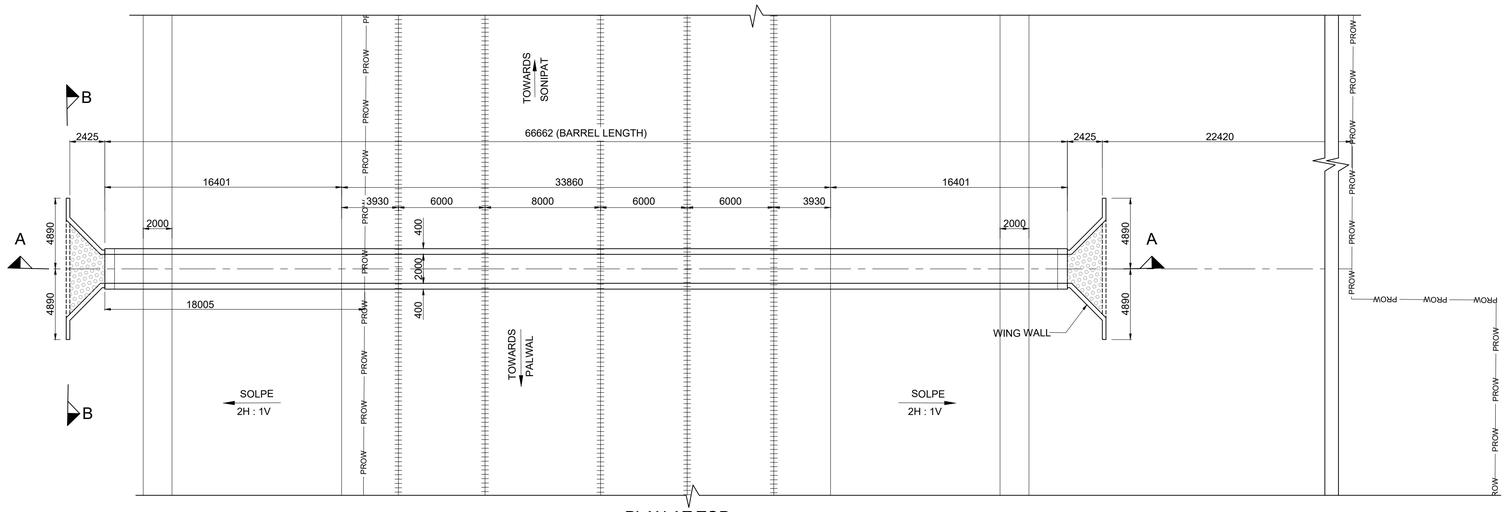
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



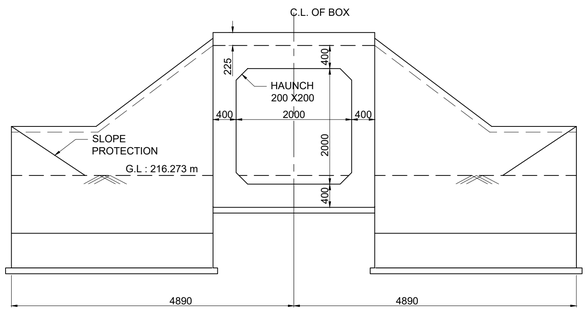
SECTIONAL ELEVATION AT A-A
SCALE 1:200



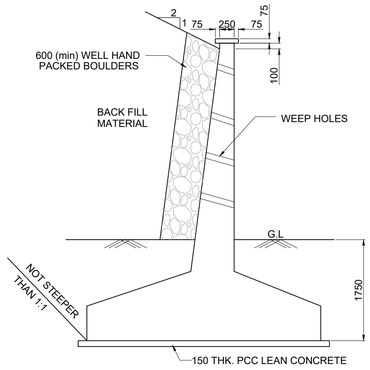
KEY PLAN
SCALE 1:NTS



PLAN AT TOP
SCALE 1:200

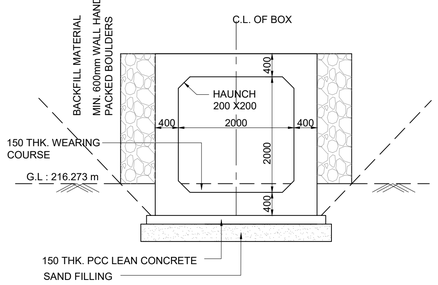


VIEW AT B-B
SCALE 1:50

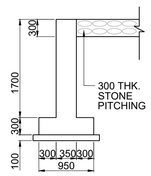


WING WALL (TO BE DESIGN AS PER SITE CONDITION)

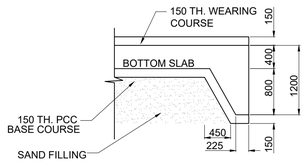
TYPICAL DETAIL OF RETURN WALL / WING WALL
SCALE 1:50



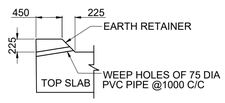
ELEVATION
SCALE 1:50



DROP / CURTAIN WALL DETAILS
SCALE 1:50



SHEAR KEY
SCALE 1:50



EARTH RETAINER
SCALE 1:50

NOTES :

A) GENERAL NOTES

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7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
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B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
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   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
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11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
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13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING
FOR BALANCING CULVERT BRIDGE NO 146
1X2.0X2.0m RCC BOX AT CH. 58565.918m

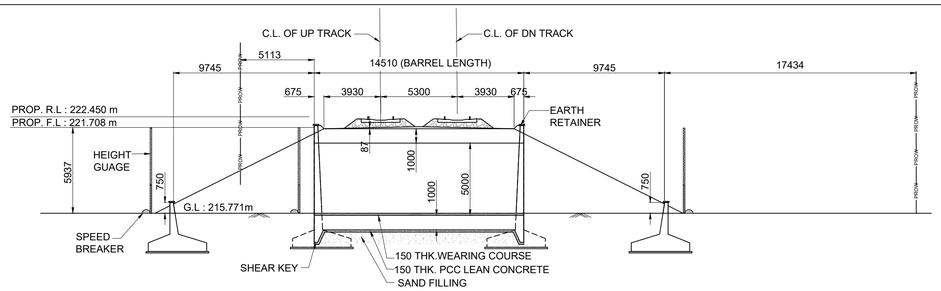
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD-146_A0

SHEET NO. 1 OF 1

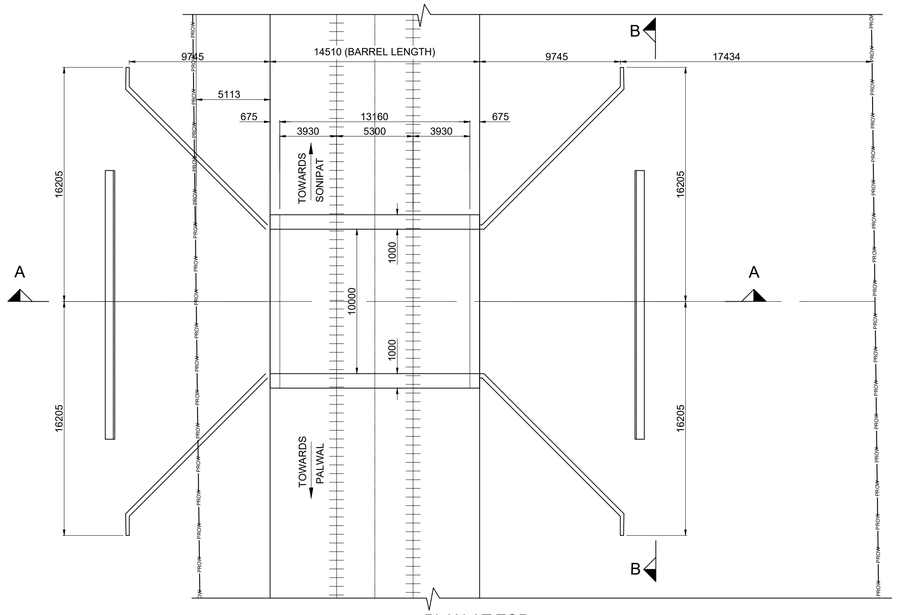
SCALE : AS SHOWN

ISSUE DATE

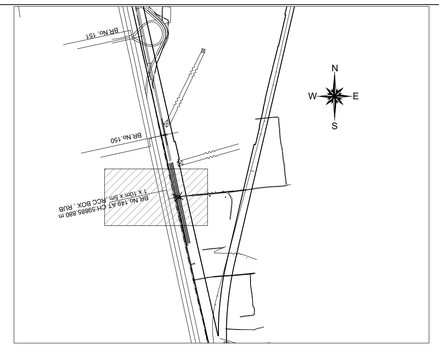
REVISED DATE



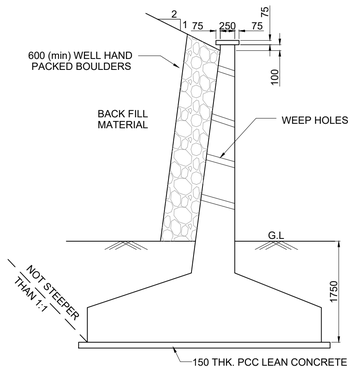
SECTIONAL ELEVATION AT A-A
SCALE 1:200



PLAN AT TOP
SCALE 1:200

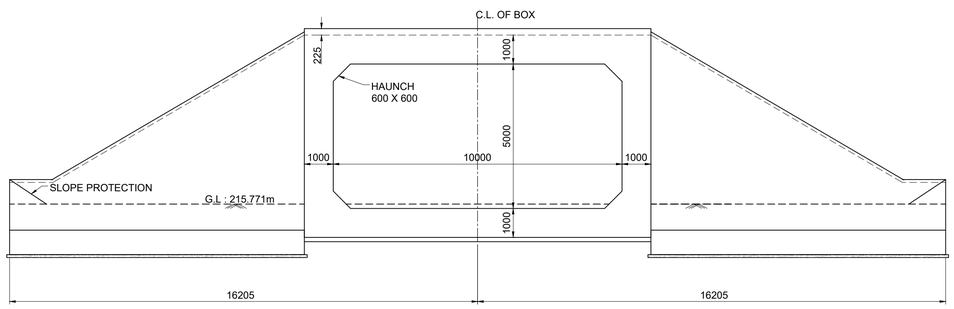


KEY PLAN
SCALE 1:NTS

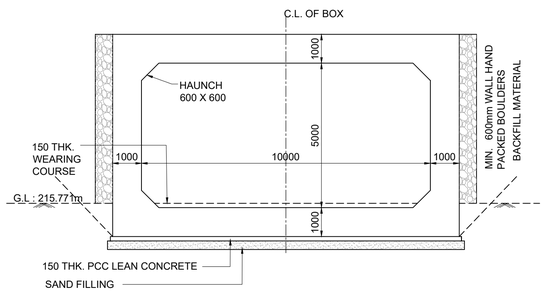


WING WALL (TO BE DESIGN AS PER SITE CONDITION)

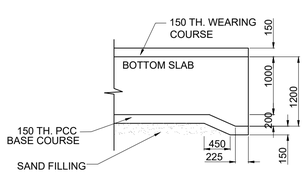
TYPICAL DETAIL OF RETURN WALL / WING WALL
SCALE 1:50



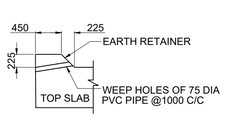
SECTION B-B
SCALE 1:100



ELEVATION
SCALE 1:100



SHEAR KEY
SCALE 1:50



EARTH RETAINER
SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING

FOR ROAD UNDER BRIDGE NO 149

1X10.0X5.0m RCC BOX AT CH. 59885.880m

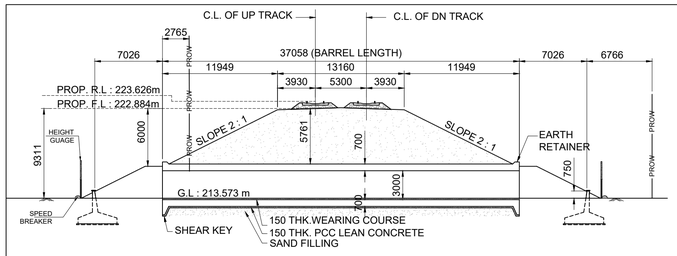
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD-149_A0

SHEET NO. 1 OF 1

SCALE : AS SHOWN

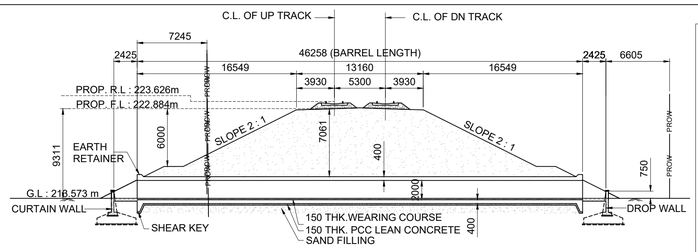
ISSUE DATE

REVISED DATE



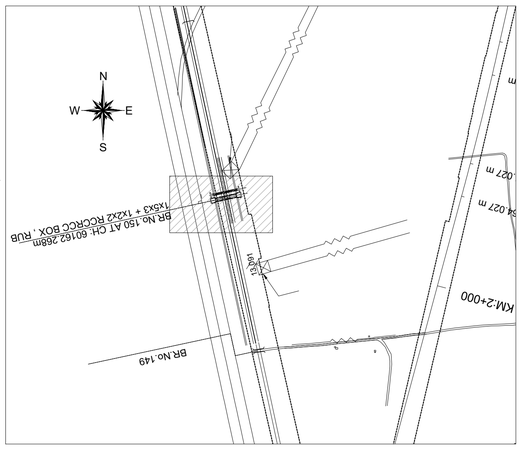
SECTIONAL ELEVATION AT A-A

SCALE 1:300



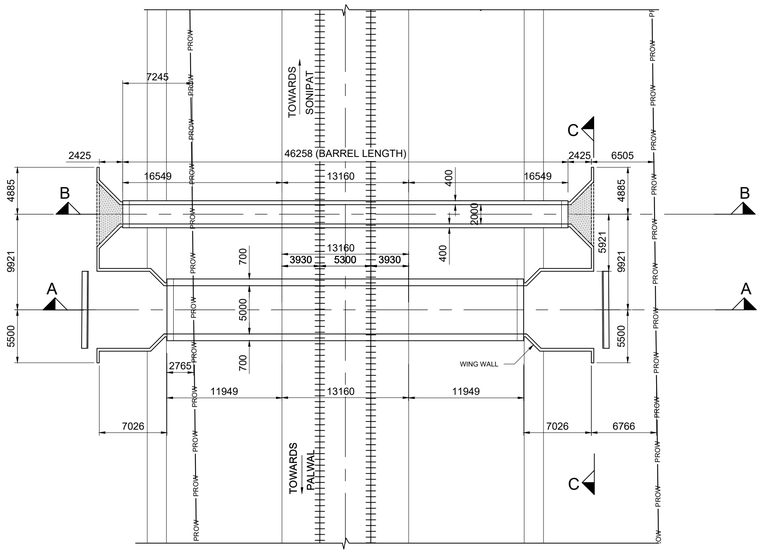
SECTIONAL ELEVATION AT B-B

SCALE 1:300



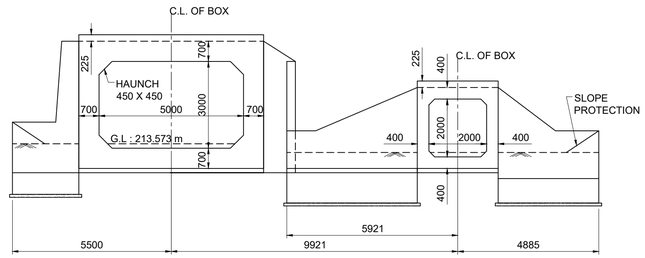
KEY PLAN

SCALE 1:NTS



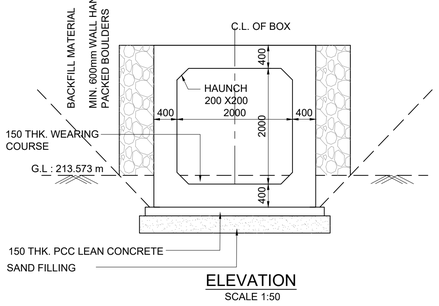
PLAN AT TOP

SCALE 1:200



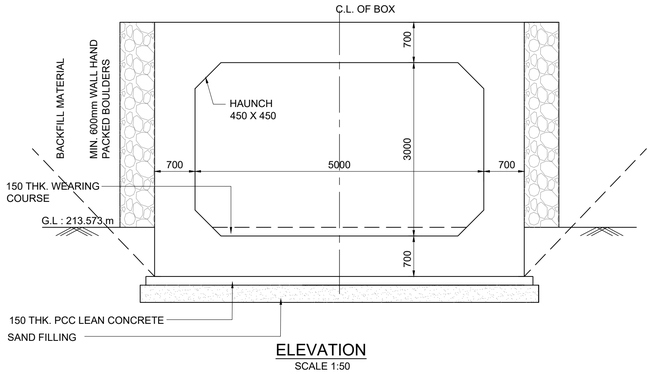
VIEW AT C-C

SCALE 1:100



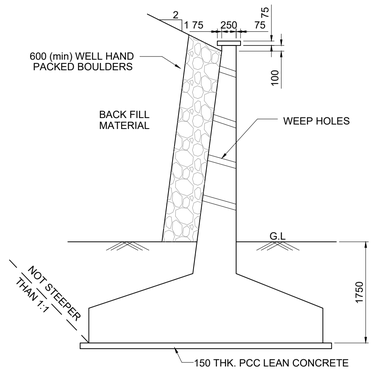
ELEVATION

SCALE 1:50



ELEVATION

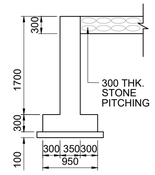
SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

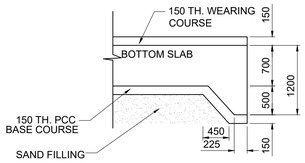
TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50



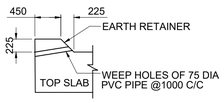
DROP / CURTAIN WALL DETAILS

SCALE 1:50



SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
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5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
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7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
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7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
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15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD+BALANCING CULVERT BRIDGE NO 150 1x5x3 + 1x2x2 RCC BOX AT CH. 60162.268m

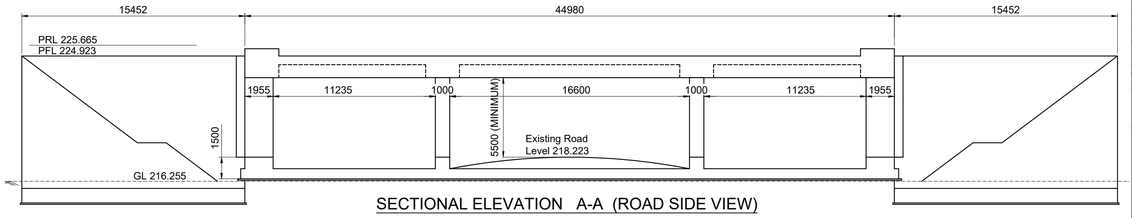
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD-150_A0

SHEET NO. 1 OF 1

SCALE : AS SHOWN

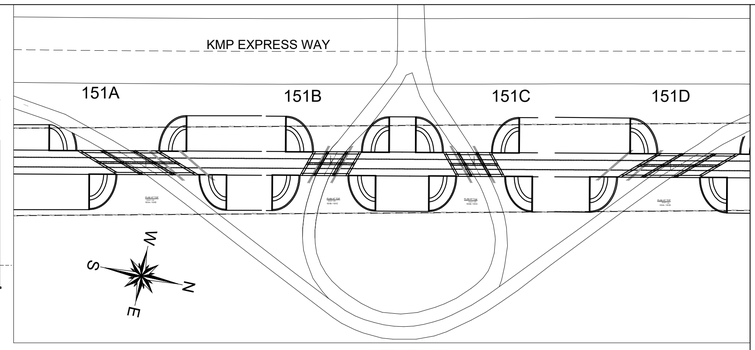
ISSUE DATE

REVISED DATE



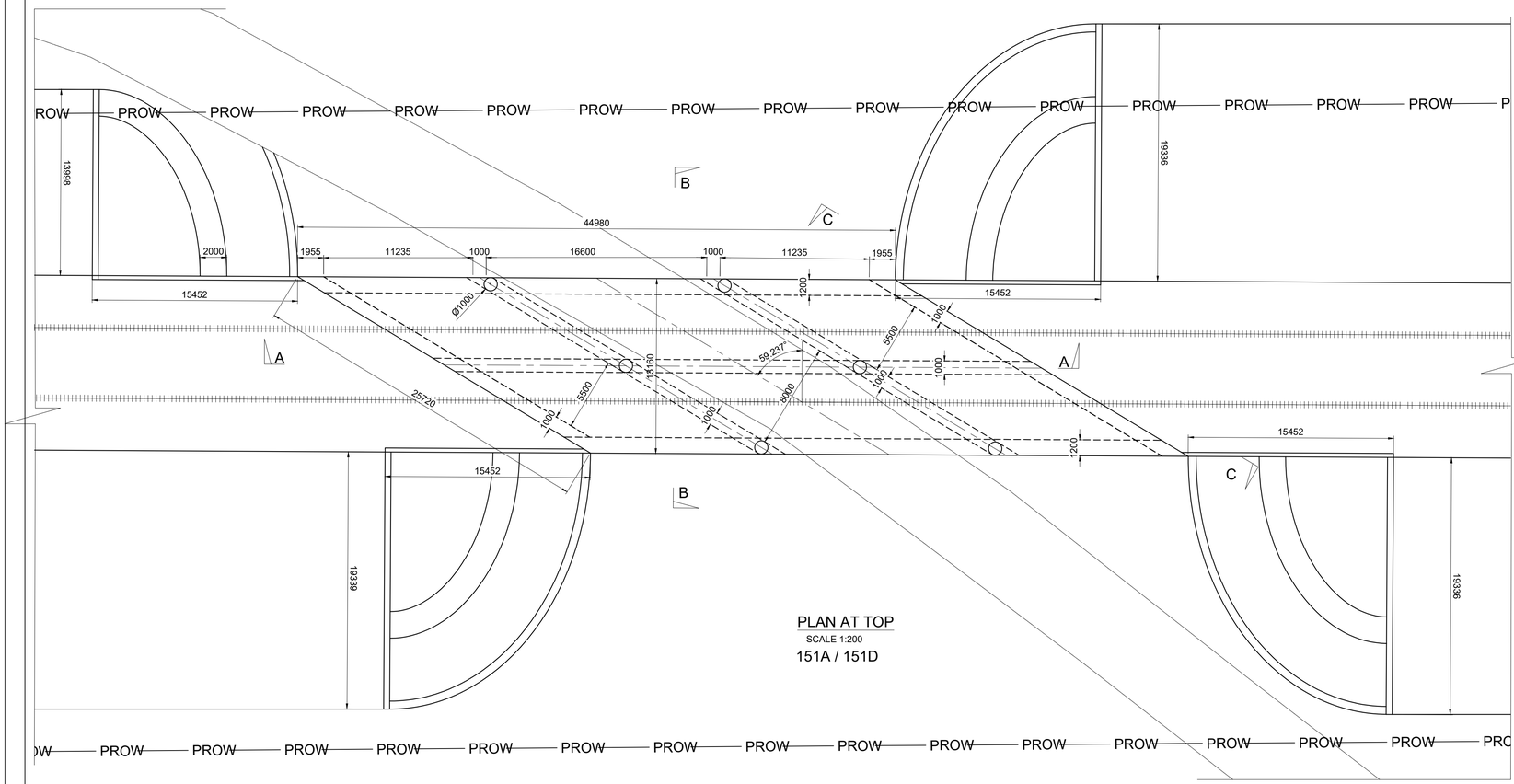
SECTIONAL ELEVATION A-A (ROAD SIDE VIEW)

SCALE 1:200



KEY PLAN

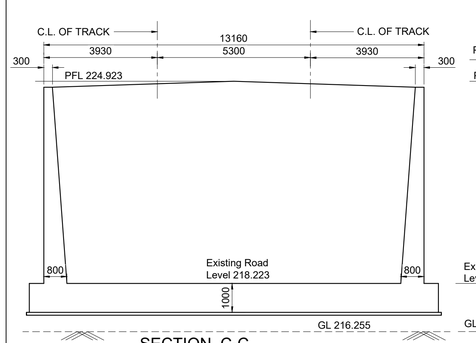
SCALE : NTS



PLAN AT TOP

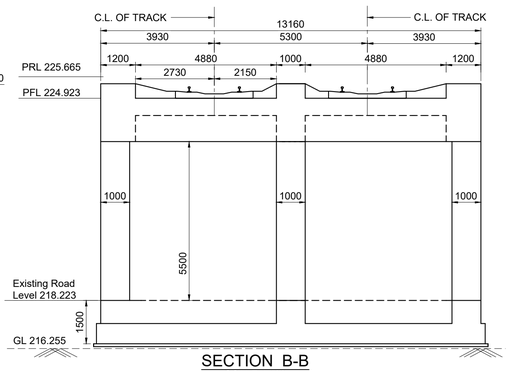
SCALE 1:200

151A / 151D



SECTION C-C

SCALE 1:100



SECTION B-B

SCALE 1:100

NOTES :

A) GENERAL NOTES

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7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
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10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD.
11. THE DIMENSIONS OF COLUMN, BEAM & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORKS SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0 .
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14. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

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CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

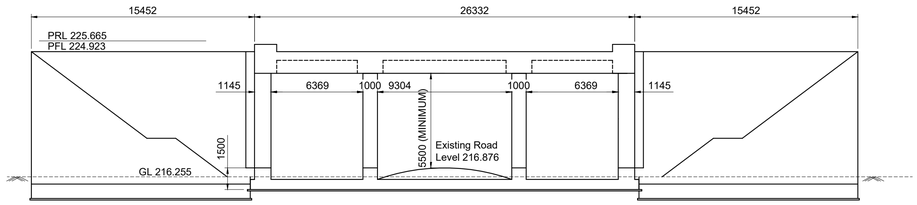
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING

FOR ROAD UNDER BRIDGE NO. 151A,151D RCC BOX AT CH: 60454.484m,CH: 60760.328m

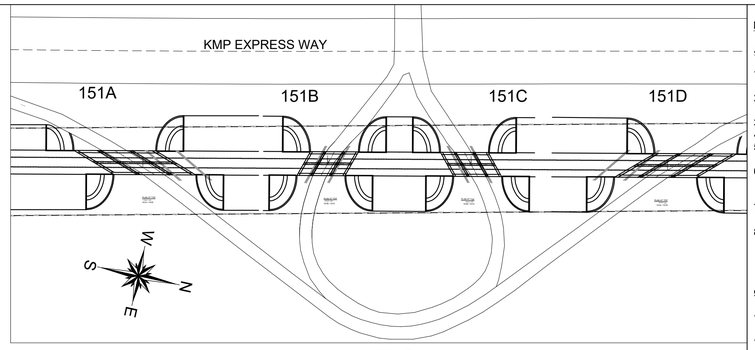
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-151_A0	1 OF 2

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



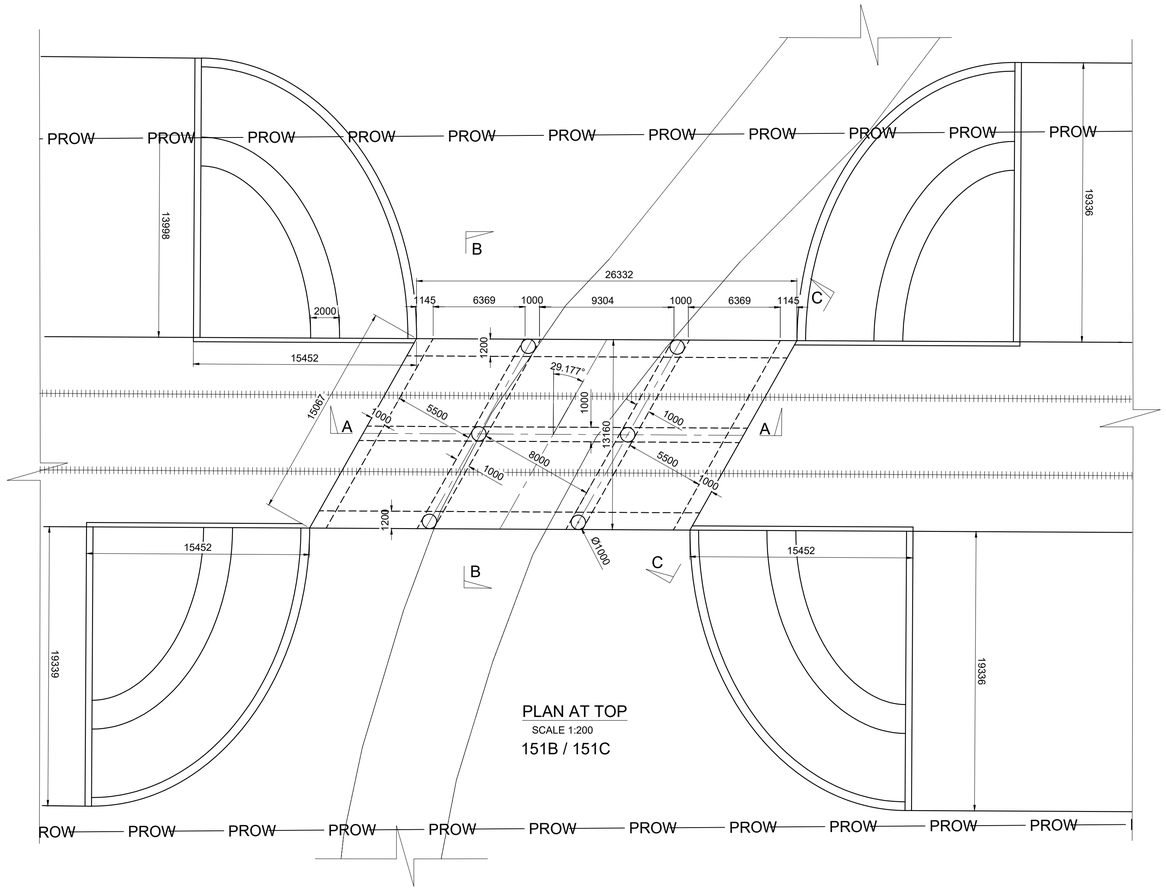
SECTIONAL ELEVATION A-A (ROAD SIDE VIEW)

SCALE 1:200



KEY PLAN

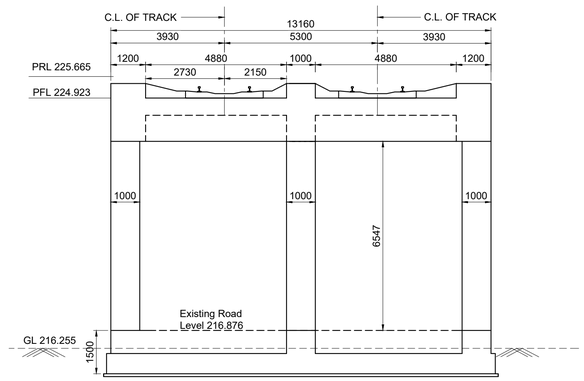
SCALE : NTS



PLAN AT TOP

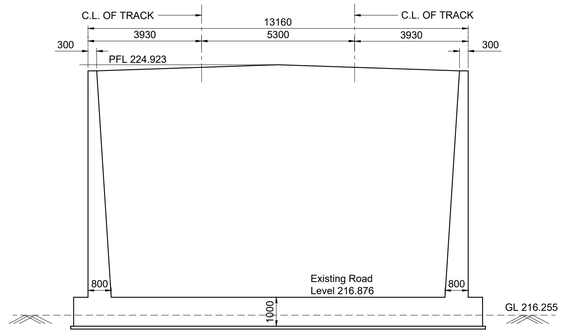
SCALE 1:200

151B / 151C



SECTION B-B

SCALE 1:100



SECTION C-C

SCALE 1:100

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD.
11. THE DIMENSIONS OF COLUMN, BEAM & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORKS SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0 .
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
6. SEISMIC ZONE- IV
7. EXPOSURE CONDITION- MODERATE.
8. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
9. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
10. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
11. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
12. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
13. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
14. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

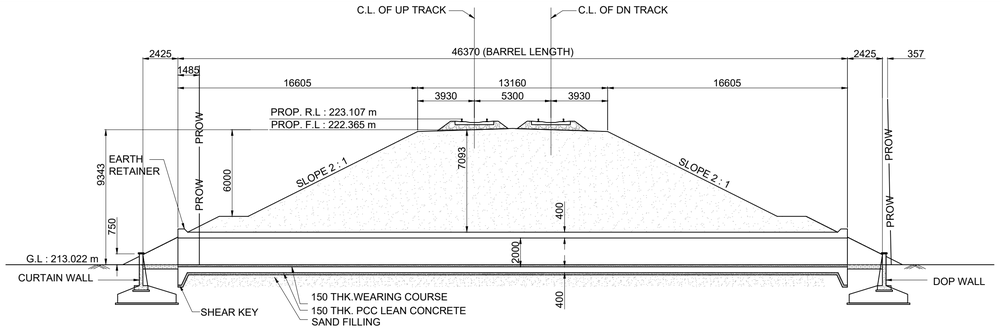
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING

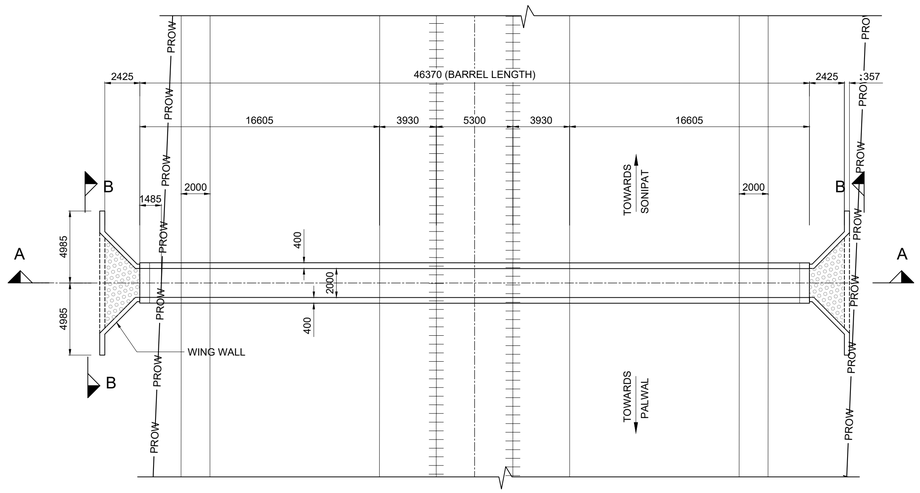
FOR ROAD UNDER BRIDGE NO. 151B,151C, RCC BOX AT CH: CH: 60566.384m,CH: 60642.158m

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-151_A0	2 OF 2

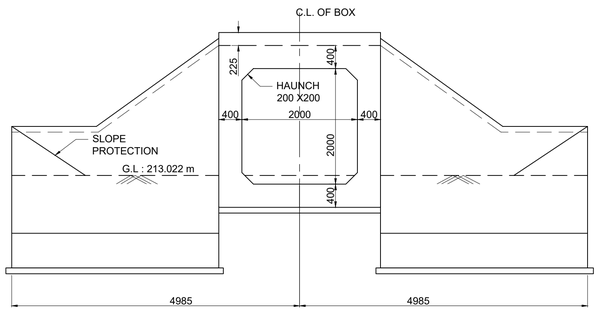
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



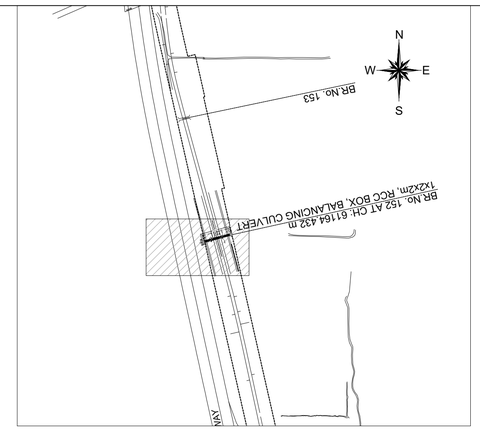
SECTIONAL ELEVATION AT A-A
SCALE 1:200



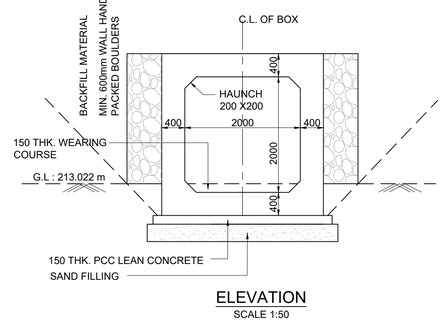
PLAN AT TOP
SCALE 1:200



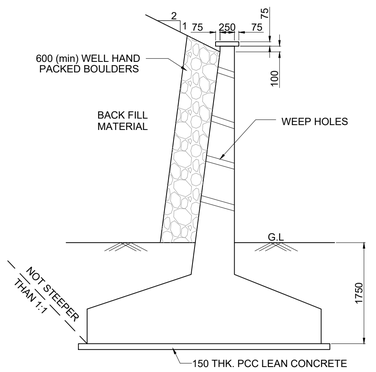
VIEW AT B-B
SCALE 1:50



KEY PLAN
SCALE 1:NTS

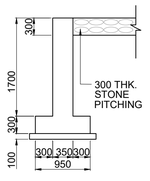


ELEVATION
SCALE 1:50

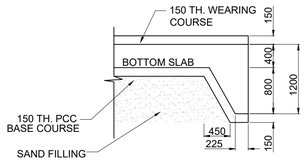


WING WALL (TO BE DESIGN AS PER SITE CONDITION)

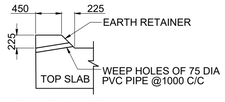
TYPICAL DETAIL OF RETURN WALL / WING WALL
SCALE 1:50



DROP / CURTAIN WALL DETAILS
SCALE 1:50



SHEAR KEY
SCALE 1:50



EARTH RETAINER
SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
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6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

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5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
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11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
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15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

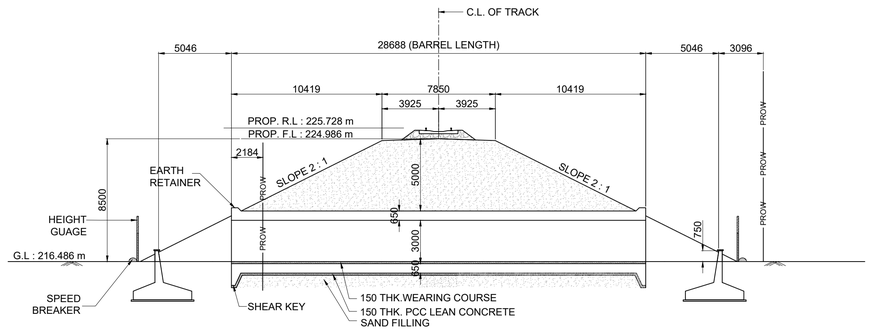
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING
FOR BALANCING CULVERT BRIDGE NO 152
1X2.0X2.0m RCC BOX AT CH. 61164.432

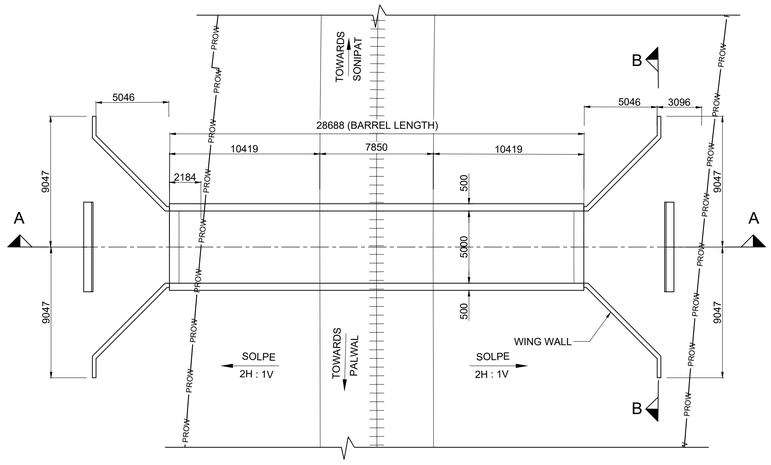
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-152_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



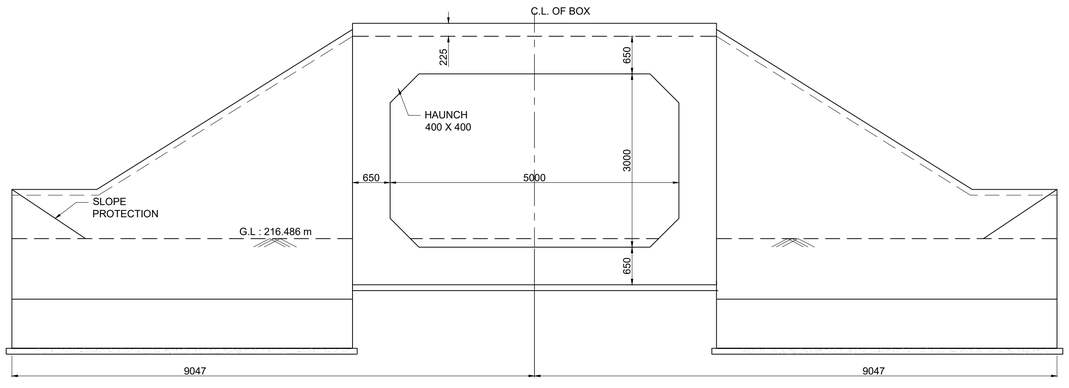
SECTIONAL ELEVATION AT A-A

SCALE 1:200



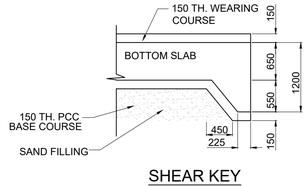
PLAN AT TOP

SCALE 1:200



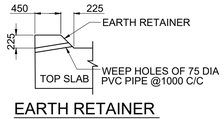
VIEW AT B-B

SCALE 1:50



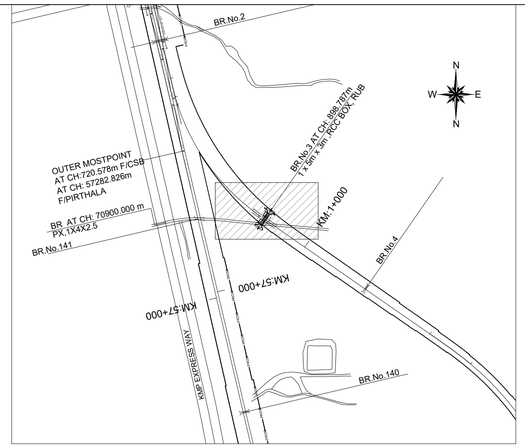
SHEAR KEY

SCALE 1:50



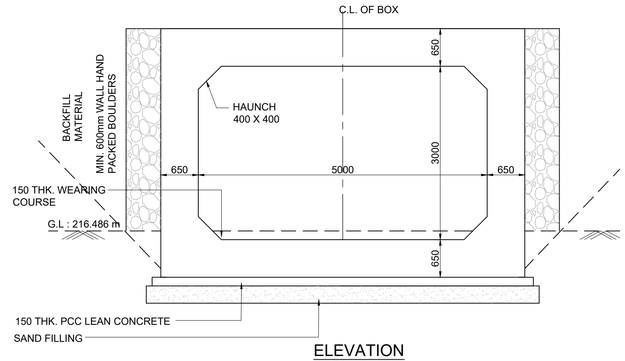
EARTH RETAINER

SCALE 1:50



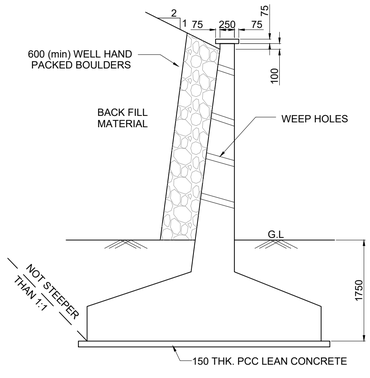
KEY PLAN

SCALE 1:NTS



ELEVATION

SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
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8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
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15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

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CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO.3 - 1X5.0X3m RCC BOX AT CH. 898.787m (CONNECTING LINE NEW PATLI TO PATLI)

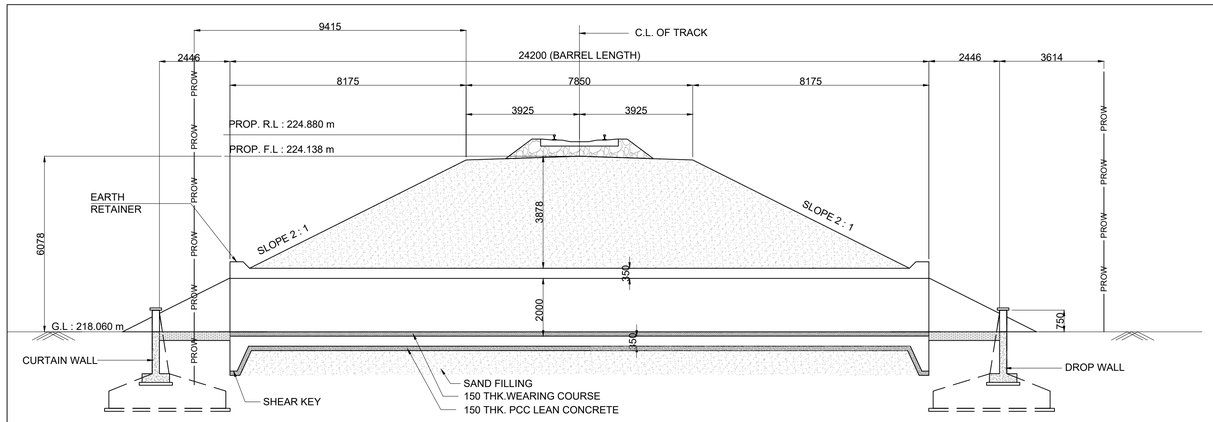
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD_NP-P-3_A0

SHEET NO. 1 OF 1

SCALE : AS SHOWN

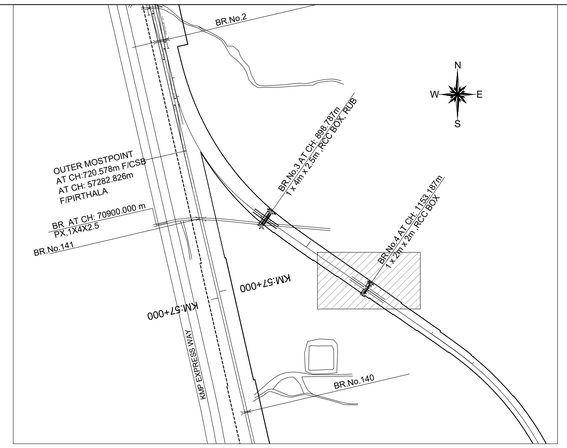
ISSUE DATE

REVISED DATE



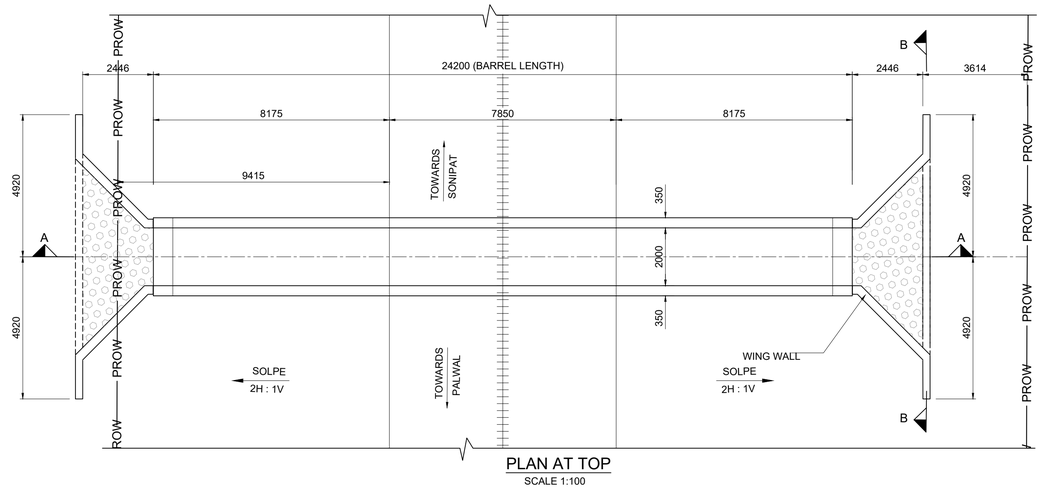
SECTIONAL ELEVATION AT A-A

SCALE 1:100



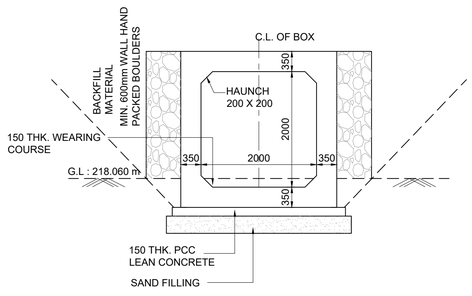
KEY PLAN

SCALE 1:NTS



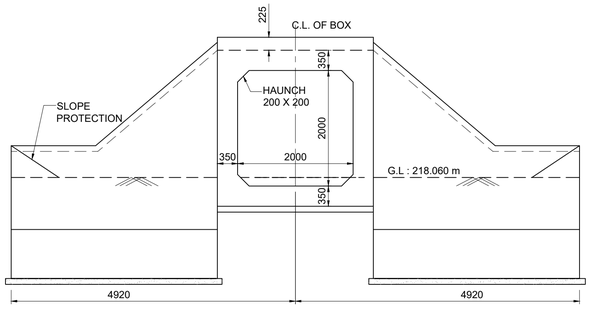
PLAN AT TOP

SCALE 1:100



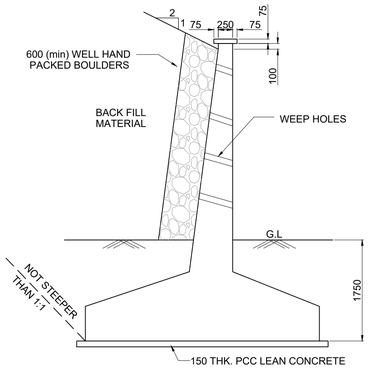
ELEVATION

SCALE 1:50



VIEW B-B

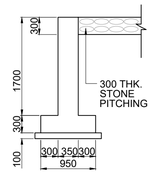
SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

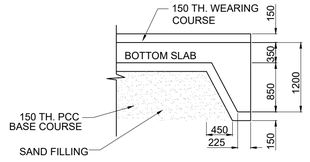
TYPICAL DETAIL OF RETURN WALL / WING LAND

SCALE 1:50



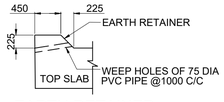
DROP / CURTAIN WALL DETAILS

SCALE 1:50



SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL, BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

THE INFRASTRUCTURE PEOPLE

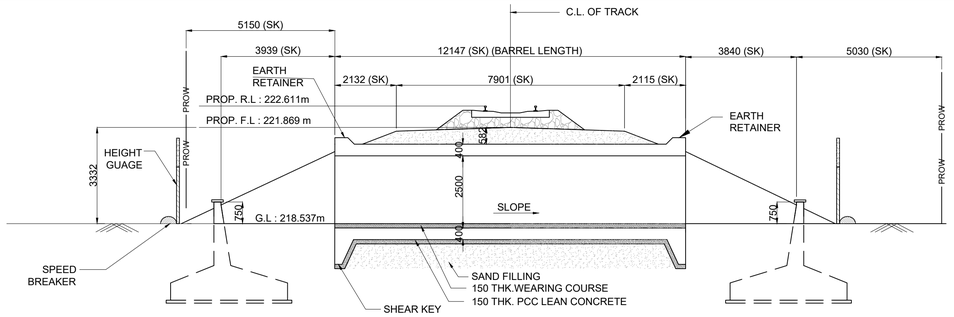
Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT NO.4 -1X2.0X2.0m RCC BOX AT CH. 1153.187m (CONNECTING LINE NEW PATLI TO PATLI)

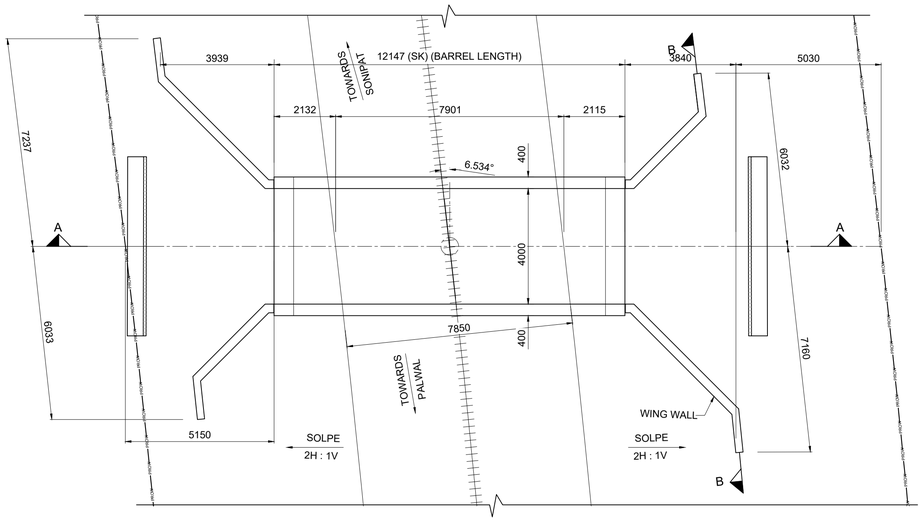
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD_NP-P-4_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



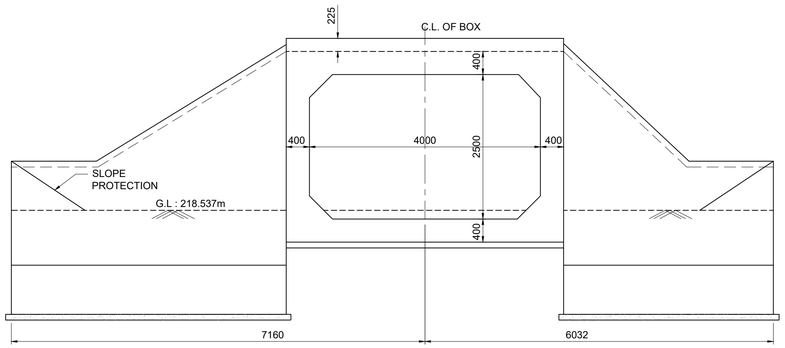
SECTIONAL ELEVATION AT A-A

SCALE 1:100



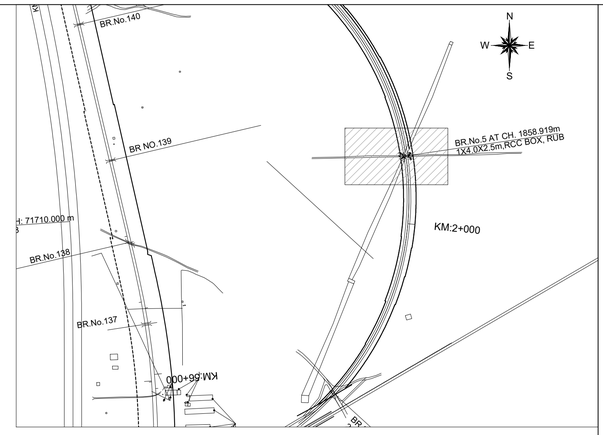
PLAN AT TOP

SCALE 1:100



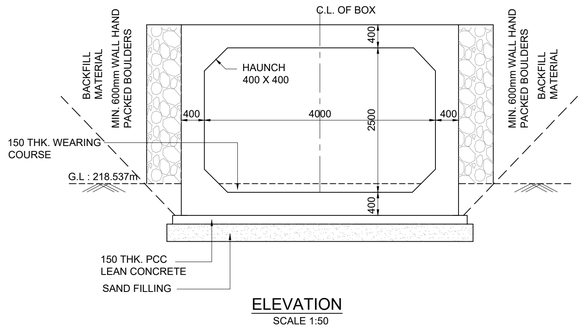
VIEW B-B

SCALE 1:50



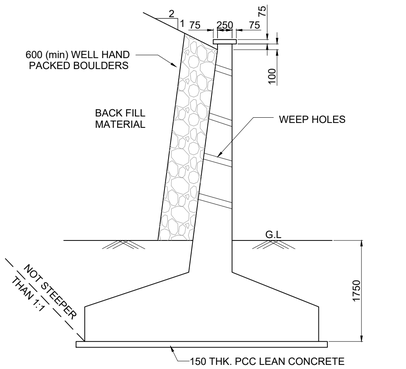
KEY PLAN

SCALE 1:NTS



ELEVATION

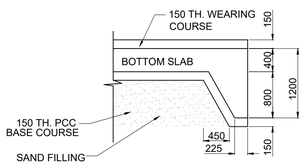
SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

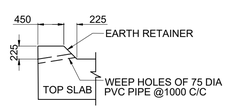
TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50



SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO.5 - 1X4.0X2.5m RCC BOX AT CH. 1858.919m (CONNECTING LINE NEW PATLI TO PATLI)

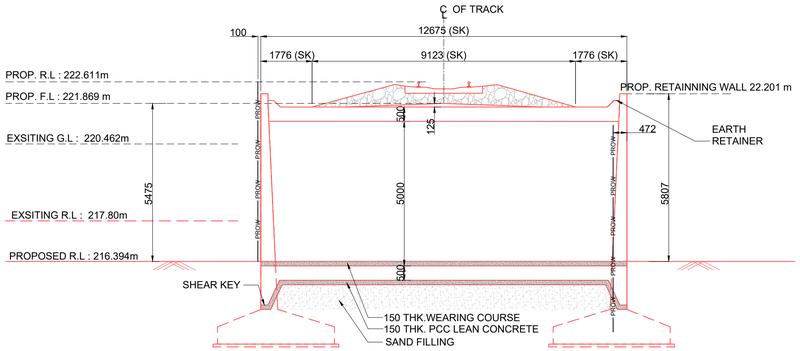
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD_NP-P-5_A0

SHEET NO. 1 OF 1

SCALE : AS SHOWN

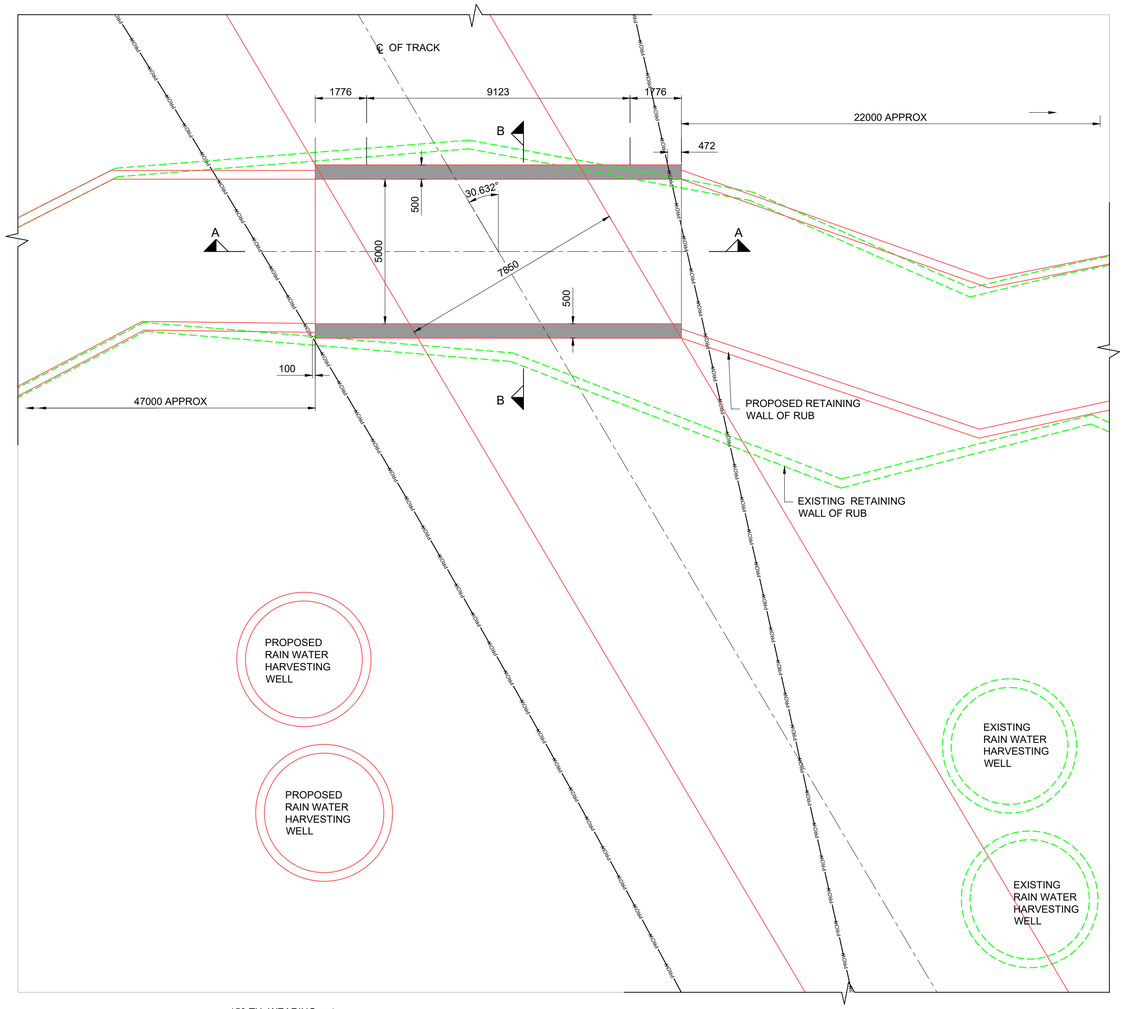
ISSUE DATE

REVISED DATE



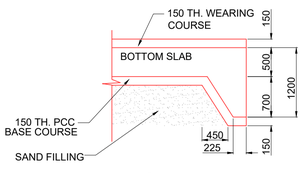
SECTIONAL ELEVATION AT A-A

SCALE 1:100



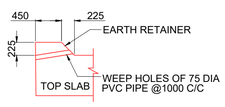
PLAN AT TOP

SCALE 1:100



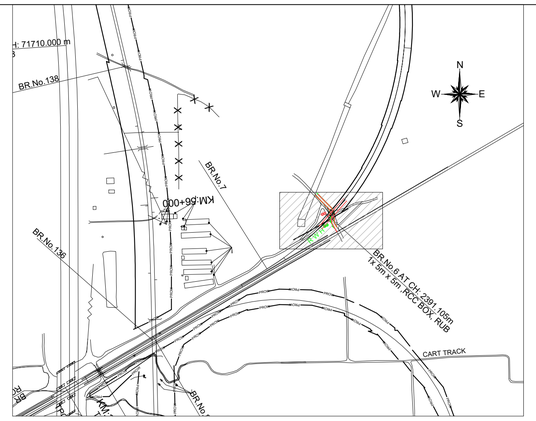
SHEAR KEY

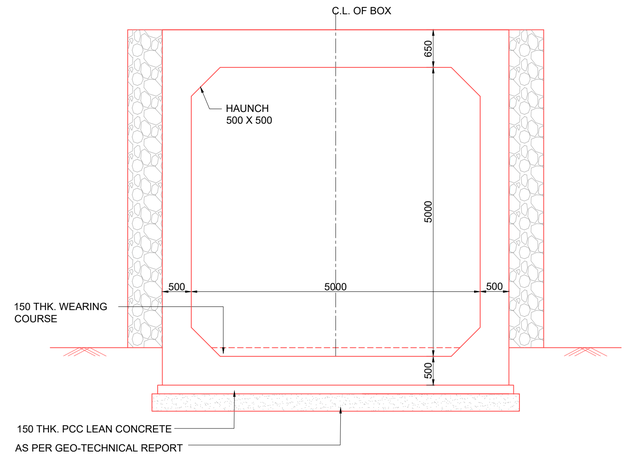
SCALE 1:50



EARTH RETAINER

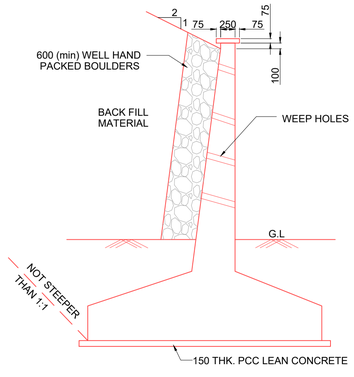
SCALE 1:50





SECTION B-B

SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER. UNLESS OTHERWISE MENTIONED.
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8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
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11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
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13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL
———	PROPOSED
- - - -	DISMANTEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING

FOR ROAD UNDER BRIDGE NO.6 - 1X5.0X5.0m RCC BOX AT CH. 2391.105m (CONNECTING LINE NEW PATLI TO PATLI)

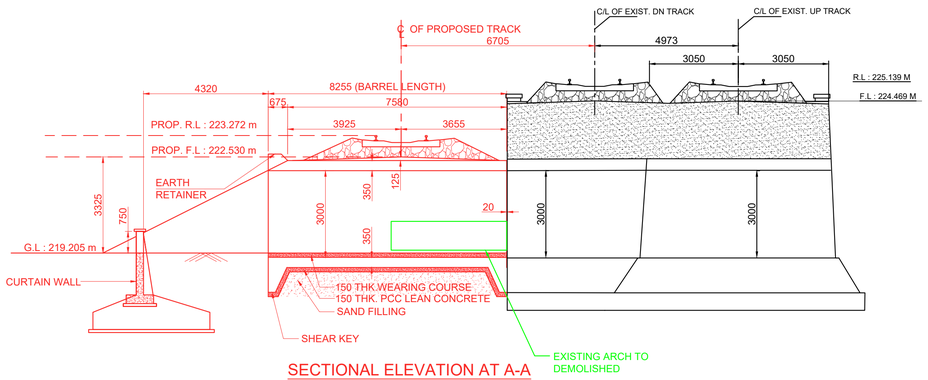
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD_NP-P-6_A0

SHEET NO. 1 OF 1

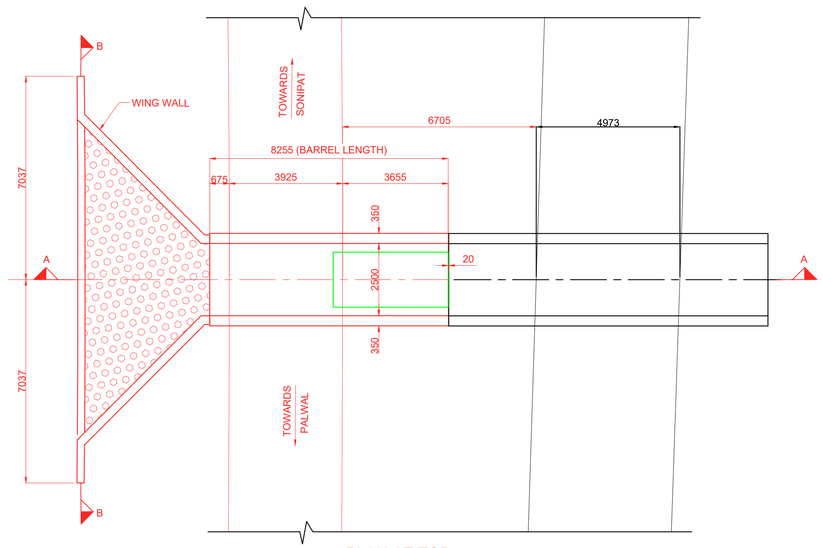
SCALE : AS SHOWN

ISSUE DATE

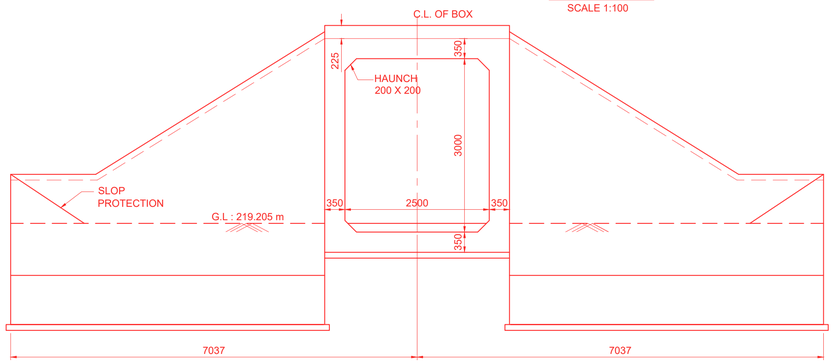
REVISED DATE



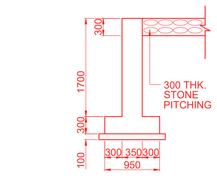
SECTIONAL ELEVATION AT A-A
SCALE 1:100



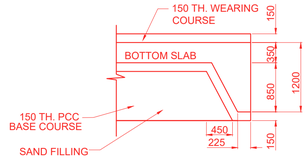
PLAN AT TOP
SCALE 1:100



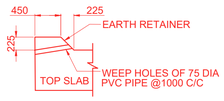
VIEW B-B
SCALE 1:50



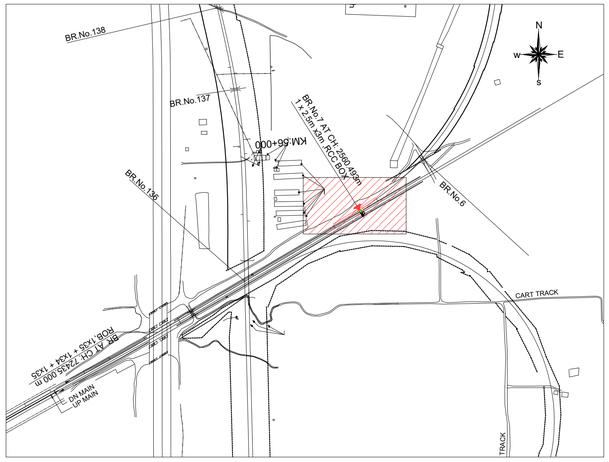
DROP / CURTAIN WALL DETAILS
SCALE 1:50



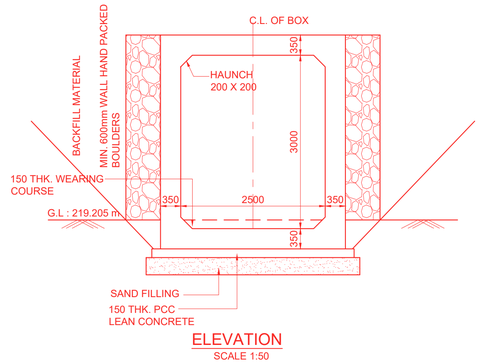
SHEAR KEY
SCALE 1:50



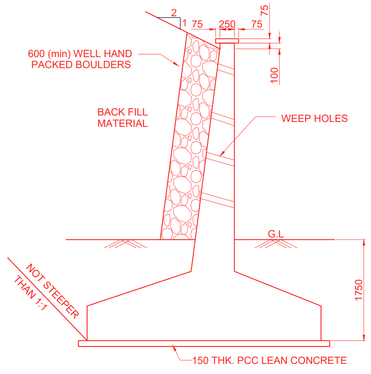
EARTH RETAINER
SCALE 1:50



KEY PLAN
SCALE 1:NTS



ELEVATION
SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

TYPICAL DETAIL OF RETURN WALL / WING WALL
SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROPOSED STRUCTURE
EXISTING STRUCTURE
DEMOLISHED STRUCTURE

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

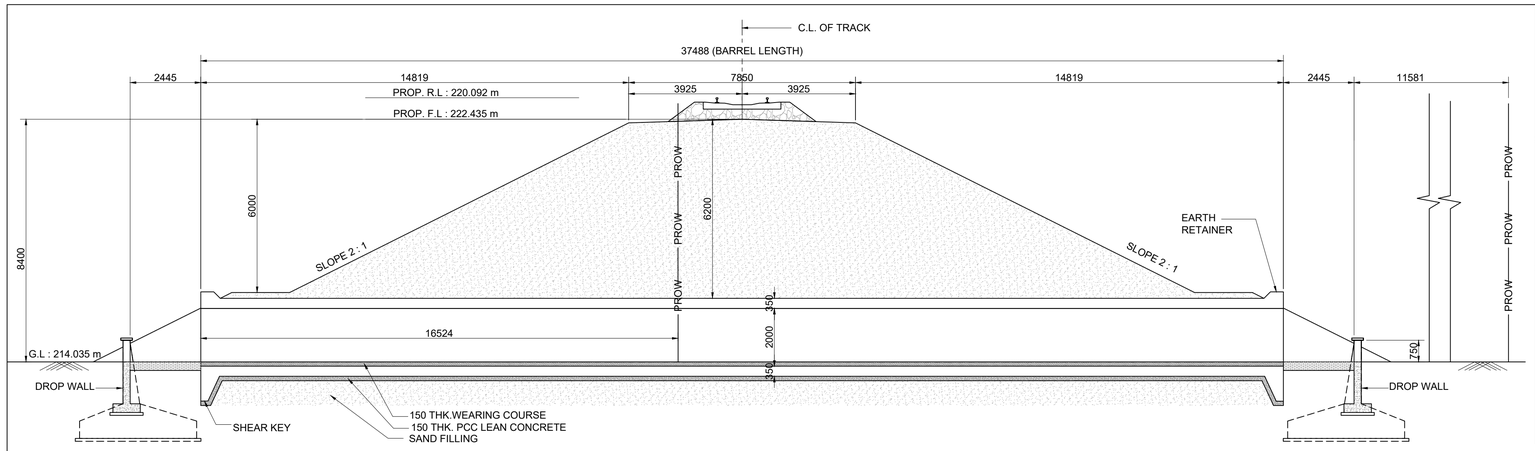
CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

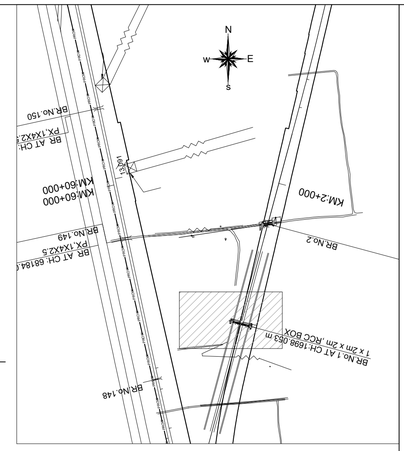
GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERTNO.7 - 1X2.5X3.0mRCC BOX AT CH. 2560.493 AND EXIST BOX. SIZE- 1X2.5X3.0 (CONNECTING LINE NEW PATLI TO PATLI)

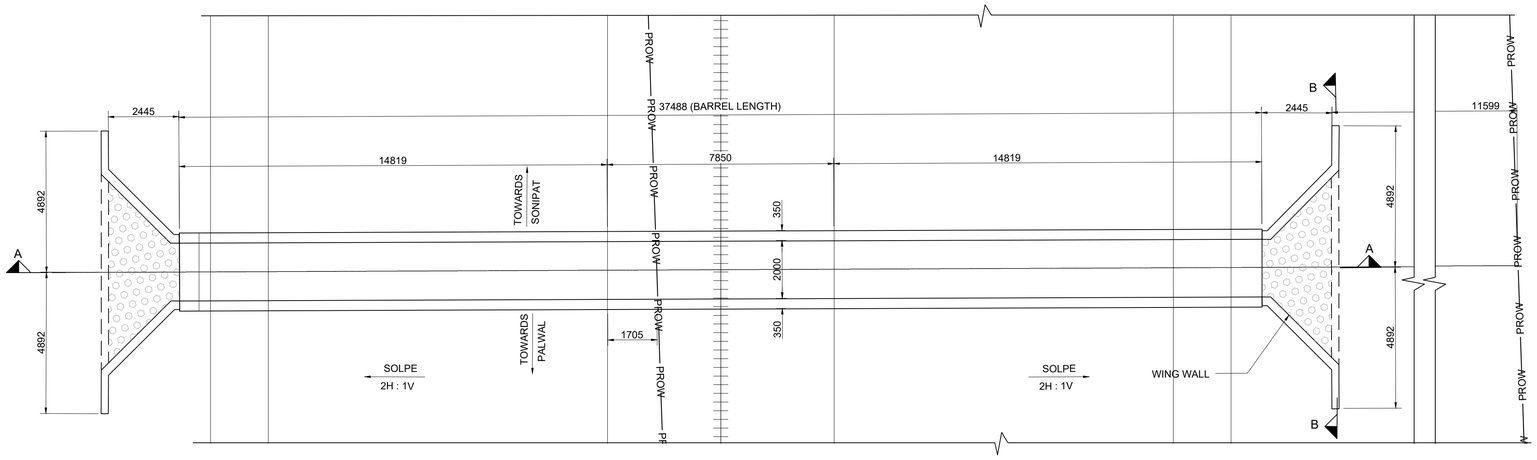
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD_NP-P-7_A0
SHEET NO. 1 OF 1
SCALE : AS SHOWN
ISSUE DATE
REVISED DATE



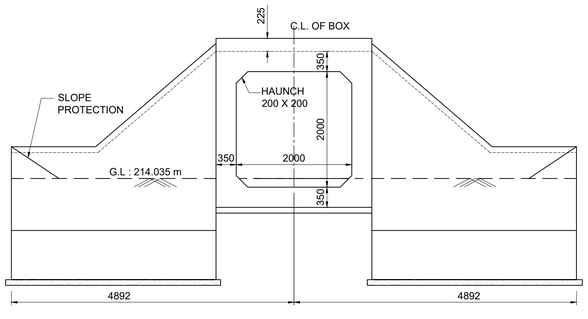
SECTIONAL ELEVATION AT A-A
SCALE 1:100



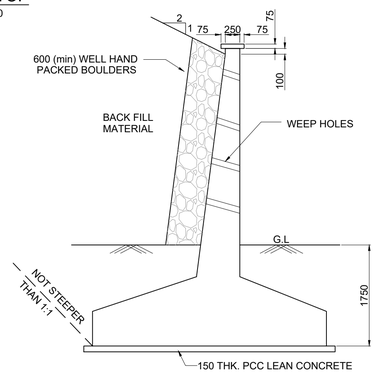
KEY PLAN
SCALE 1:NTS



PLAN AT TOP
SCALE 1:100

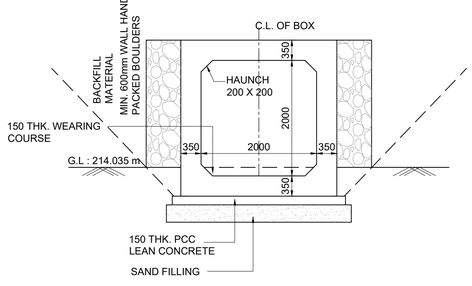


VIEW B-B
SCALE 1:50

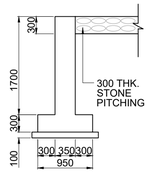


WING WALL (TO BE DESIGN AS PER SITE CONDITION)

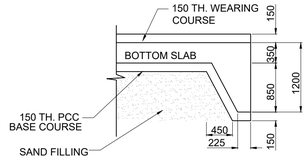
TYPICAL DETAIL OF RETURN WALL / WING WALL
SCALE 1:50



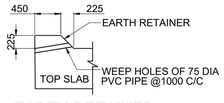
ELEVATION
SCALE 1:50



DROP / CURTAIN WALL DETAILS
SCALE 1:50



SHEAR KEY
SCALE 1:50



EARTH RETAINER
SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL, BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

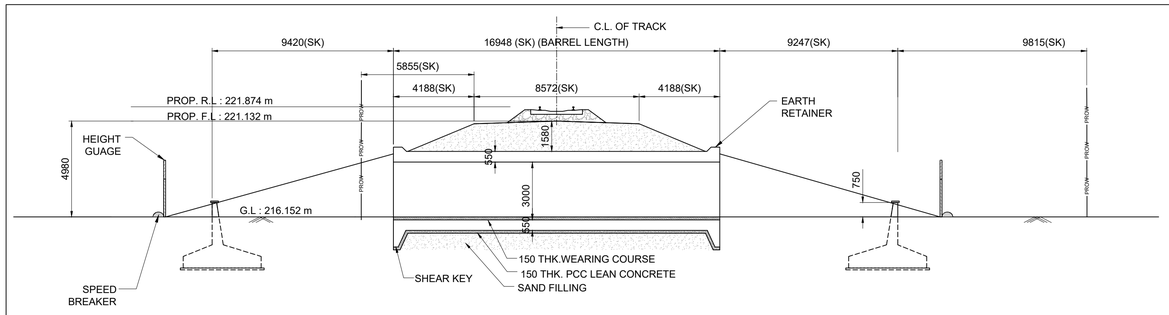
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO.1 - 1X2.0X2.0m RCC BOX AT CH. 1698.053m (CONNECTING LINE NEW PATLI TO FARUKHNAGAR)

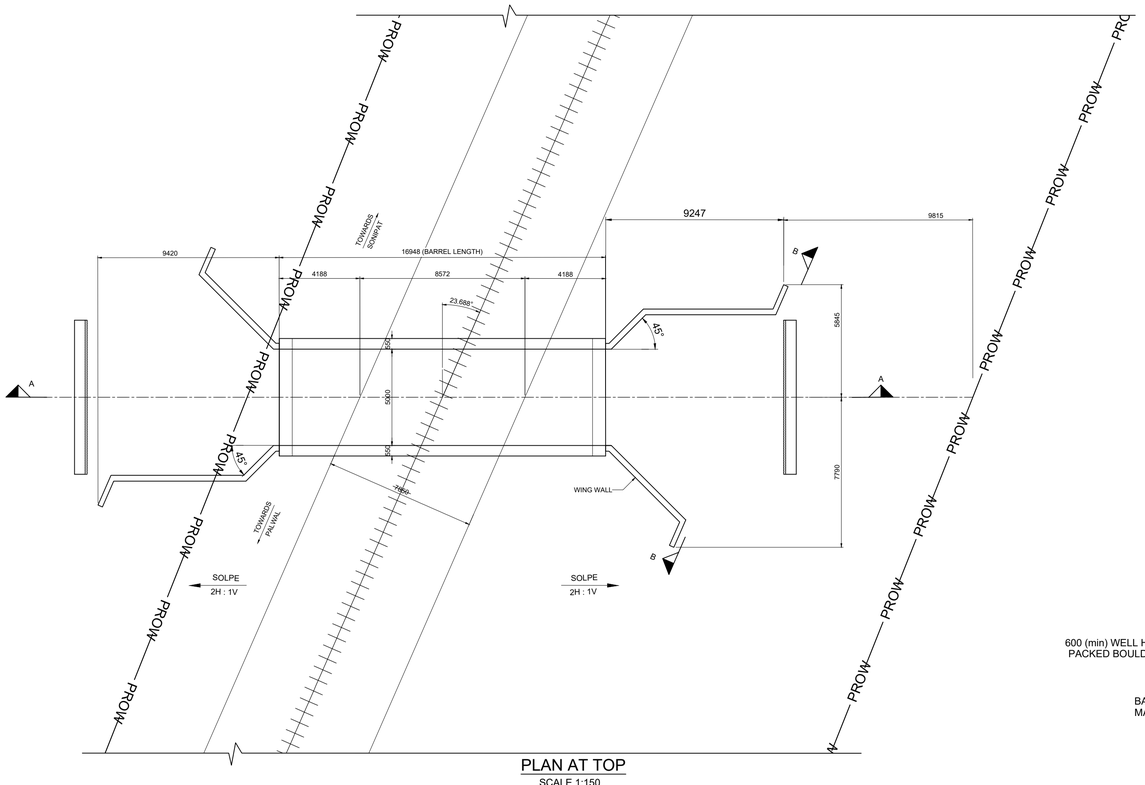
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD_NP-F-1_A0
SHEET NO. 1 OF 1

SCALE : AS SHOWN
ISSUE DATE
REVISED DATE



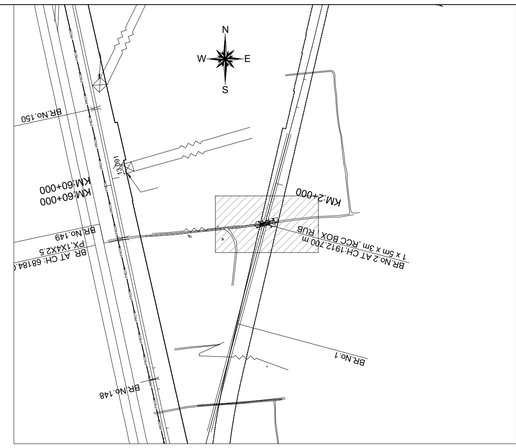
SECTIONAL ELEVATION AT A-A

SCALE 1:150



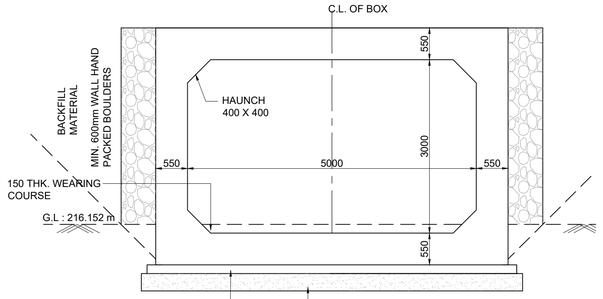
PLAN AT TOP

SCALE 1:150



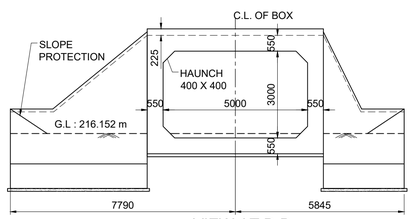
KEY PLAN

SCALE 1:NTS



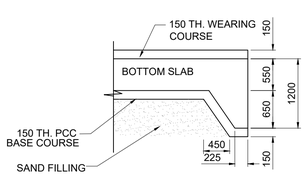
ELEVATION

SCALE 1:50



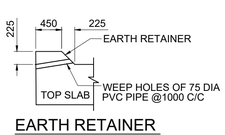
VIEW AT B-B

SCALE 1:100



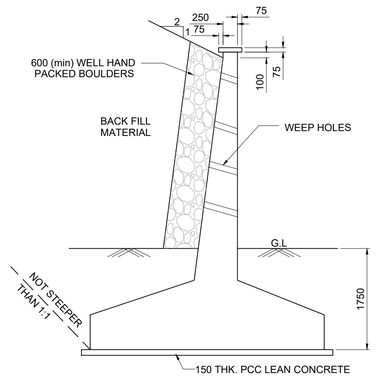
SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO.2 - 1X5.0X3.0m RCC BOX AT CH. 1912.700m (CONNECTING LINE NEW PATLI TO FARUKHNAGAR)

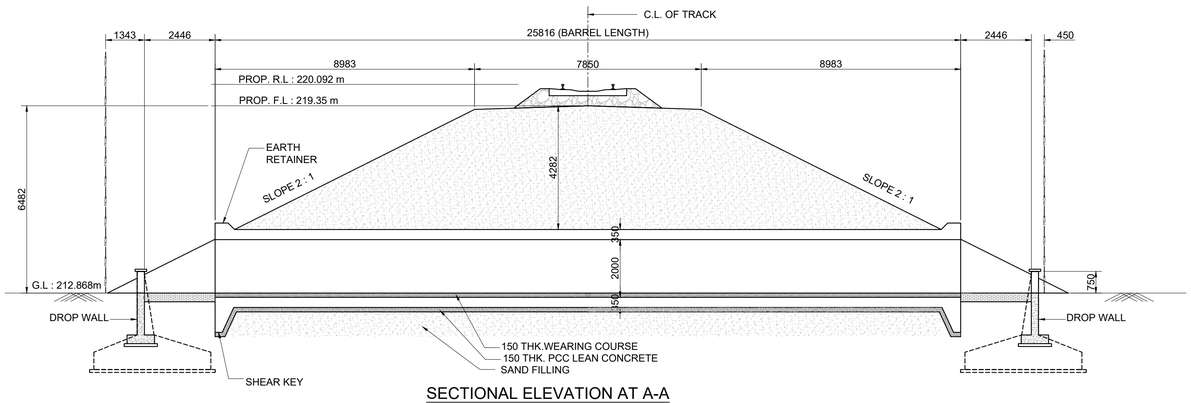
DRG. NO. GC-HRIDC-C2-DRG-BRD-GAD_NP-F-2_A0

SHEET NO. 1 OF 1

SCALE : AS SHOWN

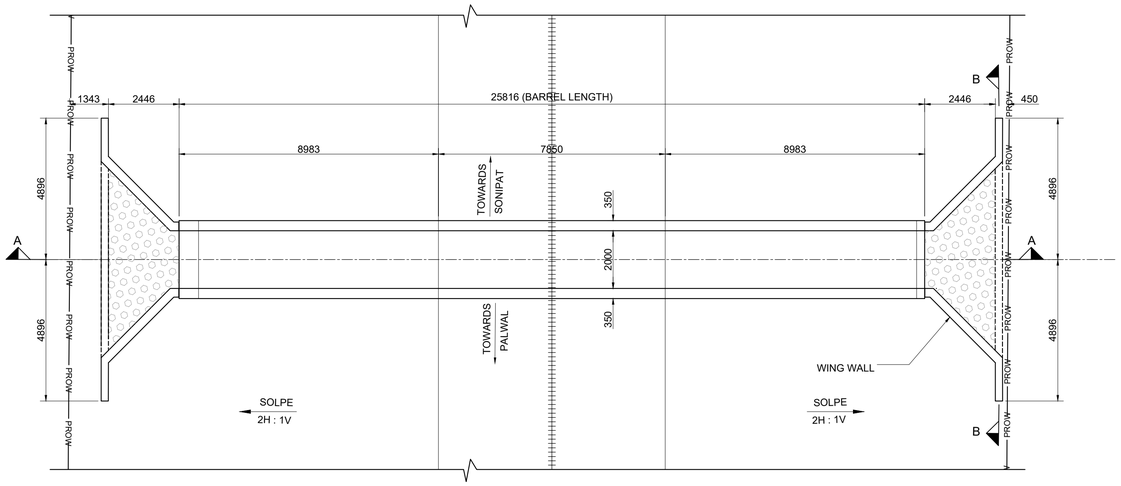
ISSUE DATE

REVISED DATE



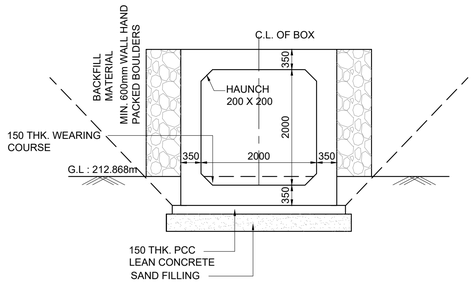
SECTIONAL ELEVATION AT A-A

SCALE 1:100



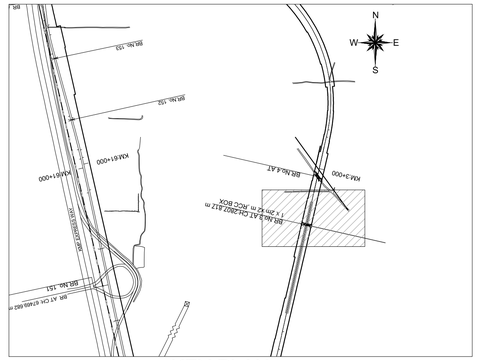
PLAN AT TOP

SCALE 1:100



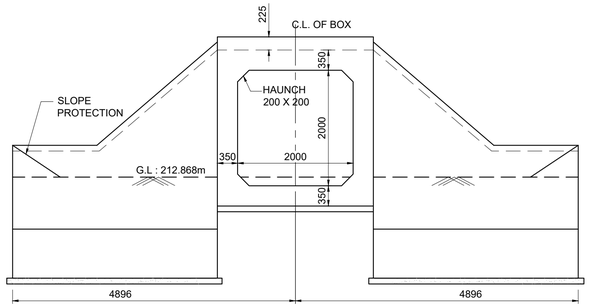
ELEVATION

SCALE 1:50



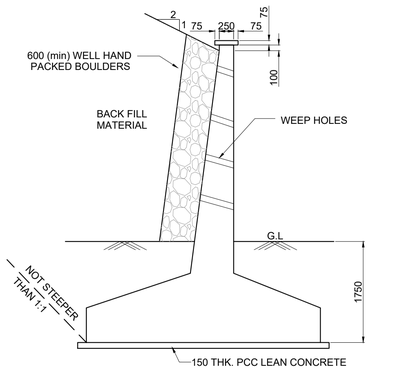
KEY PLAN

SCALE 1:NTS



VIEW B-B

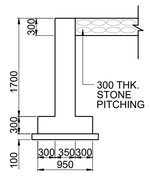
SCALE 1:50



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

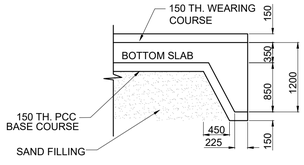
TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50



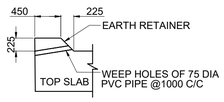
DROP / CURTAIN WALL DETAILS

SCALE 1:50



SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
5. DIMENSION OF THE BOX MAY BE SUITABLY MODIFIED AS PER SITE REQUIREMENT.
6. DESIGN CRITERIA SHALL BE BASED ON FOLLOWING IRS CODES
   (i) IRS BRIDGE RULE
   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
    (ii) WEARING COURSE =M:20/DETAILED DESIGN DRG.
    (iii) LEVELING COURSE/LEAN CONCRETE =M:20/DETAILED DESIGN DRG.
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

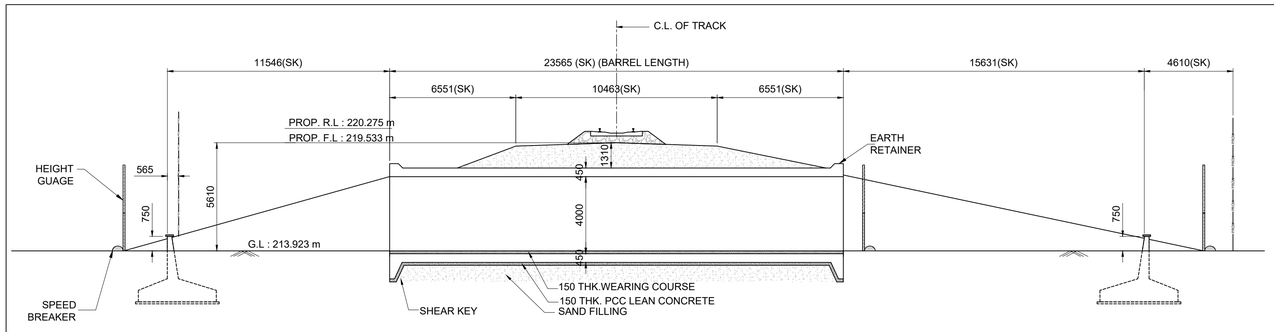
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR BALANCING CULVERT BRIDGE NO.3 - 1X2.0X2.0m RCC BOX AT CH. 2807.817m (CONNECTING LINE NEW PATLI TO FARUKHNAGAR)

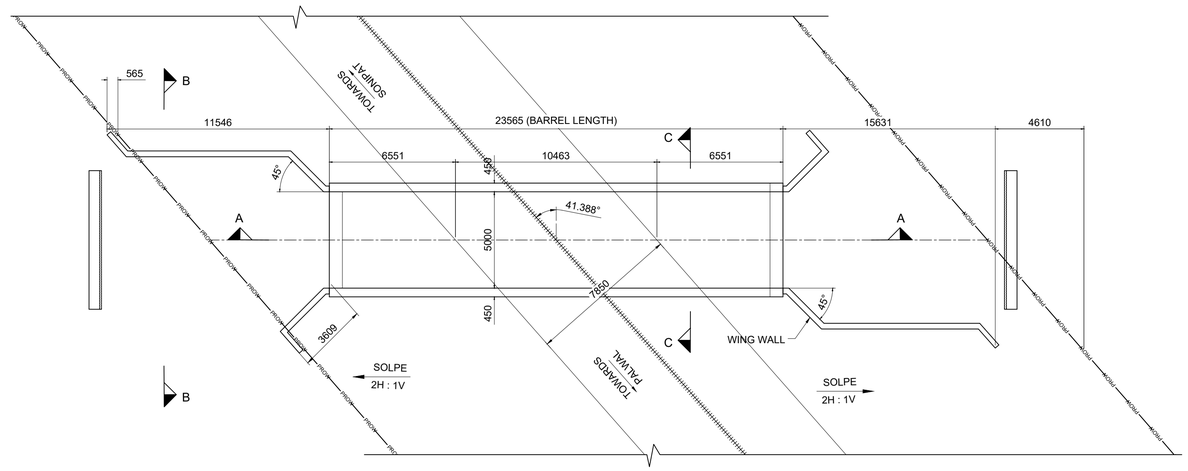
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD_NP-F-3_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



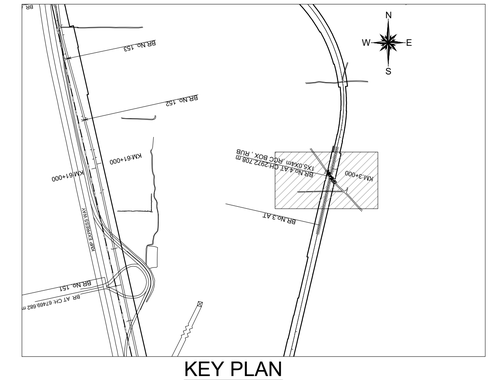
SECTIONAL ELEVATION AT A-A

SCALE 1:150



PLAN AT TOP

SCALE 1:150



KEY PLAN

SCALE 1:NTS

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS WHICH ARE IN METER, UNLESS OTHERWISE MENTIONED.
2. THE CHAINAGES SHOWN ARE RECKONED FROM C/L OF PRITHALA STATION BUILDING TAKEN AS 0.00 M, WITH RESPECT TO UP MAIN LINE.
3. FOR RAIL LEVELS, FORMATION LEVEL, GRADES ETC. REFER L-SECTION.
4. BOX BRIDGE IS TO BE DESIGNED FOR 32.5 T LOADING AS APPLICABLE.
5. THE EXISTING DETAILS ARE AS PER SITE SURVEY AND SHALL BE VERIFIED BY THE CONCTRACTOR BEFORE EXECUTION.
6. ENGINEER IN CHARGE/ SITE ENGINEER SHOULD VERIFY THE RAIL LEVEL FORMATION LEVEL , BED LEVEL & TRACK CENTER AT SITE BEFORE COMMENCEMENT OF WORK.
7. SUITABLE BED SLOPE SHALL BE PROVIDED AND ADJUSTED AS PER SITE CONDITIONS
8. ENGINEER IN CHARGE/SITE ENGINEER SHALL ENSURE THE SAFETY OF TRACK/ROAD AT ALL THE TIME AND SHALL TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE OF S&T CABLE /OFC DURING EXECUTION OF WORK CONCERNED DEPT. SUCH AS BSNL/AIRTEL/SSE/SIG/ADSTE ETC. SHALL BE INFORMED WELL IN ADVANCE BEFORE EXECUTION OF WORK.
9. THIS DRAWING IS THE PROPERTY OF HRIDC AND FOR EXCLUSIVE USE OF HORC.
10. DETAILED DESIGN DRAWING WILL BE PREPARED BASED ON THIS CONCEPTUAL APPROVED GAD,
11. THE SIZE OF BOX & SLABS ARE TENTATIVE AND WILL BE FINALISED AFTER DETAILED DESIGN.

B) TECHNICAL NOTES :

1. RETURN WALL AND OTHER PROTECTION WORK SUCH AS PITCHING ETC SHALL BE DONE AS SHOWN IN DRG. NO.GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
2. FOR PROPER DRAINAGE OF WATER, 50mm PCC M-20 WITH SUITABLE SLOPE TO BE USED ON TOP OF BOX SLAB.
3. ALL CLEAN/ EXPANSION JOINTS SHALL BE FILLED WITH BITUMINOUS BOARDS / POLYSULPHYDE SEALANT FILLING.
4. PLACEMENT LEVEL OF BOX AS SHOWN IN THIS GAD IS INDICATIVE AND MAY BE SUITABLY LOWERED/ELEVATED BASED UPON THE REQUIREMENT OF CLEARANCE AND DRAINAGE.
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   (ii) IRS CONCRETE BRIDGE CODE
   (iii) IRS BRIDGE SUB-STRUCTURE & FOUNDATION CODE
7. SEISMIC ZONE- IV
8. EXPOSURE CONDITION- MODERATE.
9. DURING CONSTRUCTION, IF REQUIRED, ROAD CLOSURE TO BE OBTAINED FROM CONCERNED ROAD/CIVIL AUTHORITIES. DIVERSION OF ROAD IF ANY, REQUIRED IS TO BE DONE BY CONTRACTOR AT HIS COST
10. THE BACK FILL MATERIAL SHALL BE CONFORMING TO CLAUSE 7.5 OF IRS SUB- STRUCTURE AND FOUNDATION CODE.
11. ALL RCC SURFACES COMING IN CONTACT WITH SOIL SHOULD BE PAINTED WITH BITUMEN OR COAL TAR OF APPROVED QUALITY @ 1.464 K.G/SQM.
12. REINFORCEMENT SHALL BE Fe 500D (TMT) CONFORMING TO IS 1786
13. FOR CONCRETE SPECIFICATION REFER IRS CONCRETE BRIDGE CODE.
    GRADE OF CONCRETE :
    (i) ALL RCC =M:35/DETAILED DESIGN DRG.
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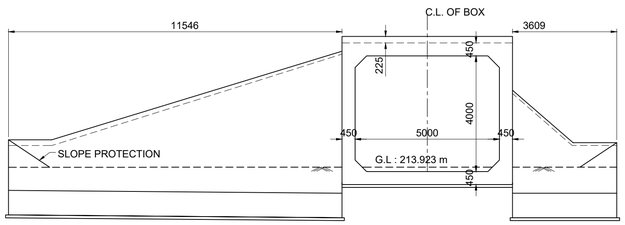
14. FOR SAFE BEARING CAPACITY OF SOIL PLEASE REFER GT REPORT. IF BEARING CAPACITY AT SITE IS INADEQUATE SUITABLE GROUND IMPROVEMENT MAY BE ADOPTED AS PER DETAILED DESIGN DRAWING.
15. FOUNDATION LEVEL SHOWN IN DRAWING IS TENTATIVE. DETAILED DESIGN DRAWING SHALL BE FOLLOWED FOR FOUNDATION LEVEL DURING EXECUTION.
16. HEIGHT GAUGE SHALL BE PROVIDED AS PER RDSO STANDARD DRAWING NO. RDSO/M0001.

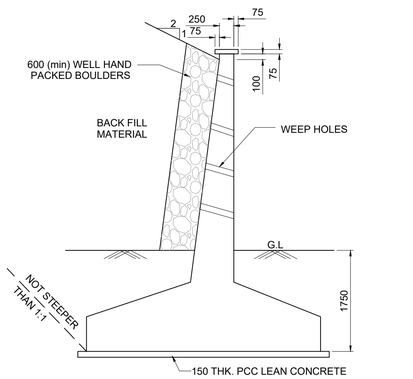
LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL



VIEW AT B-B

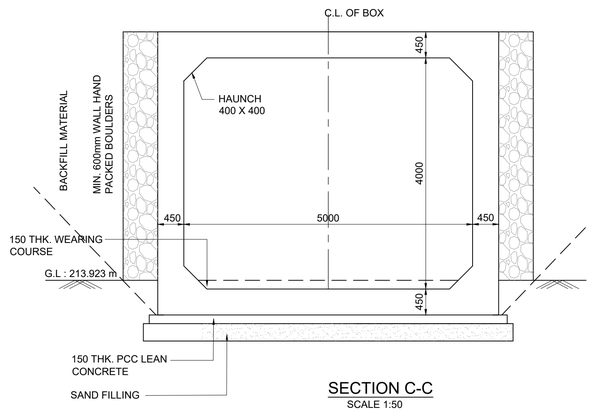
SCALE 1:100



WING WALL (TO BE DESIGN AS PER SITE CONDITION)

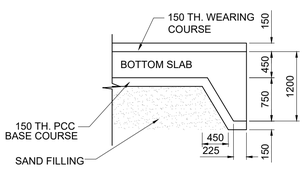
TYPICAL DETAIL OF RETURN WALL / WING WALL

SCALE 1:50



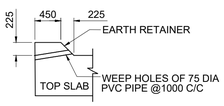
SECTION C-C

SCALE 1:50



SHEAR KEY

SCALE 1:50



EARTH RETAINER

SCALE 1:50

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

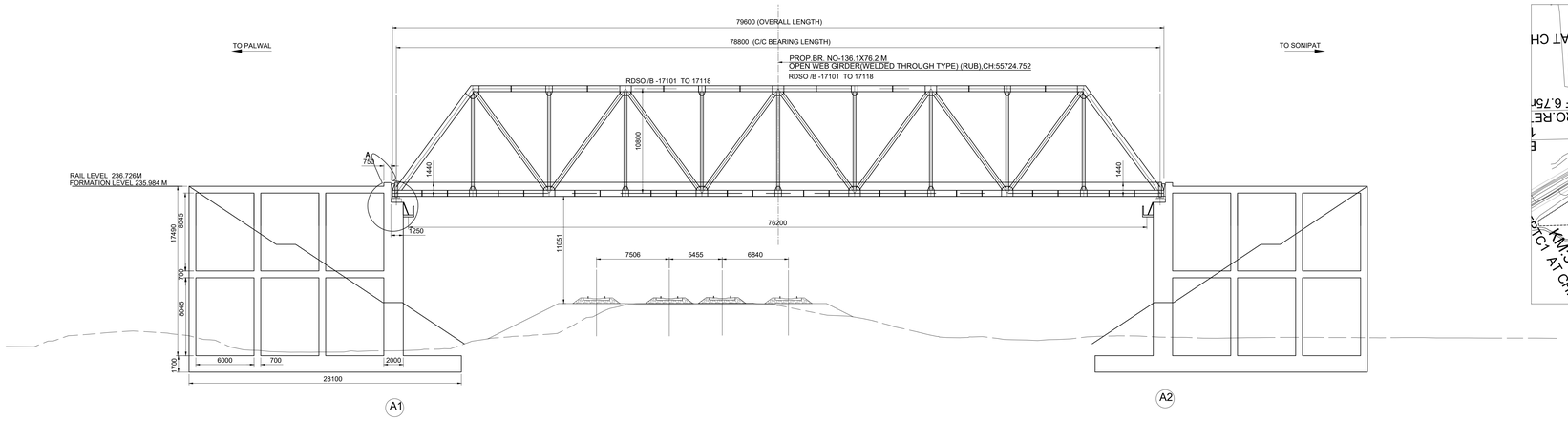
RITES Limited in consortium with SMEC International Pty. Ltd.

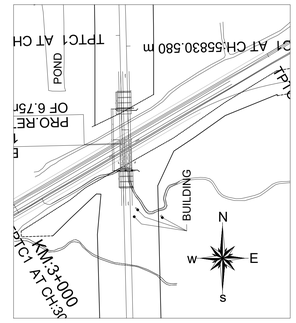
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR ROAD UNDER BRIDGE NO.4 - 1X5.0X4m RCC BOX AT CH. 2972.708m (CONNECTING LINE NEW PATLI TO FARUKHNAGAR)

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD_NP-F-4_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



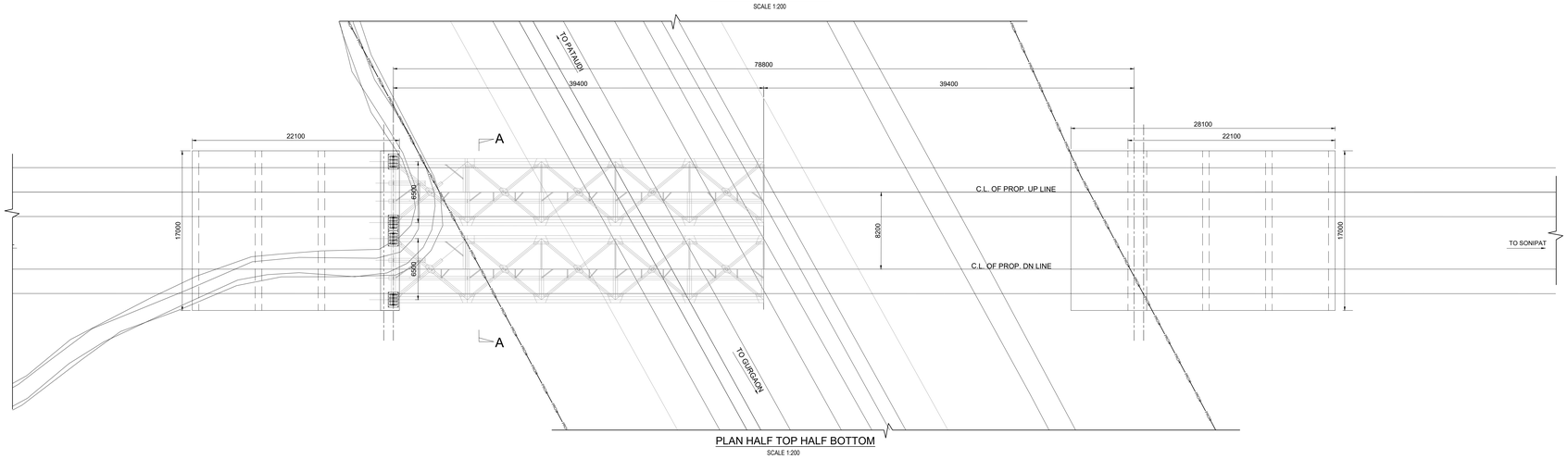


KEYPLAN
(NOT TO SCALE)

DATUM - 205.00					
FORMATION LEVEL	235.984	235.984	235.984	235.984	235.984
GROUND LEVEL	220.997	218.994	223.665	220.413	220.369
CHAINAGE	55659.152	55685.352	55724.752	55764.152	55790.352

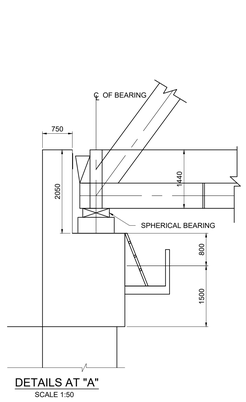
SECTIONAL ELEVATION

SCALE 1:200



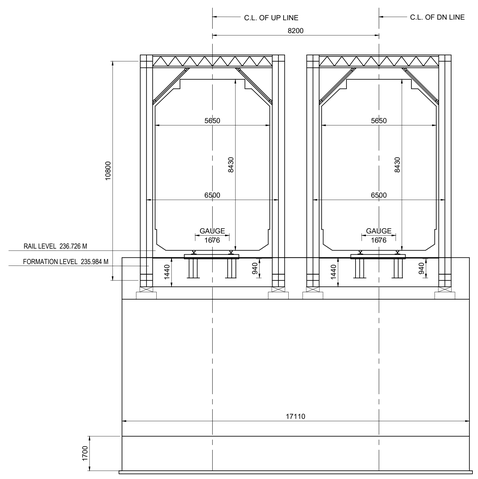
PLAN HALF TOP HALF BOTTOM

SCALE 1:200



DETAILS AT "A"

SCALE 1:50

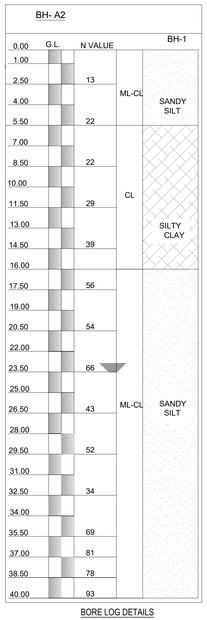


CROSS SECTION AT A-A

(SCALE 1:100)

X-683092.392
Y-3143783.105

BH- A2



BORE LOG DETAILS

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER
2. DIMENSIONS ARE NOT TO BE SCALED ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. DESIGN CRITERIA
   i) IRS BRIDGE SUBSTRUCTURE AND FOUNDATION CODE 2013.
   ii) IRS CONCRETE BRIDGE CODE 2014.
   iii) IRS BRIDGE RULES 2014.
   iv) IS 2911 PART-1 SECTION-2.
   v) EXPOSURE CONDITION - MODERATE.
   vi) SEISMIC ZONE - IV
   vii) STANDARD OF LOADING :- SUPER STRUCTURE-32.5T(RDSO STANDARD OWG) SUB STRUCTURE-32.5T- 2008 LOADING.
4. THE STRUCTURAL DIMENSIONS AND SIZES ARE INDICATIVE AND THESE MAY VARY DURING DETAIL DESIGN.
5. TYPE OF FOUNDATION SHOWN IS TENTATIVE AND MAY CHANGE DURING DETAILED DESIGN.
6. ALL RCC AND CC WORKS SHALL BE DONE IN ACCORDANCE WITH SPECIFICATION LAID DOWN IN IRS CONCRETE BRIDGE CODE.
7. THE GRADE OF CONCRETE
   i) FOR ABUTMENT,DIRT & RETURN WALL----------M35
   ii) FOR PILE & PILE CAP----------M35
   iii) FOR LEVELING COURSE----------M15
8. ALL CONCRETE WORK SHALL BE MECHANICALLY MIXED AND VIBRATED.
9. MIX DESIGN SHALL BE APPROVED BY ENGINEER - IN CHARGE.
10. HIGH YIELD STRENGTH DEFORMED BARS OF GRADE Fe-500D CONFORMING TO IS: 1786-2008 SHALL BE USED AS REINFORCEMENT.
11. BED LEVEL & ROAD LEVEL,FORMATION LEVEL AND RAIL LEVEL SHALL BE VERIFIED BY THE ENGINEER AT SITE BEFORE EXECUTION OF WORK.
12. ANGLE OF INTERNAL FRICTION OF BACK FILL SHALL NOT BE LESS THAN 35.
13. PITCHING WORK ON SLOPES OF BANK ON APPROACHES OF BRIDGE SHALL BE DONE AS PER DRAWING NO. GC-HRIDC-C2-DRG-BRD-GMD-015_A0.
14. BOULDER FILLING & BOULDER PACKING BEHIND ABUTMENT TO BE DONE AS PER IRS FOUNDATION & SUBSTRUCTURE CODE CL.7.5.2.
15. BACK FILL SHALL BE AS PER CL.7.5 OF IRS BRIDGE SUBSTRUCTURE & FOUNDATION CODE 2013.
16. 100mm DIA WEEP HOLES TO BE PROVIDED @1000 C/C HORZ. AND 1000 MM C/C VERTICALLY ABOVE LOWEST WATER LEVEL IN RETURN WALL AS PER IRS SUB STRUCTURE CODE CLAUSE 7.6.
17. CURING SHALL BE DONE AS PER CLAUSE NO 8.4 OF IRS CONCRETE BRIDGE CODE.
18. MAN REFUGE OF SUPERSTRUCTURE SHALL BE PROVIDED AS PER RDSO DRG.NO. RDSO CBS - 0028.
19. SAFETY & PROTECTION OF THE PROPOSED WORK IS TO BE ENSURED BY THE CONTRACTOR AS PER PARA 826 OF IRPWM WITH UPDATED CORRECTION SLIPS OF 2011-12.
20. THE SPECIFICATIONS FOR THE OPEN WEB GIRDER SHALL BE IN ACCORDANCE WITH RDSO DRG.NO'S : RDSO B-17101 TO 17118
21. CONCRETING SHALL BE DONE IN ACCORDANCE WITH IRS CONCRETE BRIDGE CODE WITH 20MM MAXIMUM SIZE AGGREGATE.
22. FOR PILE FOUNDATION THE RELEVANT CODE FOR PILE FOUNDATION AND TESTING WILL BE FOLLOWED.
23. ALL DIMENSIONS AND LEVELS SHOULD BE VERIFIED AT SITE BEFORE EXECUTION.
24. BRIDGE DETAILS LIKE , DL, INSPECTION STEPS PAINTINGS ETC SHOULD BE FOLLOWED AS PER BRIDGE MANUAL, DURING CONSTRUCTION.
25. THIS DRAWING IS PROPERTY OF HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (HRIDC) AND EXCLUSIVE USE OF HRIDC.
26. ARRANGEMENT FOR PATHWAY SHALL BE PROVIDED AS PER RDSO DWG. NO. CBS-0045(FOR OWG).

DESCRIPTION OF BRIDGE

1.	CHAINAGE	55724.752
2.	RAIL LEVEL	236.726 M
3.	FORMATION LEVEL	235.984 M
4.	VERTICAL ALLIGNMENT	LEVEL
4.	HORIZONTAL ALLIGNMENT	STRAIGHT
5.	SOFFIT LEVEL	234.944 M
6.	EXISTING RAIL LEVEL	223.893 M
7.	OVERALL SPAN	79600 MM
8.	EFFECTIVE SPAN	78800 MM
9.	CLEAR SPAN	76200 MM
10	TYPE OF CROSSING	RAILWAY
11	VERTICAL CLEARANCE	11051 MM

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:CONCEPTUAL GENERAL ARRANGEMENT DRAWING

FOR PROPOSED MAJOR ROR BRIDGE NO.136
AT CH: 55724.752 m 1X76.2 OPEN WEB GIRDER

DRG. NO.

GC-HRIDC-C2-DRG-BRD-GAD-136_A0

SHEET NO.

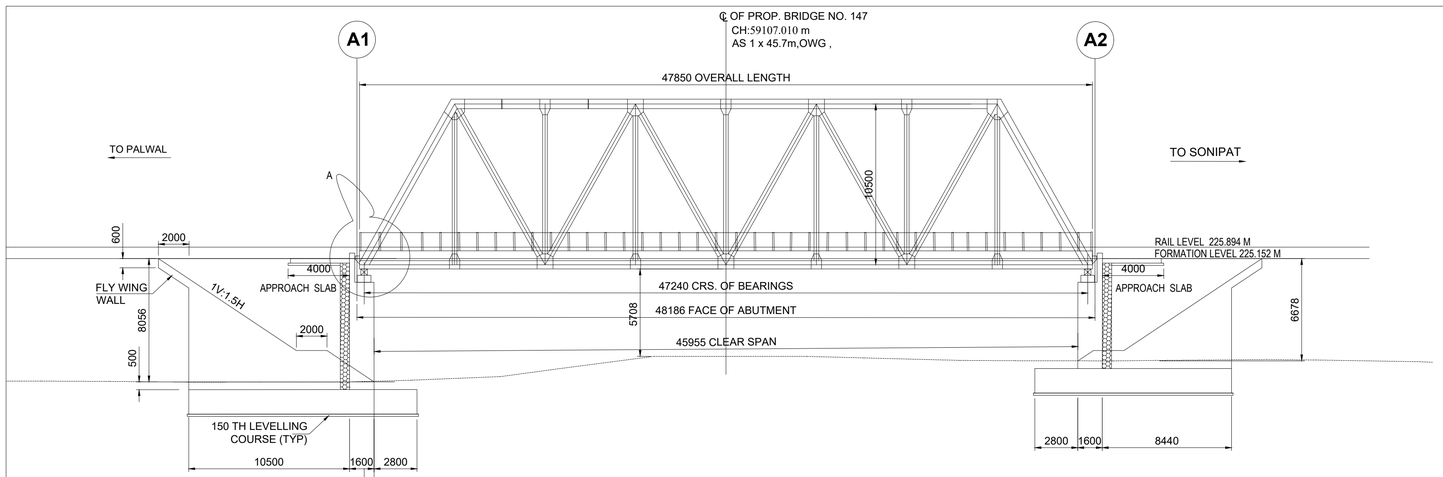
1 OF 1

SCALE :

AS SHOWN

ISSUE DATE

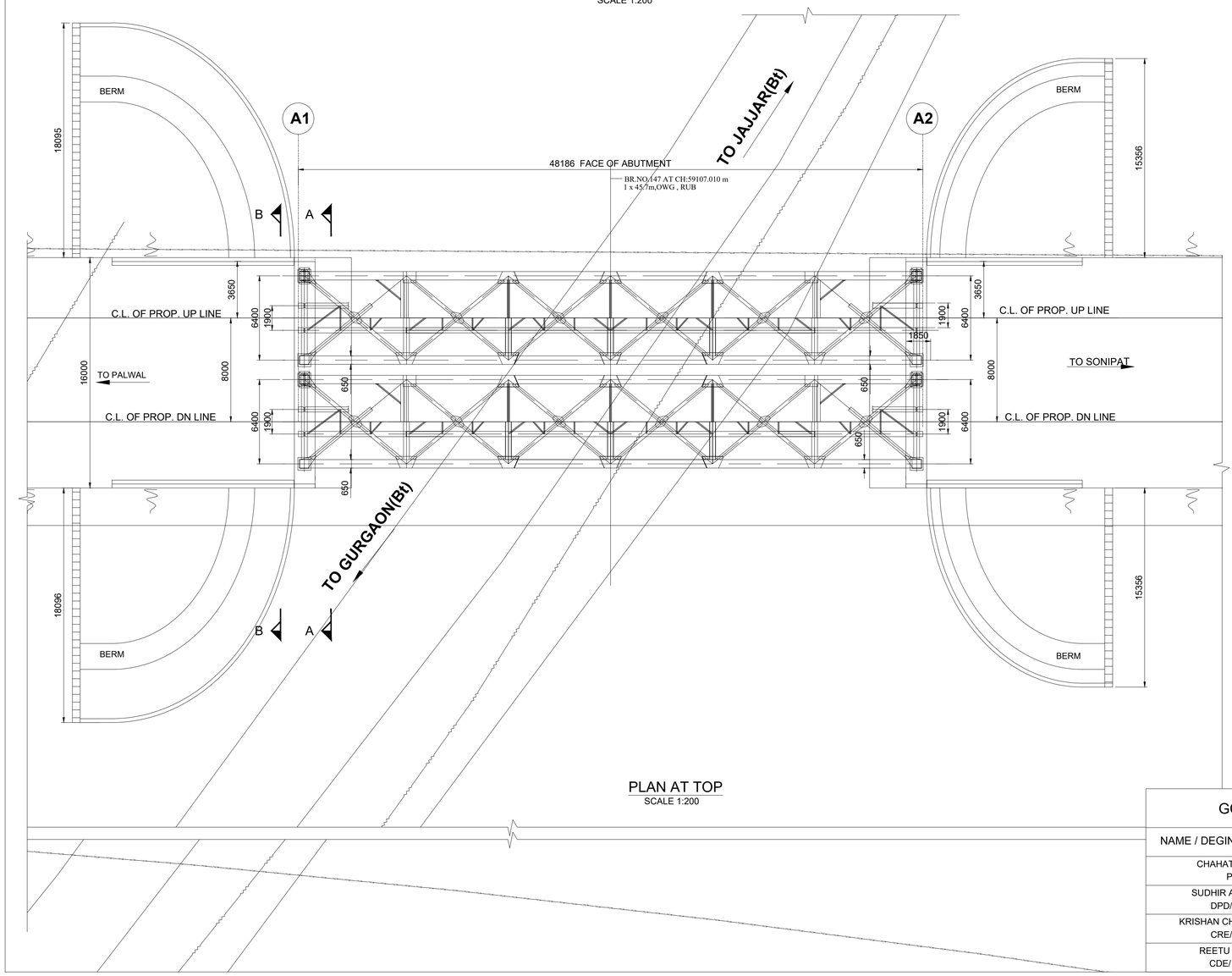
REVISED DATE



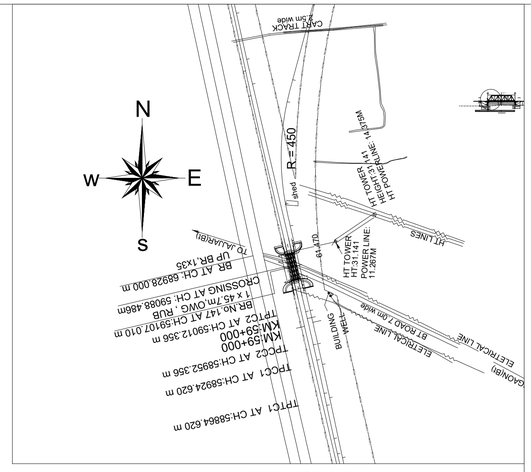
DATUM - 215.000

FORMATION LEVEL	225.152	225.152	225.152
GROUND LEVEL	217.127	218.766	218.476
CHAINAGE	-23.620	0.000	23.620

SECTIONAL ELEVATION
SCALE 1:200



PLAN AT TOP
SCALE 1:200



KEY PLAN
SCALE 1:NTS

NOTES:

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   ii) IRS CONCRETE BRIDGE CODE 2014.
   iii) IRS BRIDGE RULES 2014.
   iv) IS 2911 PART-1 SECTION-2.
   v) EXPOSURE CONDITION - MODERATE.
   vi) SEISMIC ZONE - IV
   vii) STANDARD OF LOADING :- SUPER STRUCTURE-25T AND SUB STRUCTURE-32.5T- 2008 LOADING.
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   iii) FOR LEVELING COURSE----------M15
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9. MIX DESIGN SHALL BE APPROVED BY ENGINEER - IN CHARGE.
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13. STONE PITCHING ON SLOPES OF BANK ON APPROACHES OF BRIDGE MAY BE PROVIDED AS DIRECTED BY ENGINEER.
14. BOULDER FILLING & BOULDER PACKING BEHIND ABUTMENT TO BE DONE AS PER IRS FOUNDATION & SUBSTRUCTURE CODE CL.7.5.2.
15. BACK FILL SHALL BE AS PER CL.7.5 OF IRS BRIDGE SUBSTRUCTURE & FOUNDATION CODE 2013.
16. 75mm DIA WEEP HOLES TO BE PROVIDED @1000 C/C HORZ. AND 1000 MM C/C VERTICALLY ABOVE LOWEST WATER LEVEL IN RETURN WALL AS PER IRS SUB STRUCTURE CODE CLAUSE 7.6.
17. CURING SHALL BE DONE AS PER CLAUSE NO 8.4 OF IRS CONCRETE BRIDGE CODE.
18. MAN REFUGE OF SUPERSTRUCTURE SHALL BE PROVIDED AS PER RDSO DRG.NO. RDSO CBS - 0028.
19. SAFETY & PROTECTION OF THE PROPOSED WORK IS TO BE ENSURED BY THE CONTRACTOR AS PER PARA 826 OF IRPWM WITH UPDATED CORRECTION SLIPS OF 2011-12.
20. THE SPECIFICATIONS FOR THE OPEN WEB GIRDER SHALL BE IN ACCORDANCE WITH RDSO DRG.NO'S : RDSO/B-17081 TO 17098
21. CONCRETING SHALL BE DONE IN ACCORDANCE WITH IRS CONCRETE BRIDGE CODE WITH 20MM MAXIMUM SIZE AGGREGATE.
22. FOR PILE FOUNDATION THE RELEVANT CODE FOR PILE FOUNDATION AND TESTING WILL BE FOLLOWED.
23. ALL DIMENSIONS AND LEVELS SHOULD BE VERIFIED AT SITE BEFORE EXECUTION.
24. BRIDGE DETAILS LIKE , DL, INSPECTION STEPS PAINTINGS ETC SHOULD BE FOLLOWED AS PER BRIDGE MANUAL, DURING CONSTRUCTION.
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GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

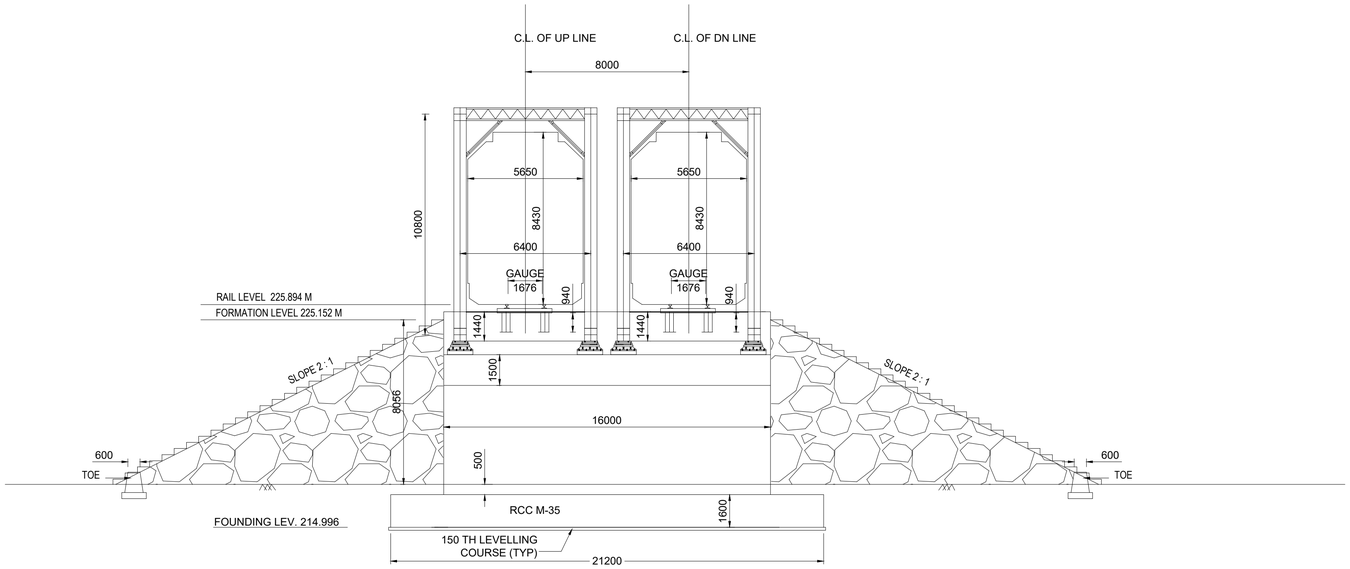
CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING
FOR PROPOSED MAJOR RUB NO.147 AT CH:59107.010 m 1 x 45.7m,OPEN WEB GIRDER

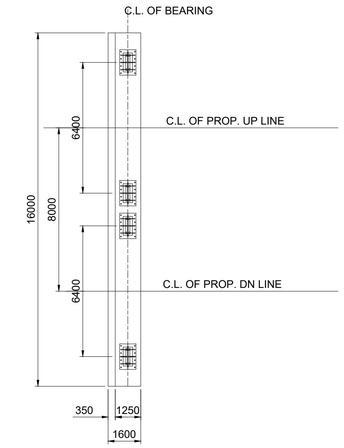
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-147_A0	1 OF 2

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



CROSS SECTION AT A-A (ABUTMENT)

SCALE 1:150



TYPICAL DETAILS OF ABUTMENT

SCALE 1:150

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER
2. DIMENSIONS ARE NOT TO BE SCALED ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. DESIGN CRITERIA
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   v) EXPOSURE CONDITION - MODERATE.
   vi) SEISMIC ZONE - IV
   vii) STANDARD OF LOADING :- SUPER STRUCTURE-25T AND SUB STRUCTURE-32.5T- 2008 LOADING.
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8. ALL CONCRETE WORK SHALL BE MECHANICALLY MIXED AND VIBRATED.
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11. ROAD LEVEL & FORMATION LEVEL AND RAIL LEVEL SHALL BE VERIFIED BY THE ENGINEER AT SITE BEFORE EXECUTION OF WORK.
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14. BOULDER FILLING & BOULDER PACKING BEHIND ABUTMENT TO BE DONE AS PER IRS FOUNDATION & SUBSTRUCTURE CODE CL.7.5.2.
15. BACK FILL SHALL BE AS PER CL.7.5 OF IRS BRIDGE SUBSTRUCTURE & FOUNDATION CODE 2013.
16. 75mm DIA WEEP HOLES TO BE PROVIDED @1000 C/C HORZ. AND 1000 MM C/C VERTICALLY ABOVE LOWEST WATER LEVEL IN RETURN WALL AS PER IRS SUB STRUCTURE CODE CLAUSE 7.6.
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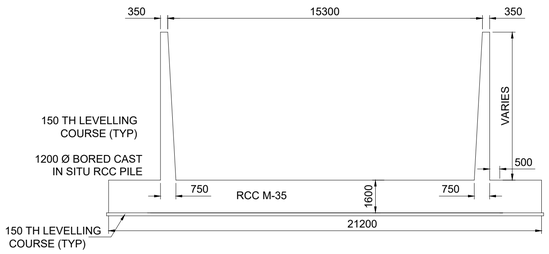
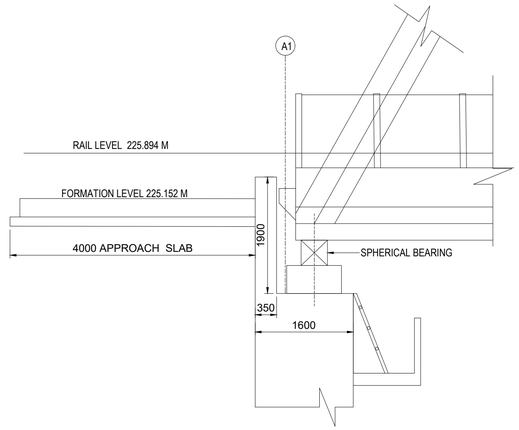


CROSS SECTION AT B-B

SCALE 1:150



DETAILS AT "A"

SCALE 1:50

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
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PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

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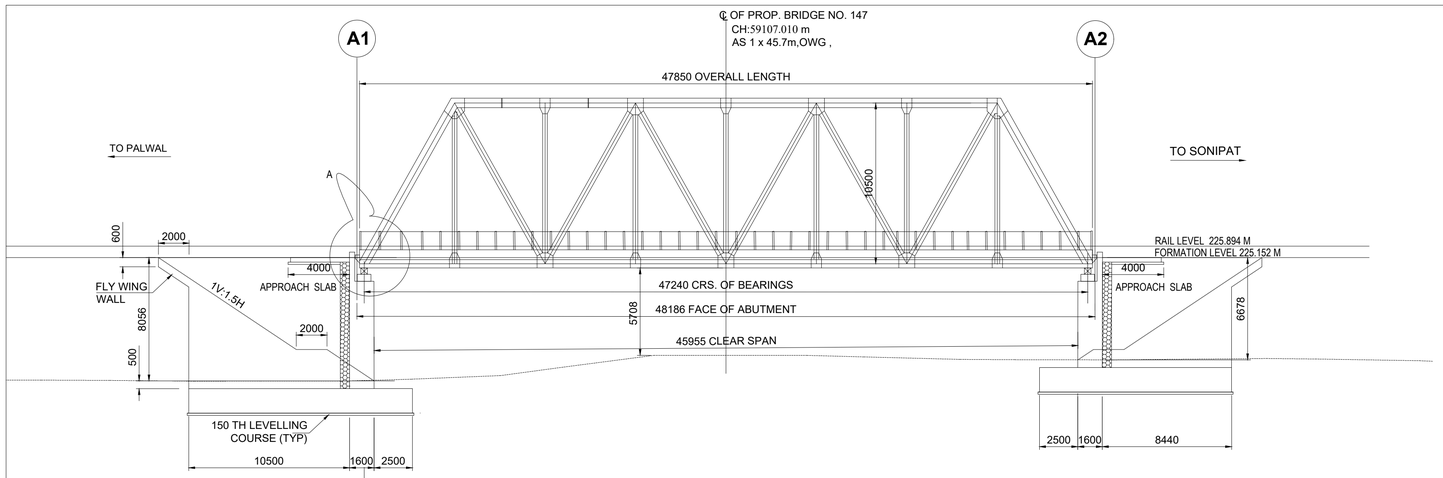
TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING

FOR PROPOSED MAJOR RUB NO.147 AT CH:59107.010 m 1 x 45.7m,OPEN WEB GIRDER

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD-147_A0	2 OF 2

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



DATUM - 215.000

FORMATION LEVEL	225.152	225.152	225.152
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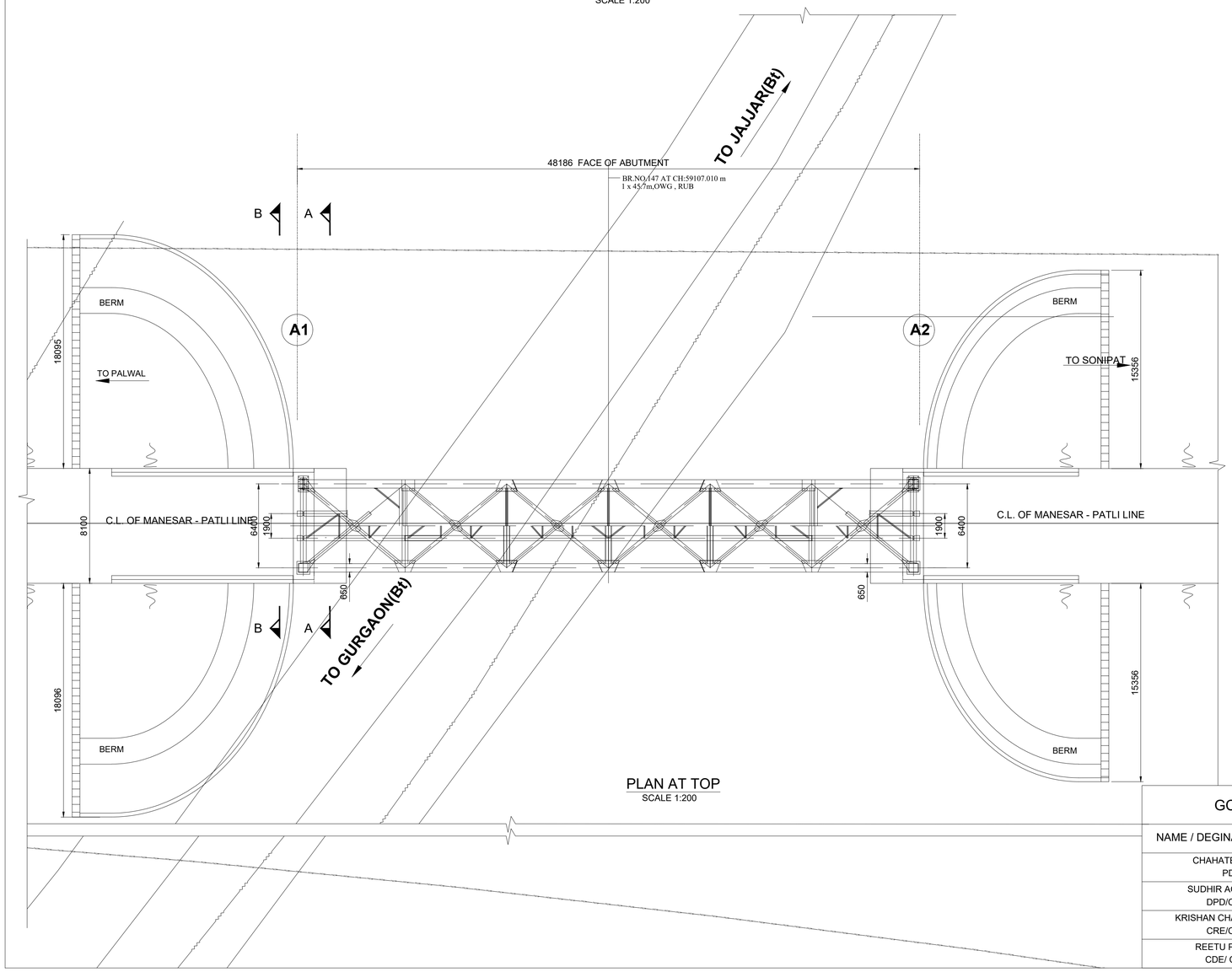
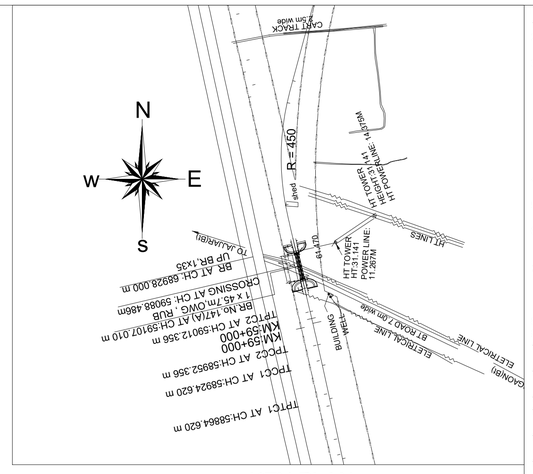
CHAINAGE	-23.620	0.000	23.620

SECTIONAL ELEVATION
SCALE 1:200



PLAN AT TOP
SCALE 1:200



KEY PLAN
SCALE 1:NTS

NOTES:
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20. THE SPECIFICATIONS FOR THE OPEN WEB GIRDER SHALL BE IN ACCORDANCE WITH RDSO DRG.NO'S : RDSO/B-17081 TO 17098
21. CONCRETING SHALL BE DONE IN ACCORDANCE WITH IRS CONCRETE BRIDGE CODE WITH 20MM MAXIMUM SIZE AGGREGATE.
22. FOR PILE FOUNDATION THE RELEVANT CODE FOR PILE FOUNDATION AND TESTING WILL BE FOLLOWED.
23. ALL DIMENSIONS AND LEVELS SHOULD BE VERIFIED AT SITE BEFORE EXECUTION.
24. BRIDGE DETAILS LIKE , DL, INSPECTION STEPS PAINTINGS ETC SHOULD BE FOLLOWED AS PER BRIDGE MANUAL, DURING CONSTRUCTION.
25. THIS DRAWING IS PROPERTY OF HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (HRIDC) AND EXCLUSIVE USE OF HRIDC.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

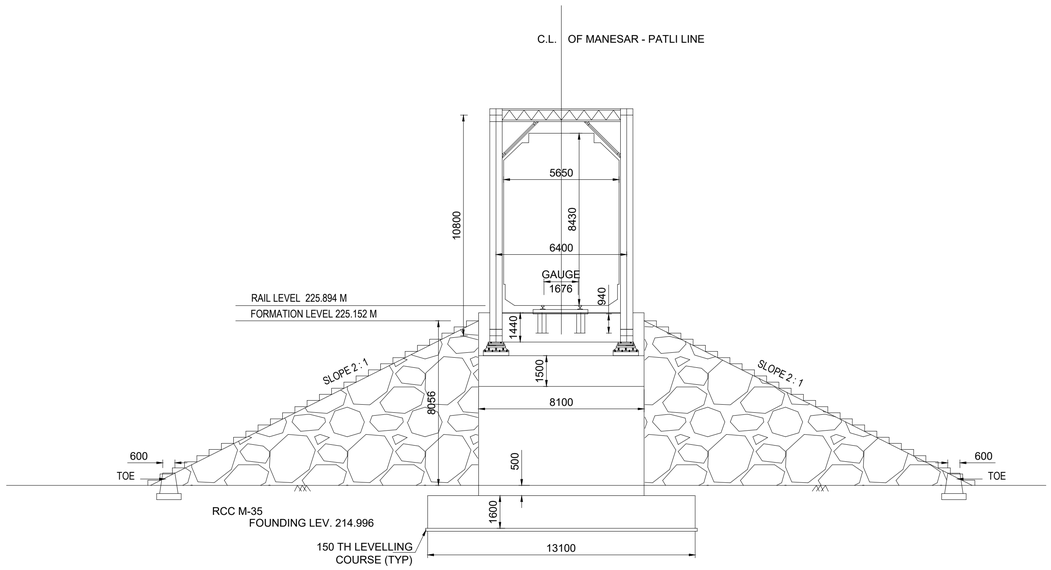
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.
THE INFRASTRUCTURE PEOPLE
Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR PROPOSED MAJOR RUB NO.147(A) AT CH:1200.000 m 1 x 45.7m,OPEN WEB GIRDER(CONNECTING LINE NEW PATLI TO FARUKHNAGAR)

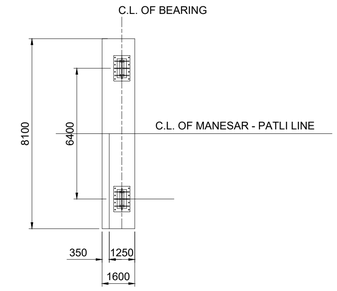
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD_NP-F-147(A)_A0	1 OF 2

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



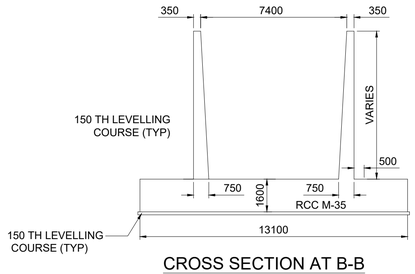
CROSS SECTION AT A-A (ABUTMENT)

SCALE 1:150



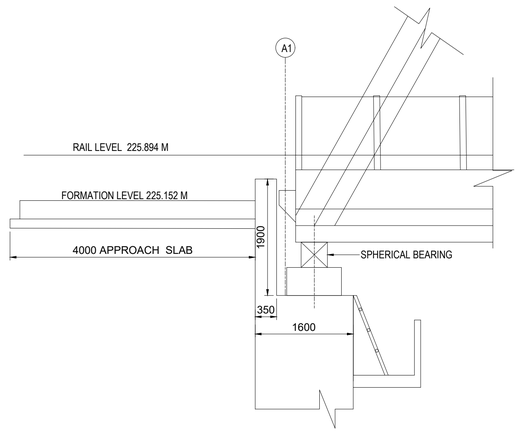
TYPICAL DETAILS OF ABUTMENT

SCALE 1:150



CROSS SECTION AT B-B

SCALE 1:150



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER
2. DIMENSIONS ARE NOT TO BE SCALED ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. DESIGN CRITERIA
   i) IRS BRIDGE SUBSTRUCTURE AND FOUNDATION CODE 2013.
   ii) IRS CONCRETE BRIDGE CODE 2014.
   iii) IRS BRIDGE RULES 2014.
   iv) IS 2911 PART-1 SECTION-2.
   v) EXPOSURE CONDITION - MODERATE.
   vi) SEISMIC ZONE - IV
   vii) STANDARD OF LOADING :- SUPER STRUCTURE-25T AND SUB STRUCTURE-32.5T- 2008 LOADING.
4. THE STRUCTURAL DIMENSIONS AND SIZES ARE INDICATIVE AND THESE MAY VARY DURING DETAIL DESIGN.
5. TYPE OF FOUNDATION SHOWN IS TENTATIVE AND MAY CHANGE DURING DETAILED DESIGN.
6. ALL RCC AND CC WORKS SHALL BE DONE IN ACCORDANCE WITH SPECIFICATION LAID DOWN IN IRS CONCRETE BRIDGE CODE.
7. THE GRADE OF CONCRETE
   i) FOR ABUTMENT,DIRT & RETURN WALL----------M35
   ii) FOR PILE & PILE CAP----------M35
   iii) FOR LEVELING COURSE----------M15
8. ALL CONCRETE WORK SHALL BE MECHANICALLY MIXED AND VIBRATED.
9. MIX DESIGN SHALL BE APPROVED BY ENGINEER - IN CHARGE.
10. HIGH YIELD STRENGTH DEFORMED BARS OF GRADE Fe-500D CONFORMING TO IS: 1786-2008 SHALL BE USED AS REINFORCEMENT.
11. ROAD LEVEL & FORMATION LEVEL AND RAIL LEVEL SHALL BE VERIFIED BY THE ENGINEER AT SITE BEFORE EXECUTION OF WORK.
12. ANGLE OF INTERNAL FRICTION OF BACK FILL SHALL NOT BE LESS THAN 35.
13. STONE PITCHING ON SLOPES OF BANK ON APPROACHES OF BRIDGE MAY BE PROVIDED AS DIRECTED BY ENGINEER.
14. BOULDER FILLING & BOULDER PACKING BEHIND ABUTMENT TO BE DONE AS PER IRS FOUNDATION & SUBSTRUCTURE CODE CL.7.5.2.
15. BACK FILL SHALL BE AS PER CL.7.5 OF IRS BRIDGE SUBSTRUCTURE & FOUNDATION CODE 2013.
16. 75mm DIA WEEP HOLES TO BE PROVIDED @1000 C/C HORZ. AND 1000 MM C/C VERTICALLY ABOVE LOWEST WATER LEVEL IN RETURN WALL AS PER IRS SUB STRUCTURE CODE CLAUSE 7.6.
17. CURING SHALL BE DONE AS PER CLAUSE NO 8.4 OF IRS CONCRETE BRIDGE CODE.
18. MAN REFUGE OF SUPERSTRUCTURE SHALL BE PROVIDED AS PER RDSO DRG.NO. RDSO CBS - 0028.
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SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

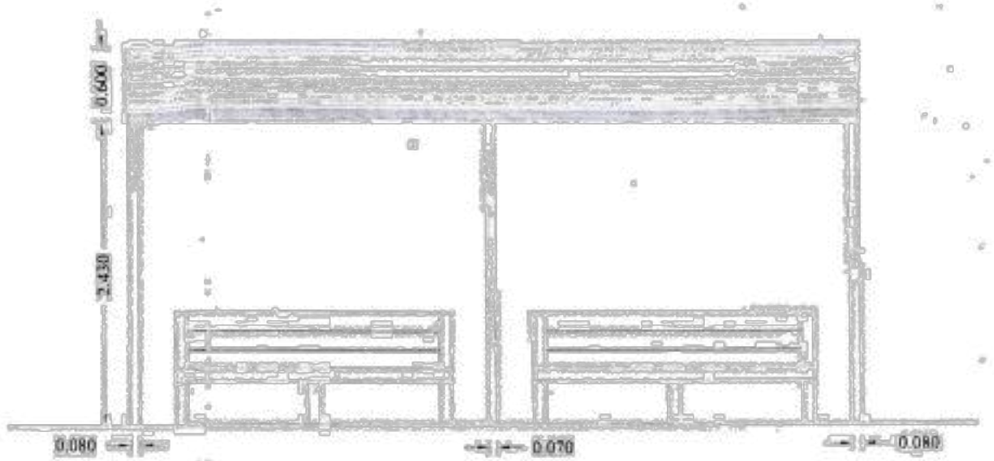
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- CONCEPTUAL GENERAL ARRANGEMENT DRAWING FOR PROPOSED MAJOR RUB NO.147(A) AT CH:1200.000 m 1 x 45.7m,OPEN WEB GIRDER(CONNECTING LINE NEW PATLI TO FARUKHNAGAR)

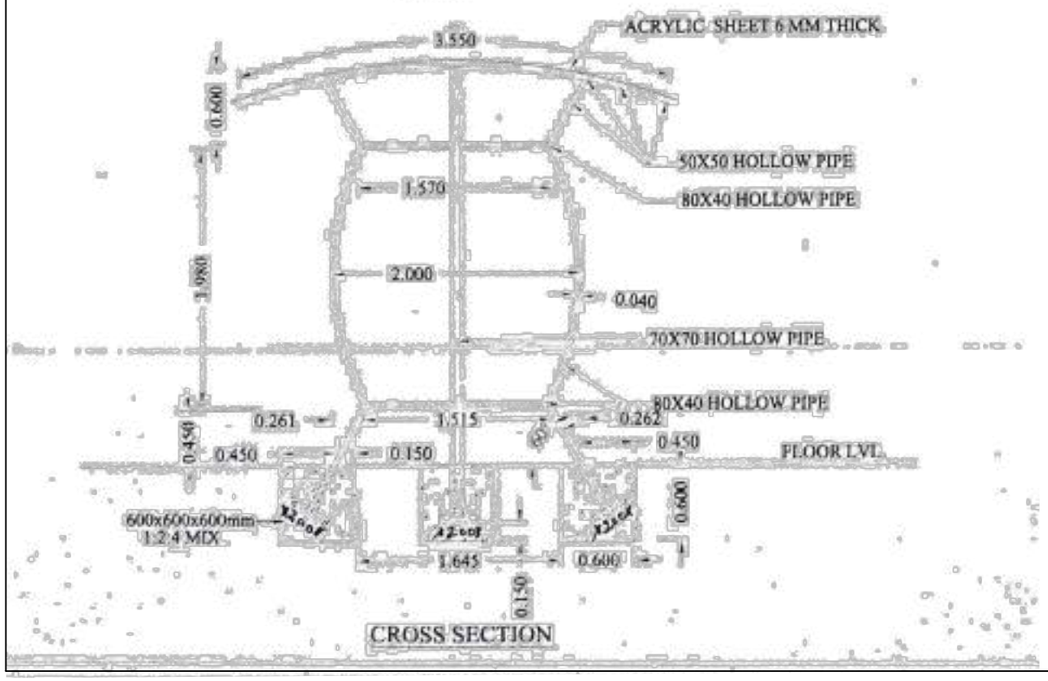
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GAD_NP-F-147(A)_A0	2 OF 2

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		

PLAN



FRONT VIEW



CROSS SECTION

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

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HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

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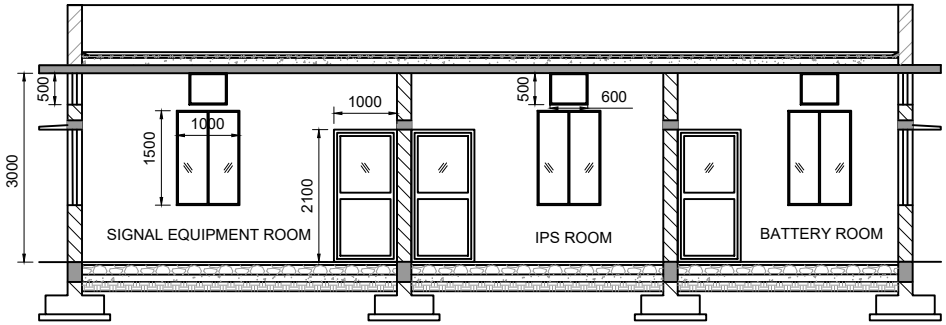
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE:- CONCEPTUAL PLAN
MINI PLATFORM SHELTER

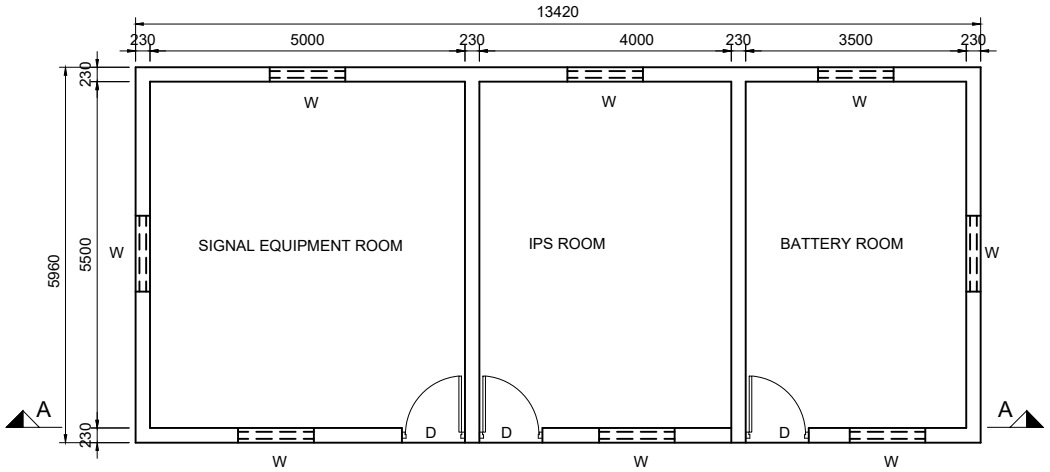
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-SAD-GMD-001_A0	1 OF 1

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



SECTIONAL ELEVATION A-A

(SCALE 1:100)



PLAN

(SCALE 1:100)

SCHEDULE

DOOR	2100x1000
WINDOW	1000x1500
TILATOR	600x500

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETERS.

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PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

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CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE:- CONCEPTUAL PLAN S & T HUT

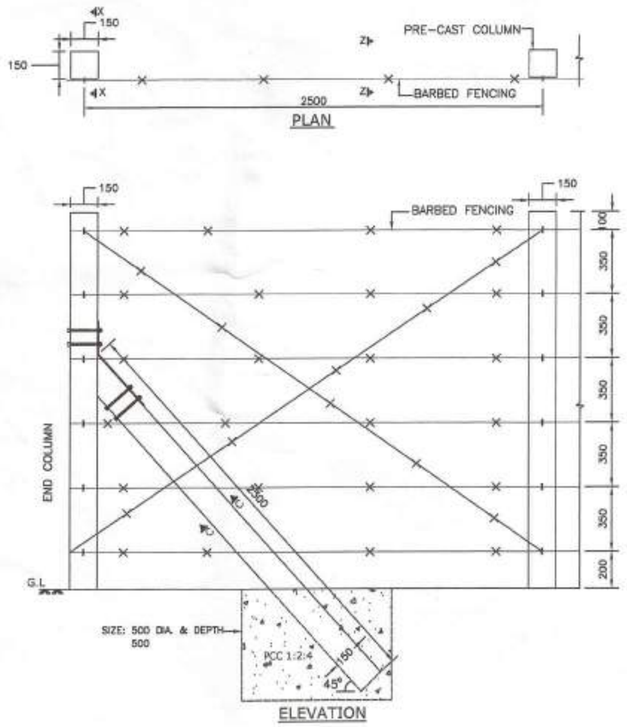
DRG. NO. GC-HRIDC-C2-DRG-SAD-GMD-002_A0

SHEET NO.

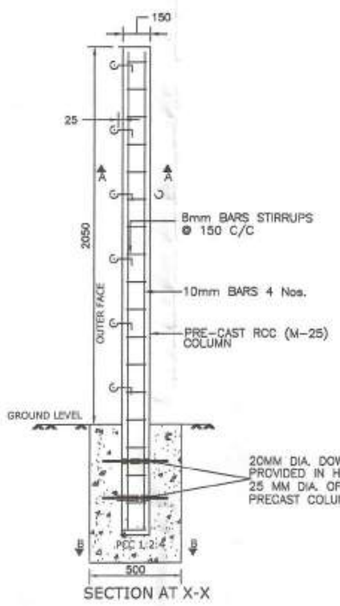
SCALE : AS SHOWN

ISSUE DATE

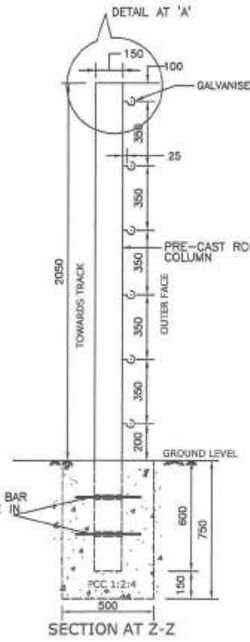
REVISED DATE



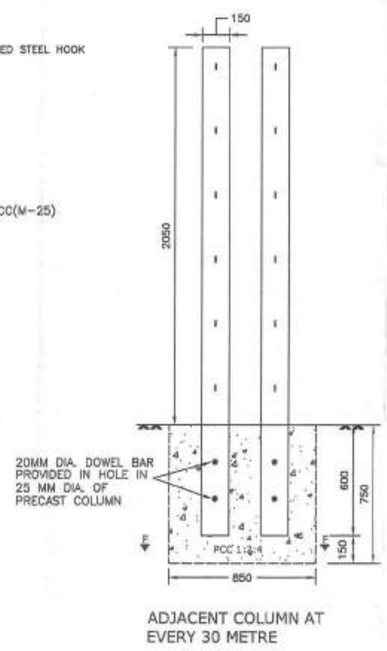
ELEVATION



SECTION AT X-X



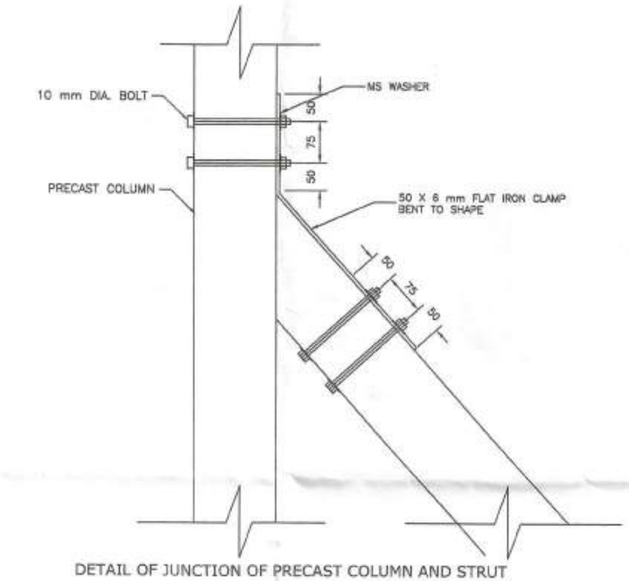
SECTION AT Z-Z



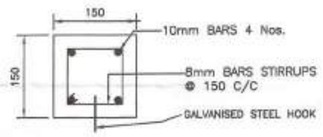
ADJACENT COLUMN AT EVERY 30 METRE

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BARBED FENCING SHALL BE MADE OF G.I. BARBED WIRES CONFIRMING TO IS: 278. THE WEIGHT OF G.I. BARBED WIRE SHALL BE AS PER SOR.
3. THE G.I BARBED WIRES SHALL BE FIXED TO THE COLUMNS WITH HOOKS MADE OF 6 mm DIA. GALVANIZED STEEL. ANOTHER END OF GALVANIZED STEEL HOOK SHALL BE PLACED BEHIND STIRRUPS AND TIED WITH STIRRUPS AS PER DRAWING TO PROVIDE STRENGTH.
4. FOR ERECTION OF WIRE FENCING, RECOMMENDATIONS GIVEN IN IS:4996-1984 SHALL BE FOLLOWED. FENCING WIRE SHALL BE TIED TO GALVANISED STEEL HOOKS WITH SHORT PIECE OF LIGHT WIRE.
5. M-25 GRADE CONCRETE SHALL BE USED IN PRECAST COLUMN/ STRUT. COLUMN/ STRUT SHALL BE CAST AT CENTRALIZED DEPOT UNDER CONTROLLED CONDITION AS PER IS :456-2000.
6. TMT BARS OF GRADE FE 415/ 500 OF SPECIFIED DIA. SHALL BE USED. TMT BAR SHALL BE CONFIRMING TO IS:1786 (LATEST).
7. ZONAL RAILWAY MAY PAINT THEIR INITIALS (SUCH AS NR, SER etc.) ON COLUMN AND STRUT.
8. STRUT OR BRACE SHALL BE FIXED WITH END RCC COLUMN BY SUITABLE ARRANGEMENT AS DETAILED IN DRAWING. 50 X 6 mm MS FLAT SHALL BE USED TO CONNECT STRUT/BRACE TO RCC COLUMN. 10 mm DIA. MS BOLT BLACK HEXAGONAL HEAD ROUND NECK WITH HEXAGONAL NUTS AND TWO WASHER SHALL BE USED. AFTER TIGHTING NUT, END OF BOLT SHALL BE HAMMERED TO MAKE ANTITHEFT.
9. SUPPORTING STRUT SHALL BE PROVIDED AT FIRST / END COLUMN OR CHANGE OF DIRECTION.
10. 1:20 SLOPE SHALL BE PROVIDED ON TOP OF COLUMN AT THE TIME OF CASTING.
11. AT EVERY 30 METRE TWO COLUMN SHALL BE GROUTED SIDE BY SIDE.
12. IN UNDULATING AREA, COLUMN SHALL BE PLACED ACCORDINGLY SO THAT BARBED WIRE ARE ALIGNED HORIZONTAL. VERTICALITY OF COLUMN SHALL BE CHECKED DURING ERECTION.
13. FOUNDATION SHALL BE DUG USING AUGAR/ MECHANICAL BORING EARTH SHALL BE RAMMED PROPERLY AND 50 MM SAND SHALL BE PLACED BEFORE FOUNDATION CASTING. FOUNDATION SHALL BE CURED PROPERLY.
14. THIS CATLE FENCE SHALL BE PROVIDED AT RAILWAY BOUNDARY.

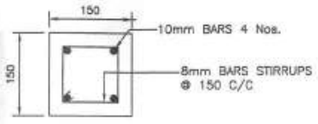


DETAIL OF JUNCTION OF PRECAST COLUMN AND STRUT

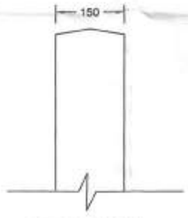


SECTION AT A-A

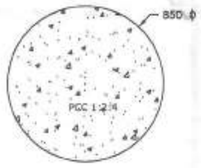
SECTION AT B-B



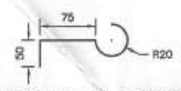
SECTION AT C-C



DETAIL AT 'A'



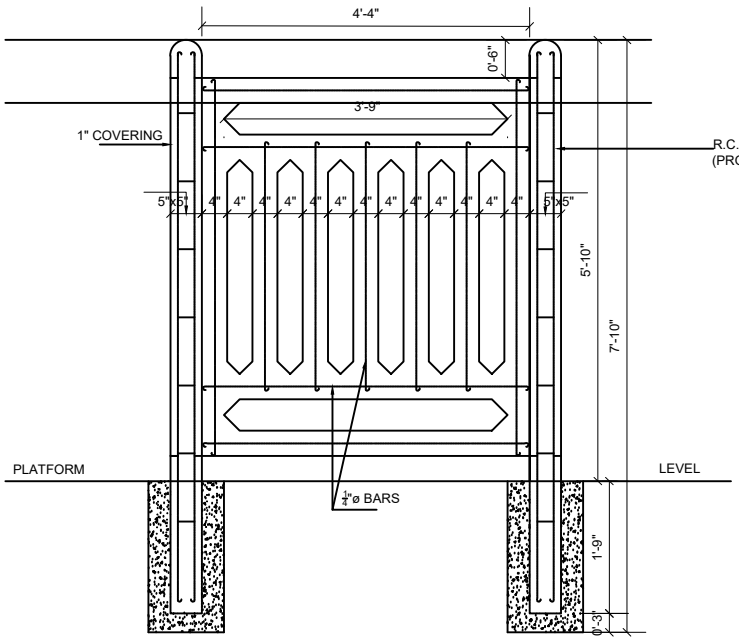
SECTION AT F-F



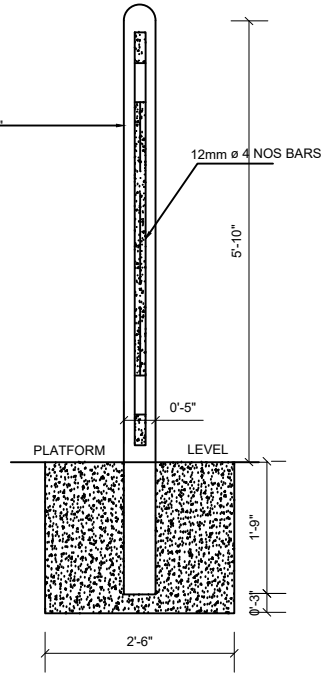
GALVANISED STEEL HOOK 6 mm DIA. FOR HOLDING BARBED WIRE

DRAWN BY	ALT	DESCRIPTION	DATE
8-5-19			

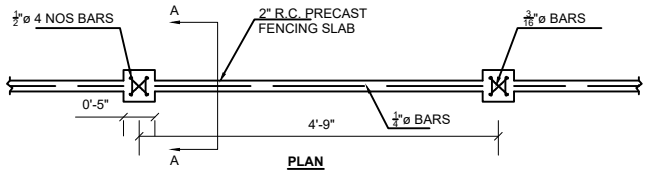
ED/WORKS	03/05/19
DIR/WORKS	08/5/19
ADE/WORKS	8/5/19
BARBED WIRE CATTLE FENCE ALONG THE TRACK WITH PRECAST COLUMN	
SCALE – N.T.S	DATE – 08.05.19
DRG. NO. – RDSO/WKS/2019/2	
WORKS DIRECTORATE / R.D.S.O.	



ELEVATION



SECTION AT A-A



PLAN

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
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CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE:- CONCEPTUAL PLAN
R.C.PRE-CAST FENCING FOR END PLATFORM

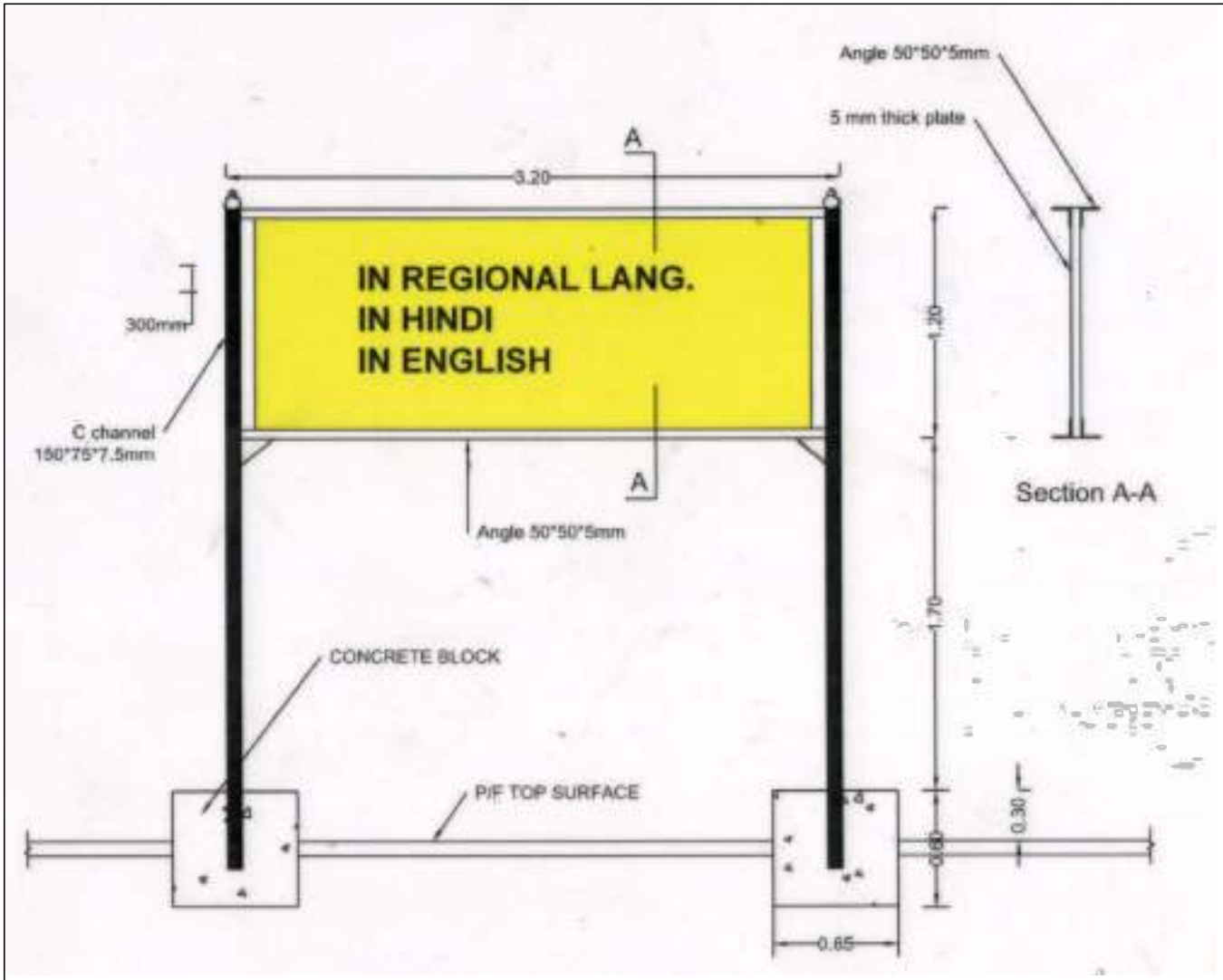
DRG. NO. GC-HRIDC-C2-DRG-SAD-GMD-004_A0

SHEET NO.

SCALE : AS SHOWN

ISSUE DATE

REVISED DATE



Notes:

1. THE PRINCIPAL NAME BOARDS PAINTED ON BOTH FACES SHOULD BE FIXED AT BOTH THE ENDS OF THE PLATFORM AND GENERALLY ORIENTED AT RIGHT ANGLE TO THE TRACK.
2. THE ACTUAL ANGEL AT WHICH THE NAME BOARD ARE FACED SHOULD BE DETERMINED BY THE SITE CONDITIONS ENSURING THE CRITERIA THAT THE NAME BOARDS ARE CLEARLY VISIBLE FROM APPROACHING TRAINS.
3. LETTERS TO BE PAINTED YELLOW WITH BLACK LETTER.
4. THE STATION NAME SHALL BE EXHIBITED IN THE FOLLOWING ORDER: REGIONAL LANGUAGE, HINDI AND ENGLISH.
5. HEIGHT OF THE LETTERS 300 MM THICKNESS IN PROPORTIONS OF TO THE STYLE OF THE SCRIPT.
6. THE LOWER EDGE OF THE PRINCIPAL OARD SHOULD BR 2 M ABOVE THE PLATFORM.
7. THE PAINTING WORK SHALL BE COMMENCE ONLY AFTER THE SATISFACTORY SURFACE PREPARATION INSPECTED AND APPROVE BY ENGINEER REPRESENTATIVE.
8. 2 COATS OF APPROVED BRAND YELLOW PAINT SHALL BE APPLIED OVER THE ONE COAT OF PRIMER.
9. THE APPLIED COAT OF PAINT SHALL BE UNIFORM AND FREE FROM BRUSH MARKS, SACK MARKS, BLEMISHES ETC.

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

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SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL PLAN
STATION NAME BOARD (M.S. STEEL BOARD)

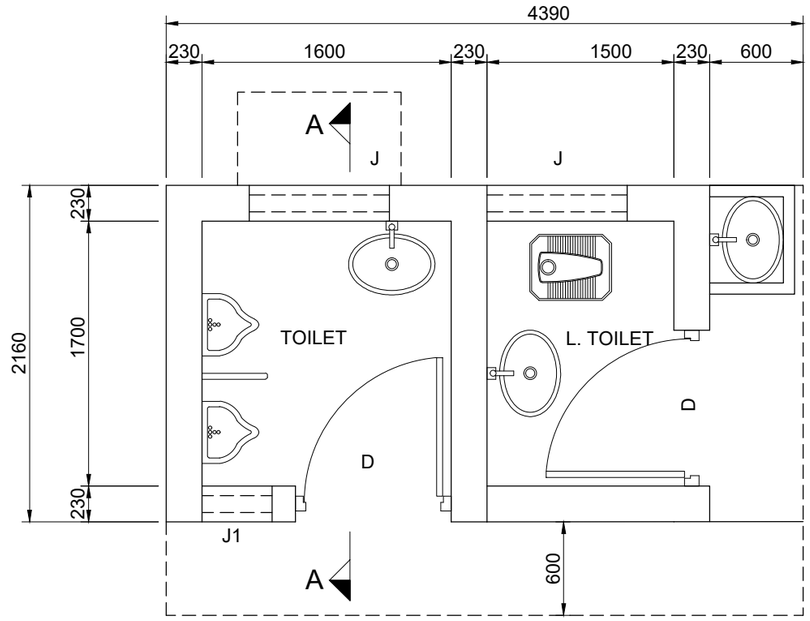
DRG. NO. GC-HRIDC-C2-DRG-SAD-GMD-005_A0

SHEET NO.

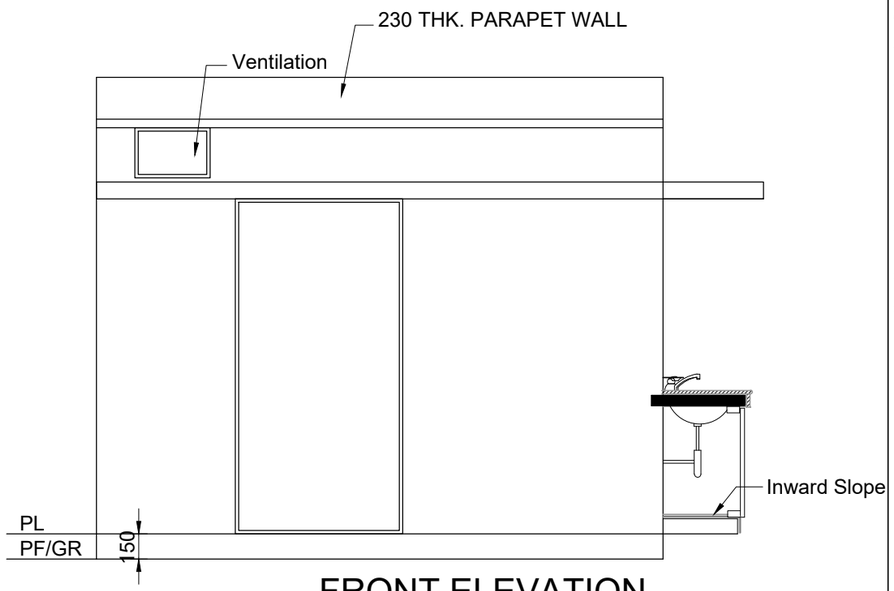
SCALE : AS SHOWN

ISSUE DATE

REVISED DATE



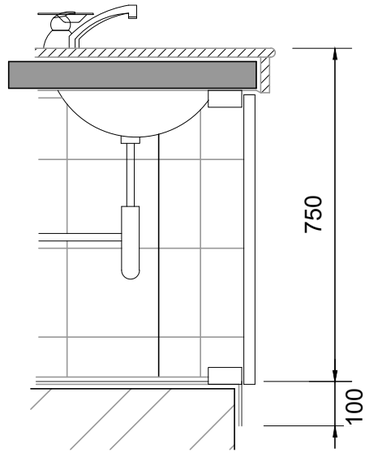
PLAN
(SCALE 1:50)

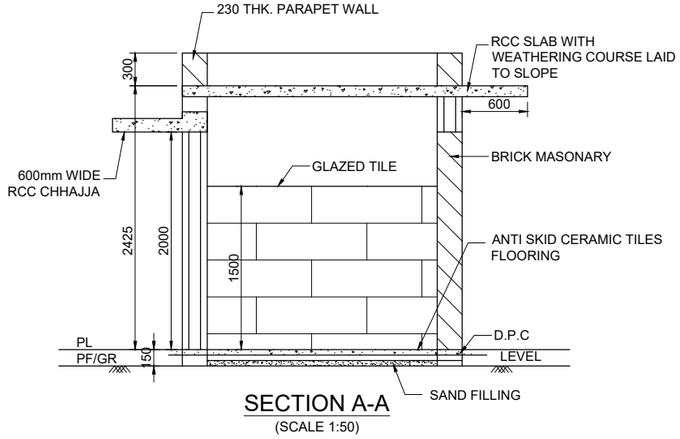


FRONT ELEVATION
(SCALE 1:50)

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FLOORING WITH CERAMIC TILES TO BE PROVIDED.
3. DADOING WITH GLAZED TILES OF APPROVED QUALITY FOR A MIGHT OF 1500MM TO BE PROVIDED IN SIDE WCS & URINALS.
4. THE FLOOR FOR URINALS SHOULD AT THE SAME LEVEL.
5. WHILE GLAZED INDIAN TILES WATER CLOSET OF SIZE 580MM WITH 2 NO. OF FOOT REST & 'P' TRAP TO BE PROVIDED.
6. WHITE GLAZED FLAT BLACK UPPED URINAL 43X260X350MM SIZE TUBE PROVIDED.
7. WHITE GLAZED SQUATTING TYPE URINAL OF SIZE 450X350XMM TO CONFORM IS NO. 771.1963 TO BE PROVIDED.
8. FLUSHING TANK TO BE PROVIDED AS UNDER
   (A) -1 NO. 1250 LITER CAPACITY FOR EACH WATER CLOSET - SUM PVC/PORCELAIN TYPE.
   (B) 1. NO. 10 LITER CAPACITY FOR 2/3 URINAL -AUTOMATIC PVC/PORCELAIN TYPE.
9. PLUMBING TO BE CONCEALED.
10. PIPE WATER SUPPLY IS TO BE PROVIDED WITHER BY CONNECTING TO THE ADJUSTING OVER HEAD TANK OR BY PROVIDING SYNTAX TANK OVER THE TOILET BLOCK
11. DRAINAGE IS TO BE CONNECTED TO ADJUSTING DRAINAGE ARRANGEMENT OR PROVIDING SEPTIC TANK / SOAK PIT SUITABLE CAPACITY.
12. EFFLUENT TO BE DISCHARGE IN DRAINAGE SYSTEM (REFER SEPRATE DRAINAGE PLAN FOR DRAINAGE SYSTEM).
13. THIS PLAN TO BE ADOPTED FOR OTHER THAN A-1 CLASS STATION.





SECTION A-A
(SCALE 1:50)

SHEDULE OF JOINERY

REF.		SIZE
D	PVC DOOR	900x2000
J	RCC JALI (RAIN PROOF TYPE)	900x600
J1	RCC JALI (RAIN PROOF TYPE)	450x300

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

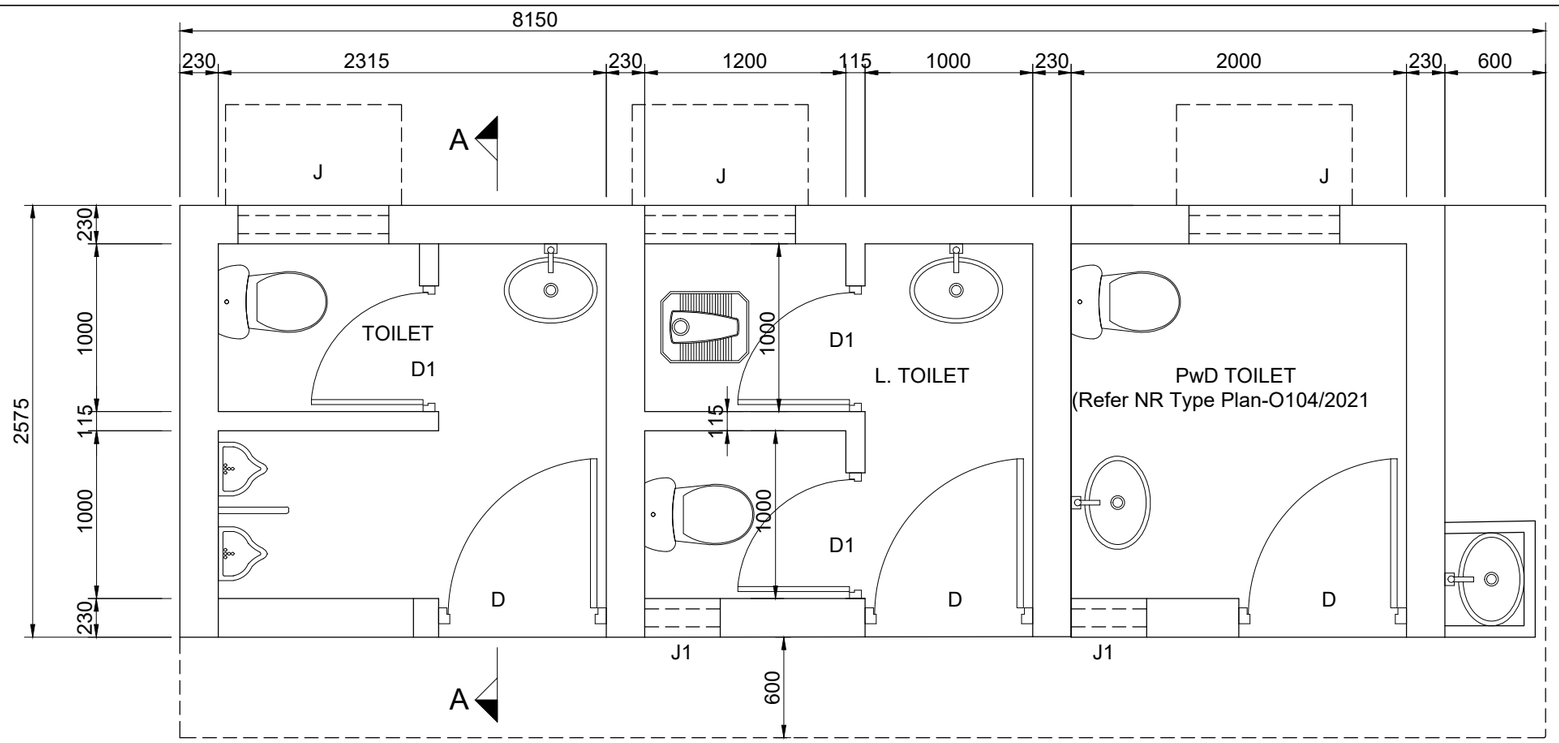
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.
RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE:-
CONCEPTUAL PLAN
PROPOSED TOILET BLOCK ON ISLAND PLATFORMS

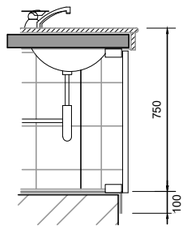
DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-SAD-GMD-006_A0	

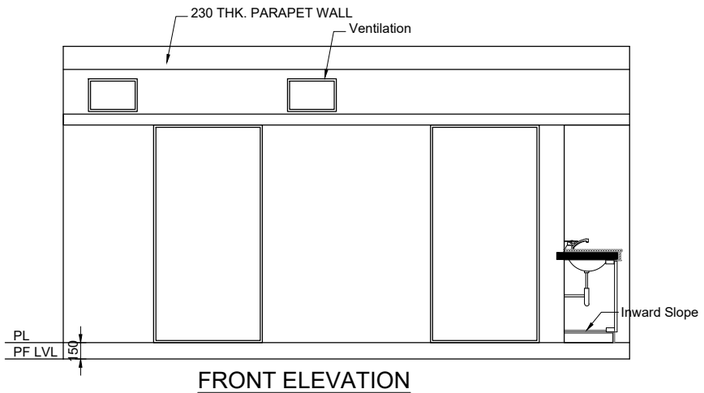
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



PLAN

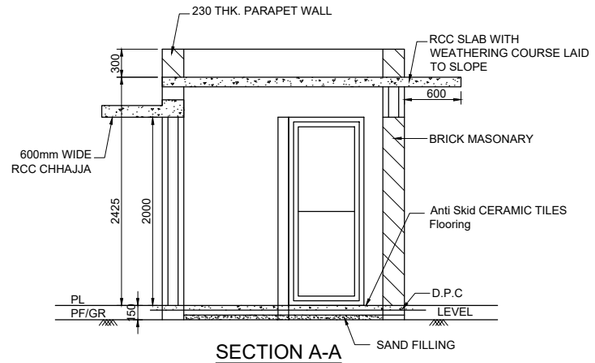
(SCALE 1:50)





FRONT ELEVATION

(SCALE 1:50)



SECTION A-A

(SCALE 1:50)

SHEDULE OF JOINERY

REF.		SIZE
D	PVC DOOR	900x2000
J	RCC JALI (RAIN PROOF TYPE)	900x600
J1	RCC JALI (RAIN PROOF TYPE)	450x300

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FLOORING WITH CERAMIC TILES TO BE PROVIDED.
3. DADOING WITH GLAZED TILES OF APPROVED QUALITY FOR A MIGHT OF 1500MM TO BE PROVIDED IN SIDE WCS & URINALS.
4. THE FLOOR FOR URINALS SHOULD AT THE SAME LEVEL.
5. WHILE GLAZED INDIAN TILES WATER CLOSET OF SIZE 580MM WITH 2 NO. OF FOOT REST & 'P' TRAP TO BE PROVIDED.
6. WHITE GLAZED FLAT BLACK UPPED URINAL 43X260X350MM SIZE TUBE PROVIDED.
7. WHITE GLAZED SQUATTING TYPE URINAL OF SIZE 450X350XMM TO CONFORM IS NO. 771.1963 TO BE PROVIDED.
8. FLUSHING TANK TO BE PROVIDED AS UNDER
   (A) -1 NO. 1250 LITER CAPACITY FOR EACH WATER CLOSET - SUM PVC/PORCELAIN TYPE.
   (B) 1. NO. 10 LITER CAPACITY FOR 2/3 URINAL -AUTOMATIC PVC/PORCELAIN TYPE.
9. PLUMBING TO BE CONCEALED.
10. PIPE WATER SUPPLY IS TO BE PROVIDED WITHER BY CONNECTING TO THE ADJUSTING OVER HEAD TANK OR BY PROVIDING SYNTAX TANK OVER THE TOILET BLOCK
11. DRAINAGE IS TO BE CONNECTED TO ADJUSTING DRAINAGE ARRANGEMENT OR PROVIDING SEPTIC TANK / SOAK PIT SUITABLE CAPACITY.
12. EFFLUENT TO BE DISCHARGE IN DRAINAGE SYSTEM (REFER SEPRATE DRAINAGE PLAN FOR DRAINAGE SYSTEM).
13. THIS PLAN TO BE ADOPTED FOR OTHER THAN A-1 CLASS STATION.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

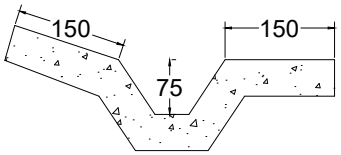
RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE:-

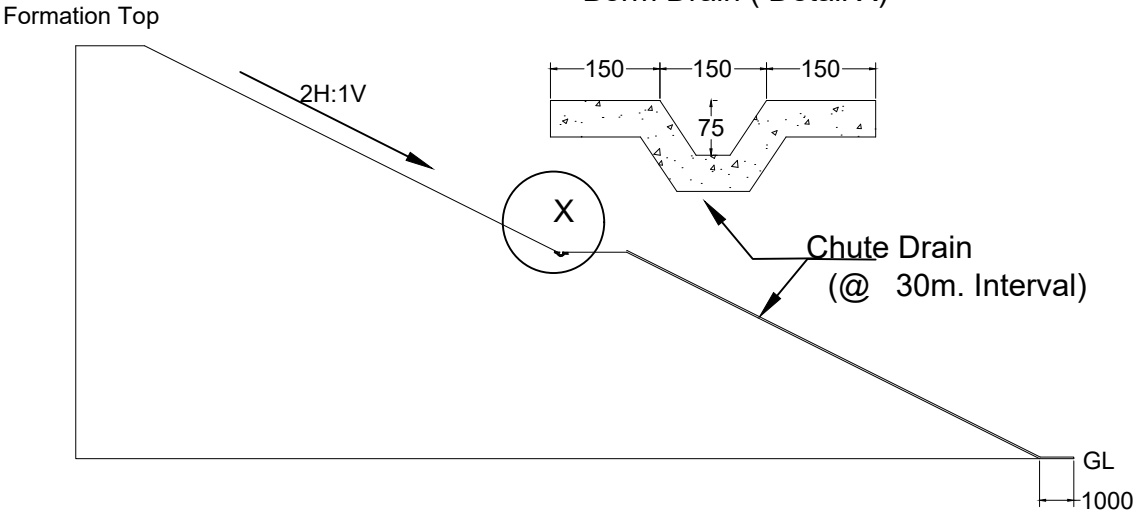
CONCEPTUAL PLAN
PROPOSED TOILET BLOCK ON MAIN PLATFORMS

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-SAD-GMD-007_A0	

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



Berm Drain (Detail X)



Note:-
1. All dimension are in mm unless otherwise specified.

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED

CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

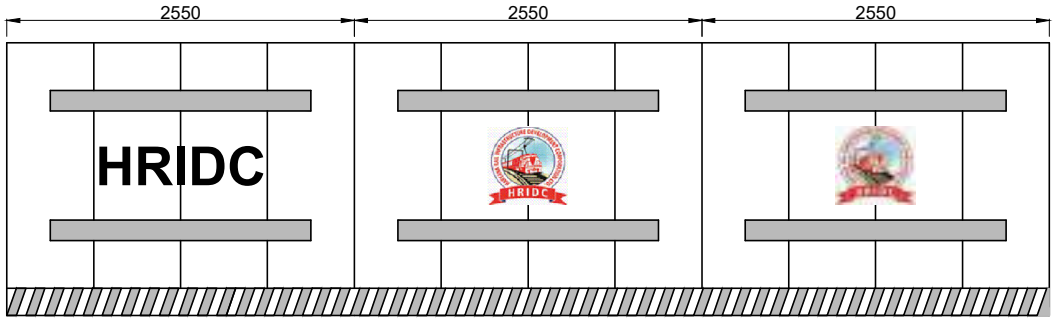
GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL PLAN
DRAINS FOR FORMATION

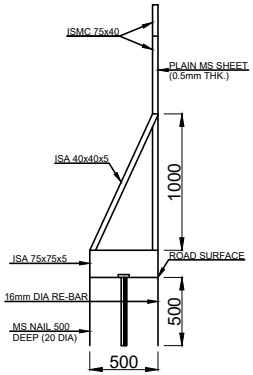
DRG. NO. GC-HRIDC-C2-DRG-DRN-GMD-008_A0

SHEET NO. 1 OF 1

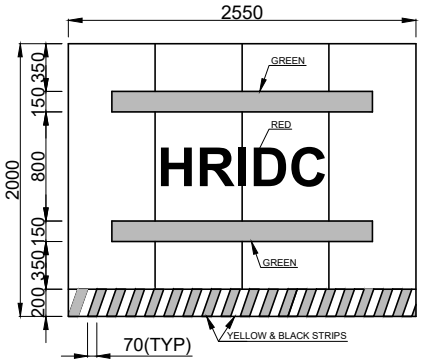
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



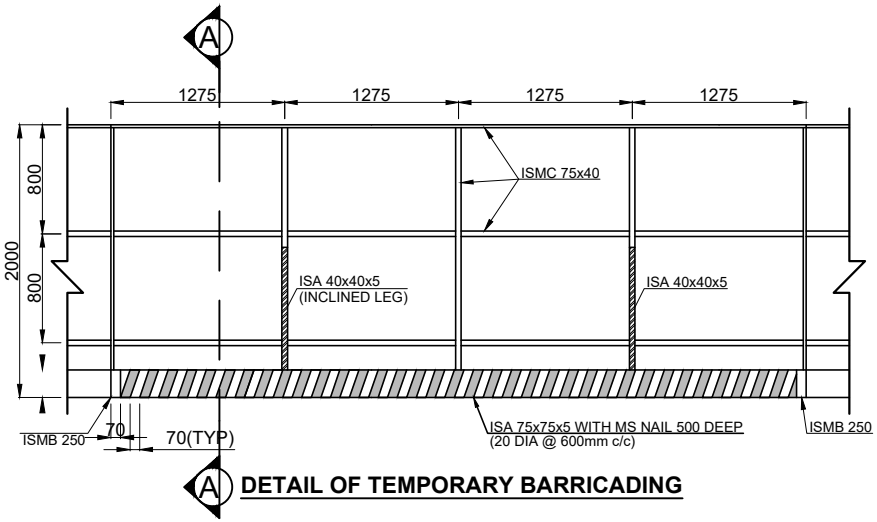
ELEVATION OF ONE UNIT OF TEMPORARY BARRICADING



SECTION A-A



ELEVATION OF ONE SET OF TEMPORARY BARRICADING



DETAIL OF TEMPORARY BARRICADING

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE:- CONCEPTUAL PLAN
STEEL BARRICADE

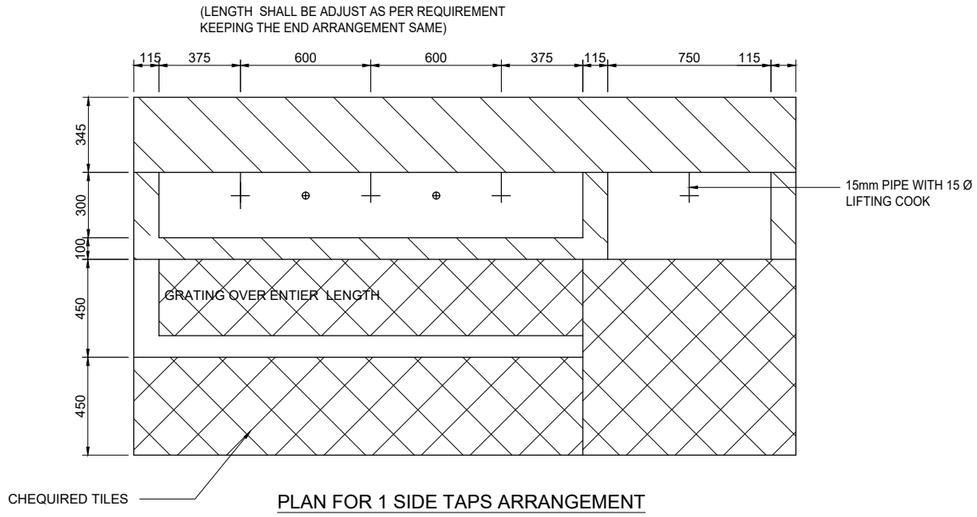
DRG. NO. GC-HRIDC-C2-DRG-SAD-GMD-9_A0

SHEET NO. 1 OF 1

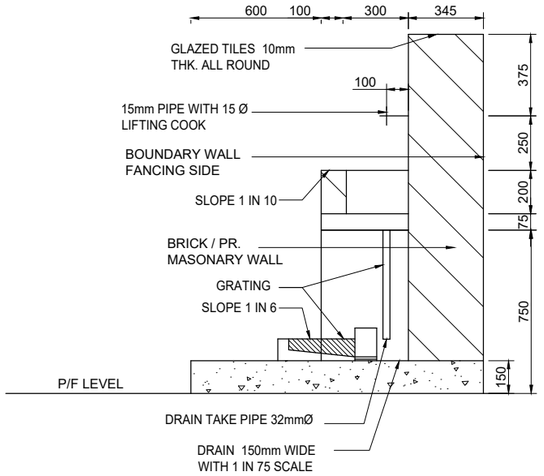
SCALE : AS SHOWN

ISSUE DATE

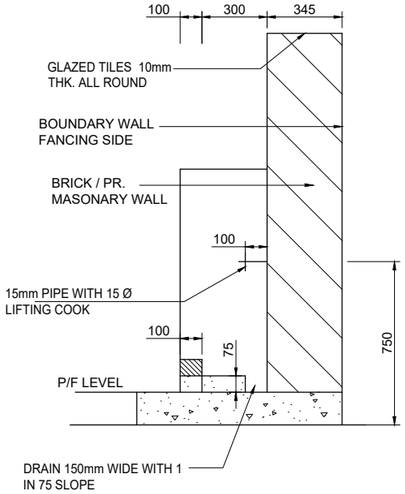
REVISED DATE



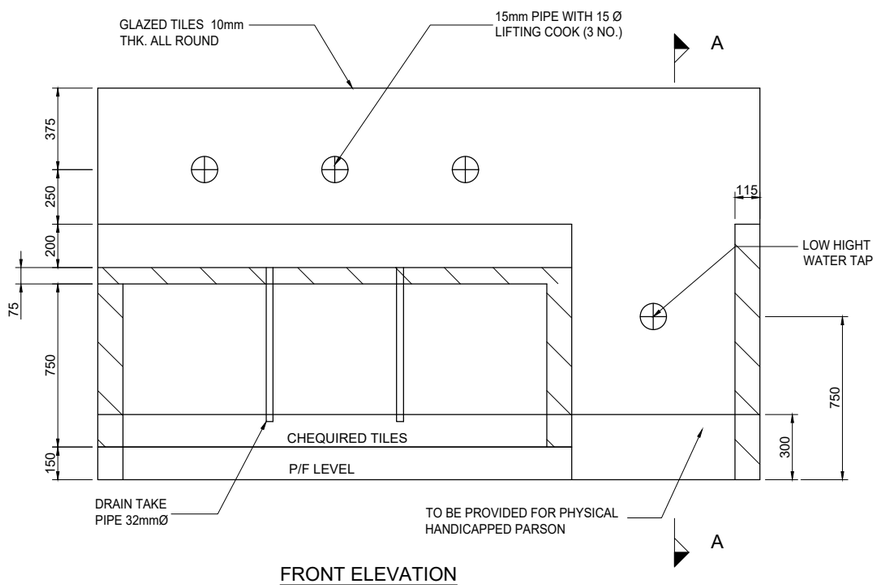
PLAN FOR 1 SIDE TAPS ARRANGEMENT



SECTION FOR ONE SIDE TAPS



SECTION AT A-A



FRONT ELEVATION

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETER
2. LENGTH SHALL BE ADJUSTED AS PER REQUIREMENT KEEPING THE END ARRANGEMENT SAME.
3. PEDESTAL THE END ARRANGEMENT TILES AT TOP AND 1:6 SLOPE INWARD
4. ALL FINISHING IN GLAZED OR WITH SUITABLE TYPE & CLEANING FINISHING MATERIALS.
5. LIFTING COCK SHALL BE CP BRASS OR SIMILAR OR PTMS & TYPE SABOTAGE FITTINGS.
6. LOW HEIGHT WATER TO BE PROVIDED ONLY IF FOR PHYSICALLY HANDICAPPED PERSONS AS PER.
7. THIS DRAWING IS BASED ON DRG. NO. 1 OF 1 DATED 05/03/2017 OF RVNL JODHAPUR.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

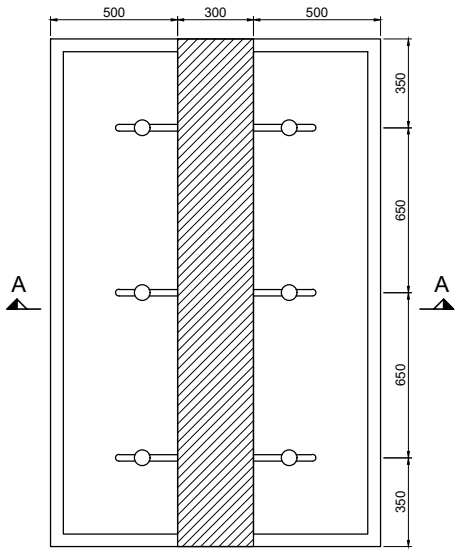
CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

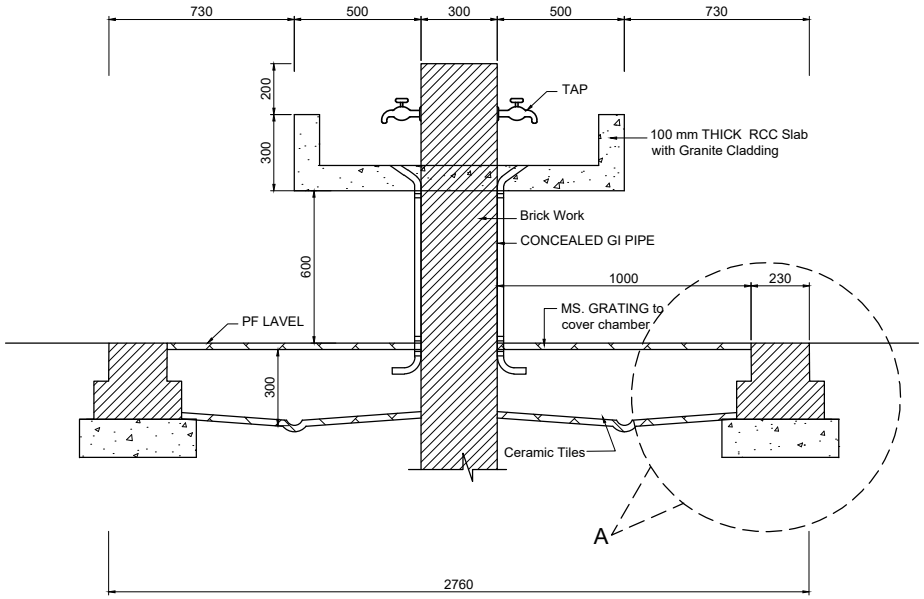
TITLE:- CONCEPTUAL PLAN
WATER BOOTH WITH ONE SIDE TAPS
ARRANGEMENT (END PLATFORM)

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-SAD-GMD-010_A0	

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



PLAN



SECTION A-A

NOTES :

1. ALL DIMENSIONS ARE IN MM .
2. ALL OUTER SURFACE WILL BE GRANITE CLADDING
3. TAP WILL BE PUSH COCK 15MM DIA UPVC & CP Brass
4. SEPARATE DRAINAGE PLAN SHALL BE REFERRED FOR EFFLUENT DISCHARGE etc.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

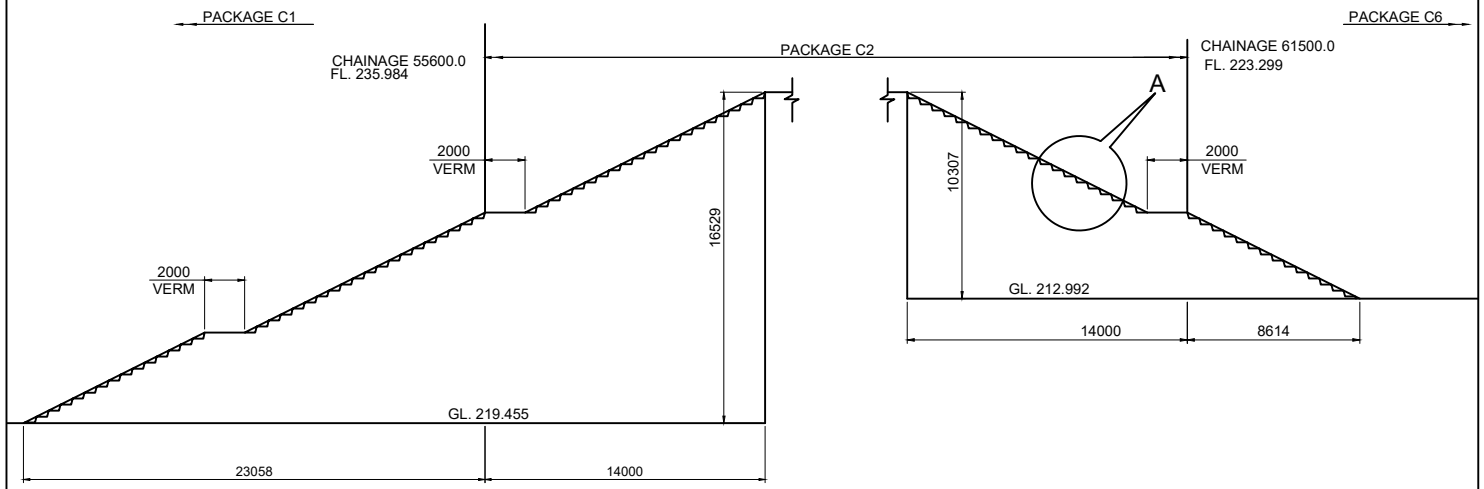
CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

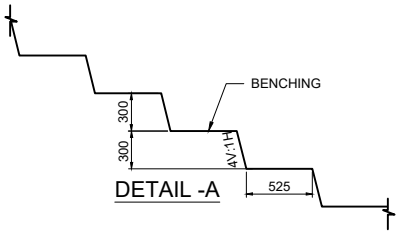
TITLE:- CONCEPTUAL PLAN
WATER BOOTH WITH BOTH SIDE TAPS
ARRANGEMENT (ISLAND PLATFORM)

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-SAD-GMD-011_A0	

SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



SECTIONAL ELEVATION



DETAIL -A

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOR OTHER DETAILS REFER RDSO SPECIFICATION NO. RDSO/2020/GE:IRS-004 SEPTEMBER 2020 "COMPREHENSIVE GUIDELINES AND SPECIFICATIONS FOR RAILWAY FORMATION".

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED

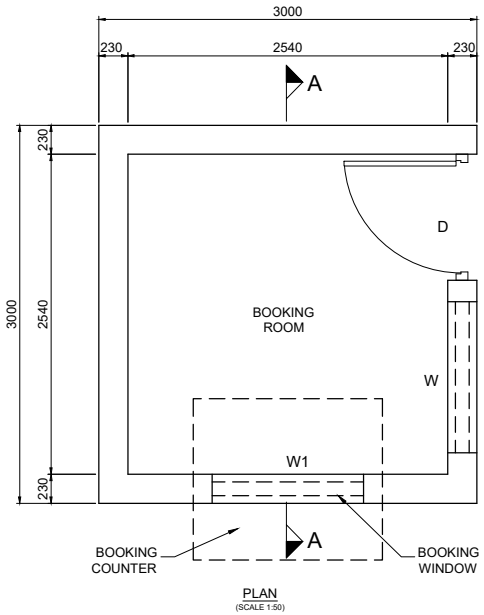
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

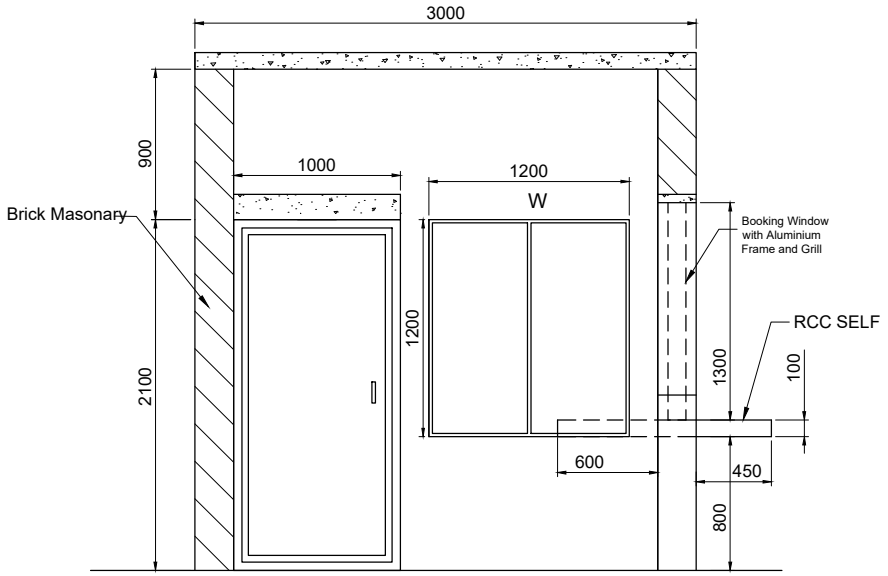
TITLE:- CONCEPTUAL PLAN
INTERFACING LOCATION BANK BENCHING

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-SAD-GMD-012_A0	

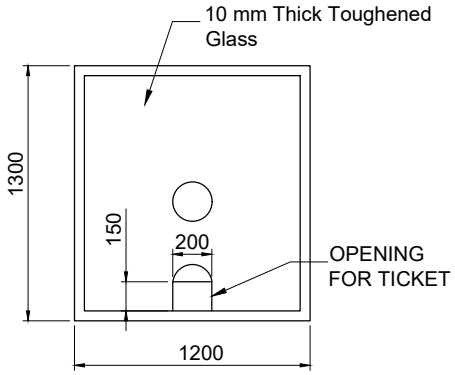
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



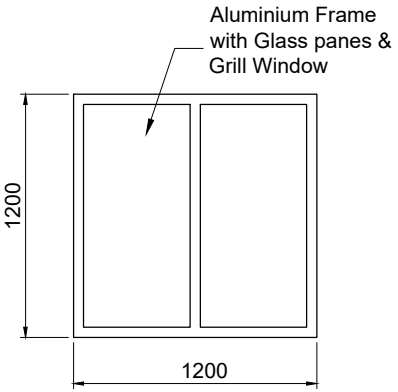
PLAN
(SCALE 1:50)



SECTION A-A
(SCALE 1:50)



DETAIL OF WINDOR (W1)
(SCALE 1:50)



DETAIL OF WINDOR (W)
(SCALE 1:50)

NOTES :

1. ALL DIMENSIONS ARE IN MILIMETERS.
2. DEEPTH OF FOUNDATION TO BE DECIDED AS PER SITE CONDITION.
3. RCC SELF WITH GRANITE TOP TO BE PROVIDING FOR BOOKING WINDOW.
4. ALLWELDING HAS TO BE DONE AS PER IS: 816
   (1) FLUSH DOOR SHUTTER: D - 1.00 x 2.10
   (2) WINDOW : W- 1.20 x 1.20
   (3) WINDOW : W1- 1.20 x 1.30
5. ALL HINGES SHOULD BE as per IS standard.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED

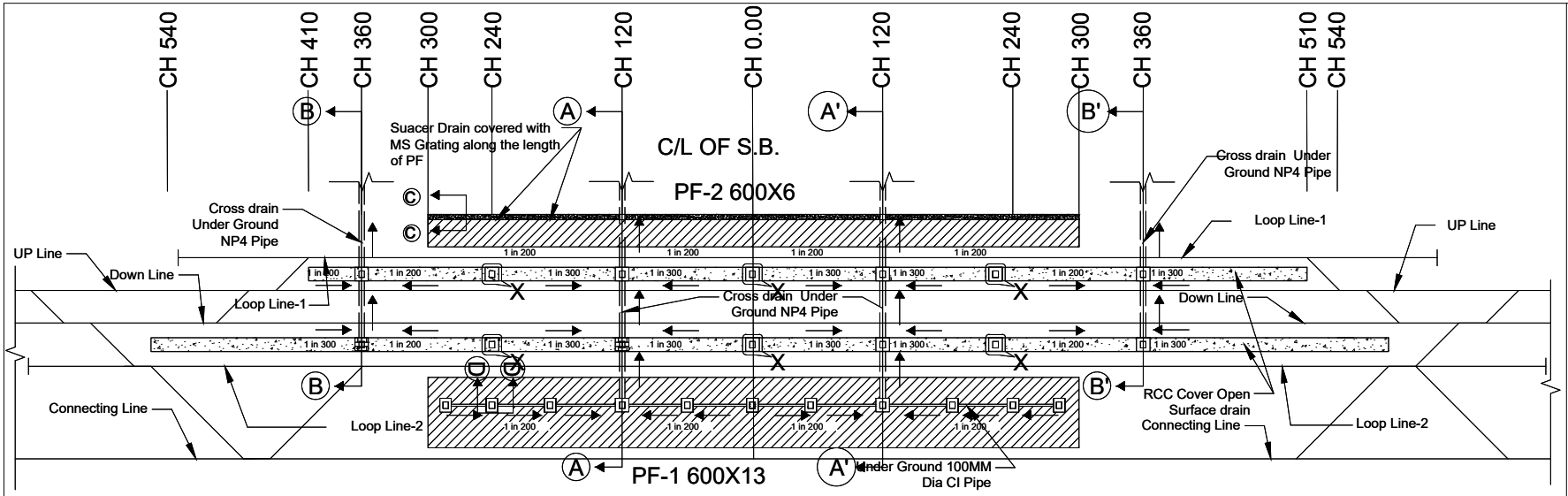
CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE:-
CONCEPTUAL PLAN
TICKET COUNTER

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-SAD-GMD-013_A0	

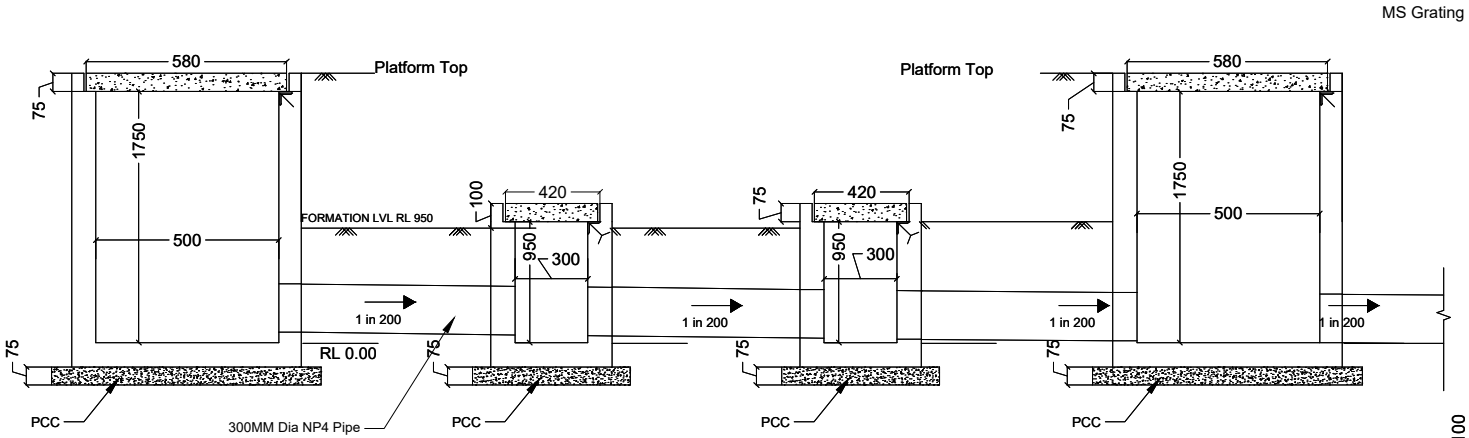
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



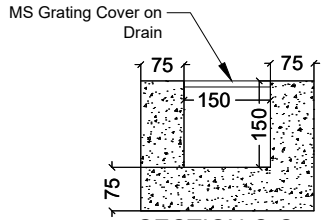
DRAIN OF YARD AND PLATFORM AT NEW PATLI STATION

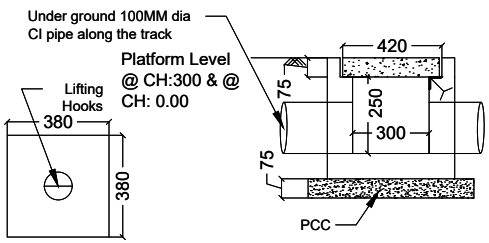
Note:-
1. All dimension are in mm unless otherwise specified.
2. Precast RCC Cover to be provided as per drawing.
3. Drain to be provided in slope as specified in the drawing.
4. Drain to be made of RCC.

Legend
- RCC COVER OPEN SURFACE DRAIN
- PLATFORM AREA
- SAUCER DRAIN WITH GRATING
- YARD INTERMEDIATE DRAIN



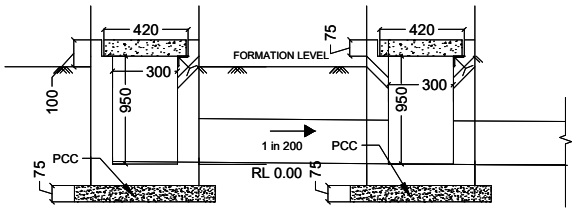
SECTION A-A & A'-A'

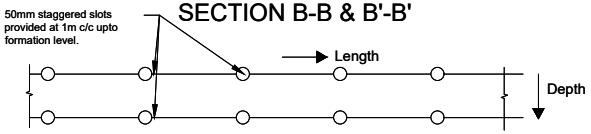




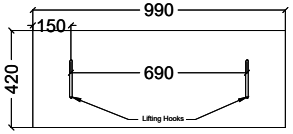
TYP. RCC Cover of Platform Drain

Platform Intermediate Drain Chamber SECTION D-D

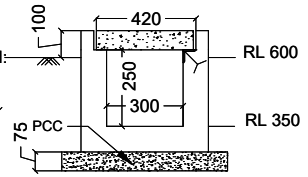




SECTION B-B & B'-B'



TYP. RCC Cover of Yard Drain



Yard Intermediate Drain SECTION- X

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.
RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE:- CONCEPTUAL PLAN DRAINAGE ARRANGEMENT (NEW PATLI)

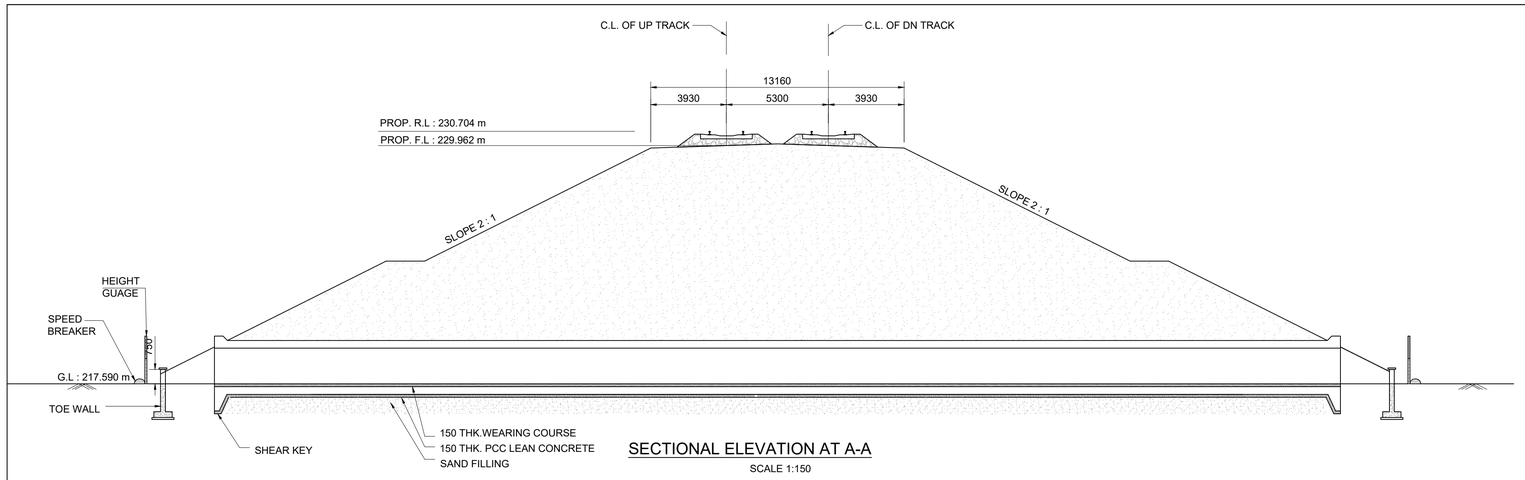
DRG. NO. GC-HRIDC-C2-DRG-SAD-GMD-014_A0

SHEET NO. 1 OF 1

SCALE : AS SHOWN

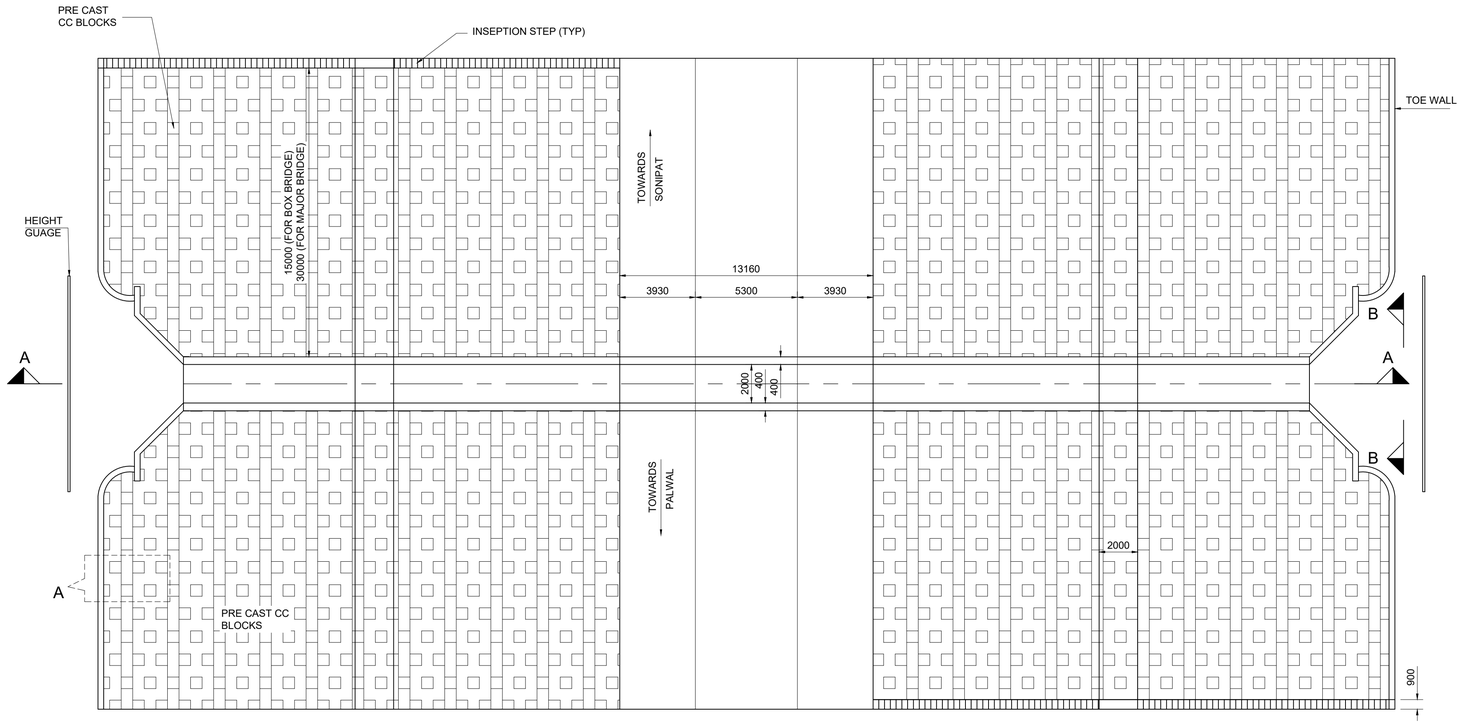
ISSUE DATE

REVISED DATE



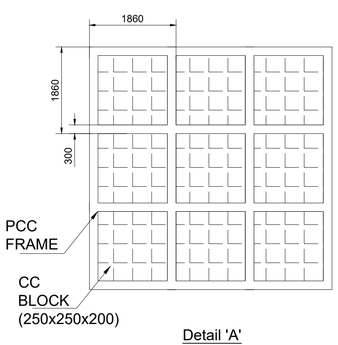
SECTIONAL ELEVATION AT A-A

SCALE 1:150

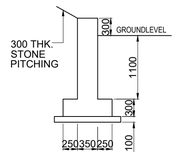


PLAN AT TOP

SCALE 1:150



Detail 'A'



SEC. OF TOE WALL

SCALE 1:50

NOTES :

A) GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE MENTIONED.
2. PROTECTION WORK WITH PRECAST CC BLOCK ON BOTH SIDES OF BRIDGES SHALL BE DONE FOR 15m LENGTH AND 30m LENGTH FOR MINOR BRIDGES & MAJOR BRIDGES RESPECTIVELY.

LEGEND

PRL	PROPOSED RAIL LEVEL
PFL	PROPOSED FORMATION LEVEL
HFL	HEIGHEST FLOOD LEVEL
GL	GROUND LEVEL

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:

GENERAL CONSULTANTS FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

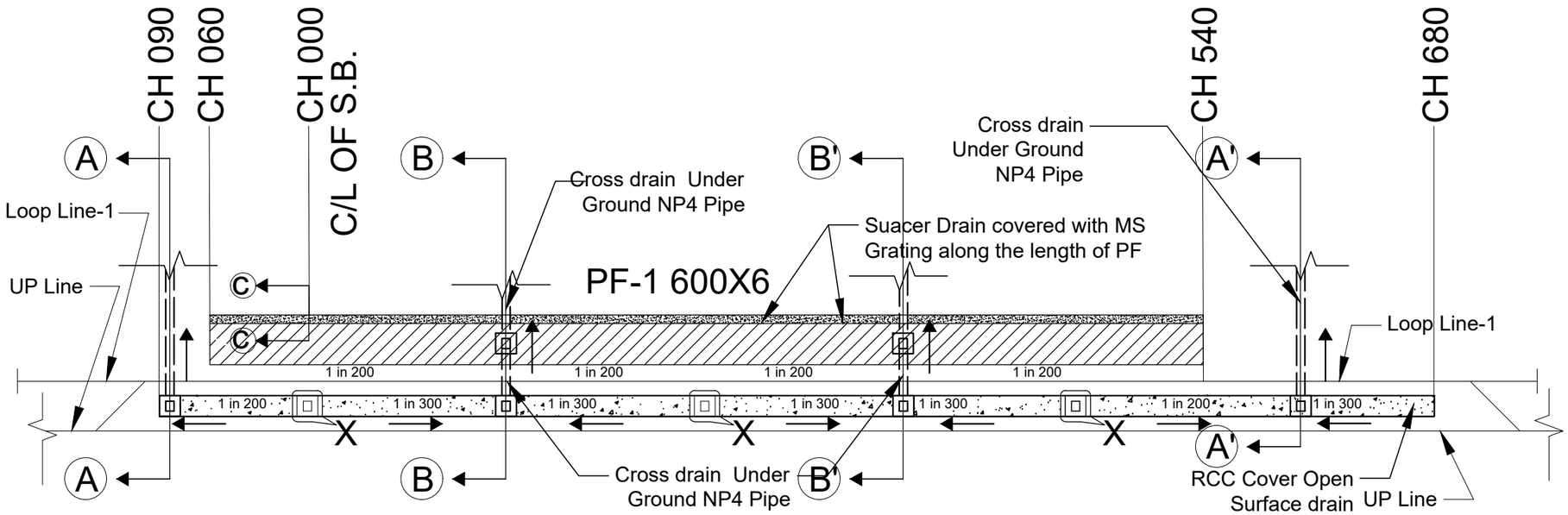
TITLE:- CONCEPTUAL PLAN

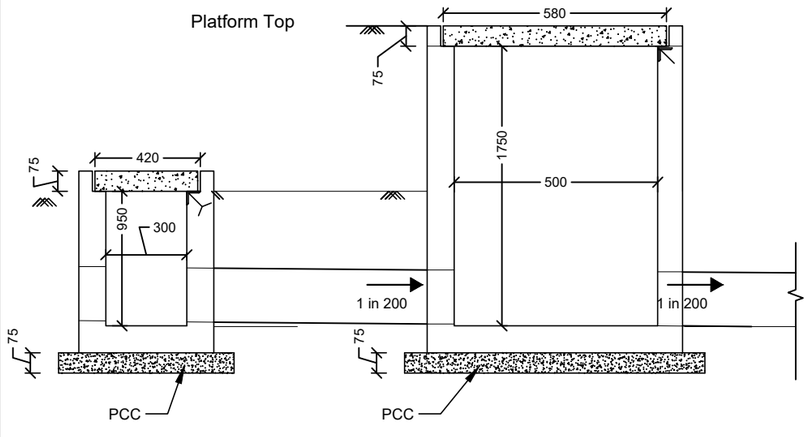
TYPICAL DETAILS OF PROTECTION WORK

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-BRD-GMD-015_A0	1 OF 1

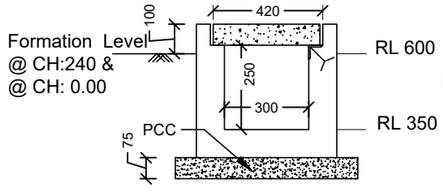
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		

DRAIN OF YARD AND PLATFORM AT SULTANPUR STATION

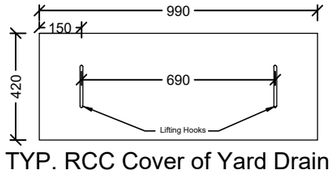




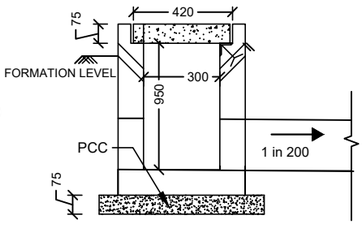
SECTION B-B & B'-B'



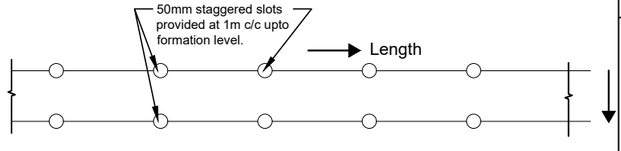
Yard Intermediate Drain SECTION- X

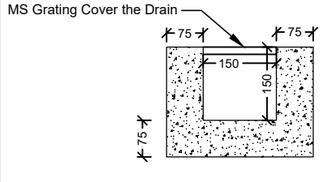


TYP. RCC Cover of Yard Drain



SECTION A-A & A'-A'





SECTION C-C

Note:-

1. All dimension are in mm unless otherwise specified.
2. Precast RCC Cover to be provided as per drawing.
3. Drain to be provided in slope as specified in the drawing.
4. Drain to be made of RCC.

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C-1	
KRISHAN CHAND SAINSI CRE/CIVIL			
REETU PATIAL CDE/ CIVIL			

Legend

	RCC COVER OPEN SURFACE DRAIN
	PLATFORM AREA
	SAUCER DRAIN WITH GRATING
	YARD INTERMEDIATE DRAIN

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

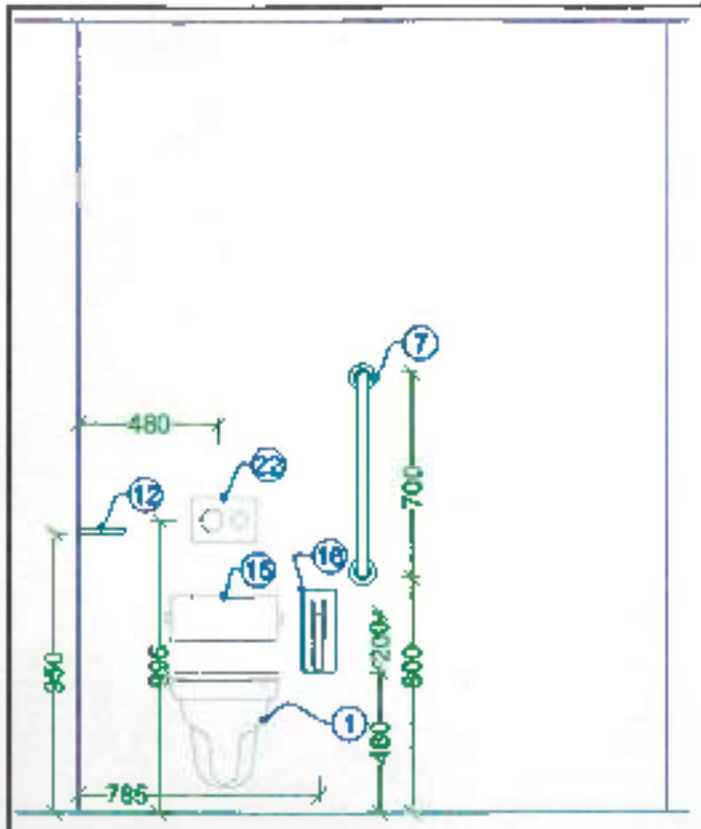
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

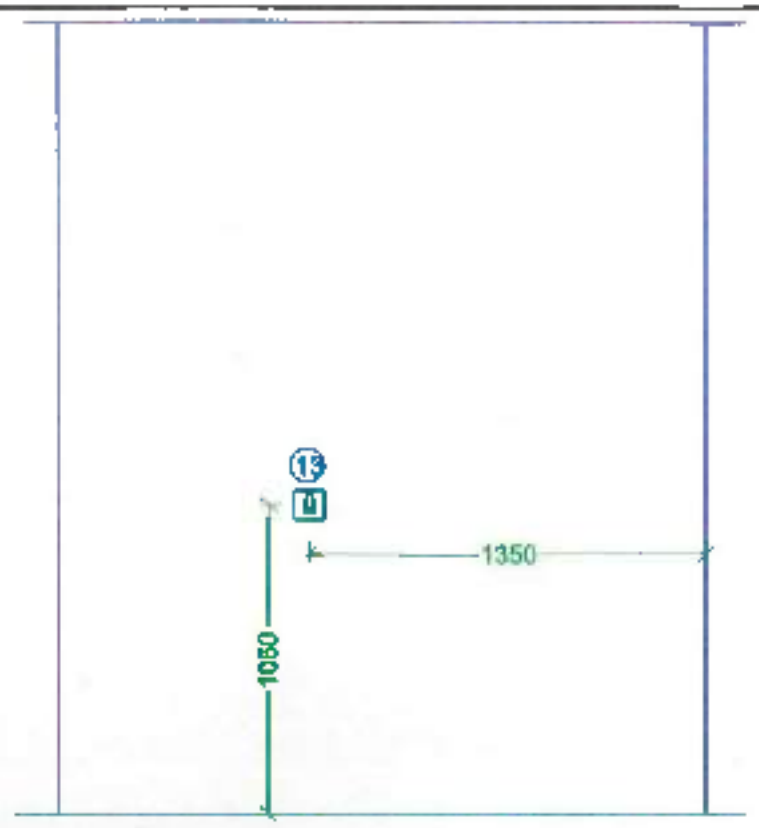
TITLE:- CONCEPTUAL PLAN
DRAINAGE ARRANGEMENT (SULTANPUR)

DRG. NO.	SHEET NO.
GC-HRIDC-C2-DRG-SAD-GMD-016_A0	1 OF 1

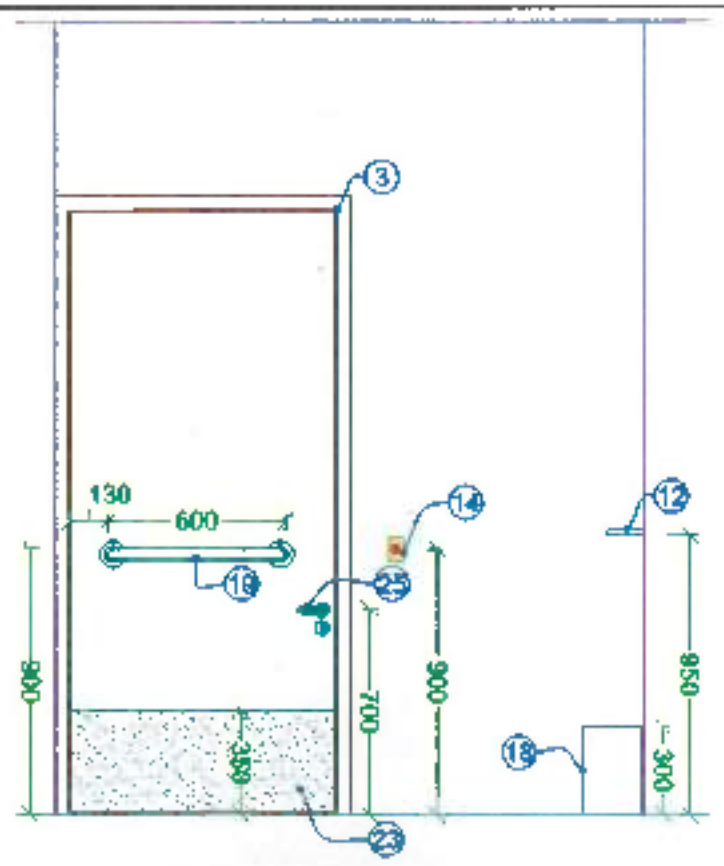
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN		



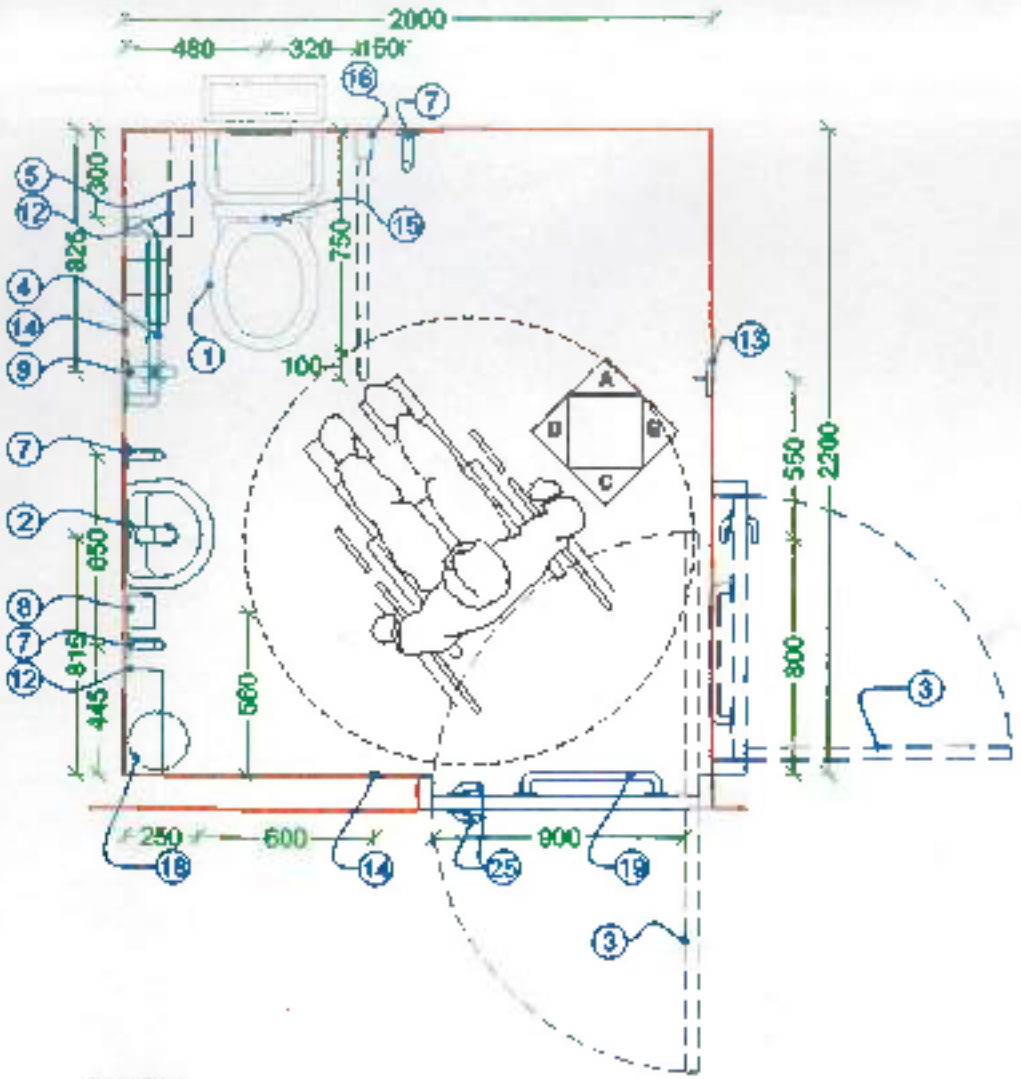
ELEVATION 'A'



ELEVATION 'B'



ELEVATION 'C'

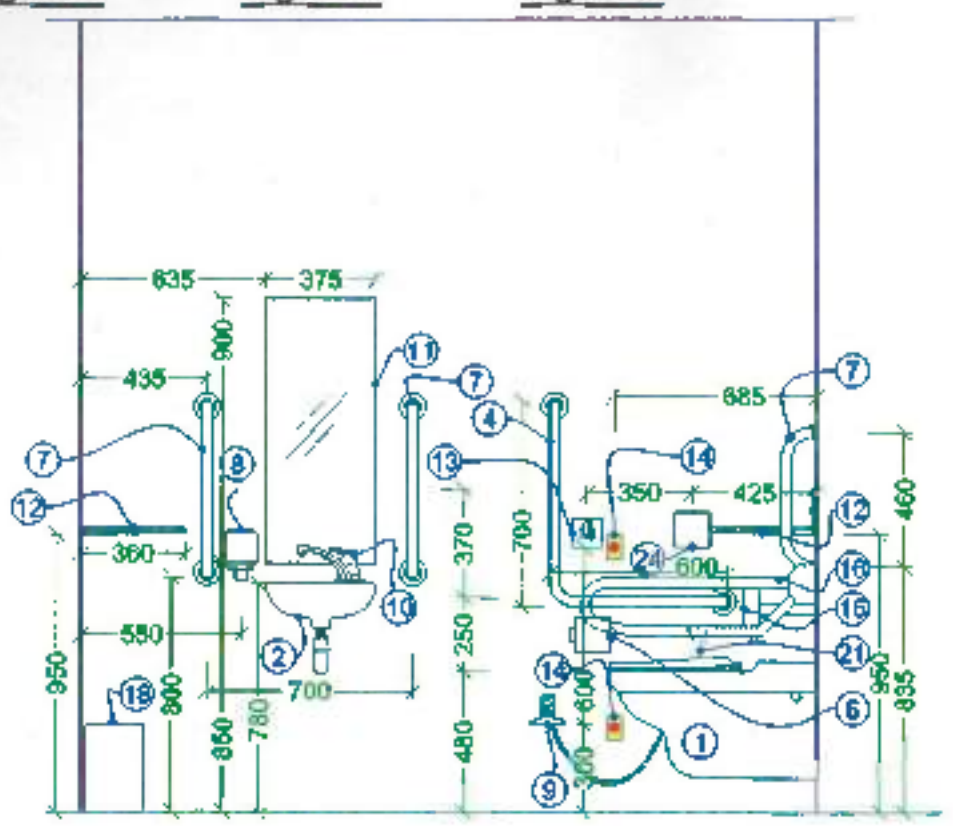


PLAN

Figure 1

Figure 2

Figure 3



ELEVATION 'D'

N.R.H.Q.E. PLAN NO.	: HQ/20/11-2021
TYPE PLAN NO.	: O-104/2021
CANCEL TYPE PLAN NO.	...

NOTE:-

1. DO NOT SCALE THIS DRAWING.
2. THIS DRAWING IS TO BE READ WITH ALL RELATED INFORMATION.
3. ALL DIMENSIONS TO BE VERIFIED ON SITE BY MAIN CONTRACTOR BEFORE THE COMMENCEMENT OF ANY DRAWING OR WORK WHATSOEVER.
4. ALL DIMENSIONS ARE IN MILLIMETER UNLESS SHOWN OTHERWISE.
5. ALL GRAB RAIL SHOULD BE PROPERLY FIXED TO HANDLE THE MINIMUM LOAD OF 45 kg (100 lbs).
6. ANTI-SKID OR SLIP RESISTANT TILES SHOULD BE USED ON FLOORING.
7. MIRROR SHOULD BE TILTED AT AN ANGLE OF 30° FOR BETTER VISIBILITY OF WHEELCHAIR USER.
8. VENTILATOR (600mm x 600mm) TO BE PROVIDED ACCORDING TO SITE OPENING.
9. ACCESSIBLE TOILET SHOULD HAVE THE INTERNATIONAL SYMBOL OF ACCESSIBILITY (WITH BRAILLE SIGNAGE) DISPLAYED OUTSIDE FOR WHEELCHAIR ACCESS (Figure 1).
10. THERE SHOULD BE ADEQUATE COLOUR & TONAL CONTRAST BETWEEN THE FIXTURES, WALLS & FLOORING. THIS IS TO ENABLE EASY RECOGNITION BY PERSONS WITH VISUAL IMPAIRMENTS.
11. TOILET LEVEL SHOULD BE KEPT SAME AS LEVEL OF PLATFORM SO AS TO AVOID REQUIREMENT OF RAMP.
12. THIS DRAWING IS BASED ON RAILWAY BOARD'S LETTER NO. 2019/Stn.Dev.-MS/06/Policy/PwDs dated 12.02.2020.

LEGENDS:-

ITEM NO.	PARTICULARS/ DESCRIPTION OF ITEM
1	WALL HUNG COMMODE
2	WASH BASIN
3	DOUBLE SWING DOOR POSITIONS
4	STAINLESS STEEL WALL MOUNTED L-SHAPE GRAB RAIL
5	STAINLESS STEEL SANITARY NAPKIN DISPOSAL
6	STAINLESS STEEL TISSUE HOLDER
7	STAINLESS STEEL VERTICAL GRAB RAIL
8	SOAP DISPENSER
9	TWO WAY BIB COCK
10	LEVER HANDLE TAP (Figure 2)
11	MIRROR
12	STAINLESS STEEL SHELF
13	SINGLE POST CLOTH HOOK
14	ALARM SWITCH
15	BACK REST (Figure 3)
16	STAINLESS STEEL DROP DOWN RAIL
17	SANITARY DISPOSAL UNIT
18	STAINLESS STEEL DISPOSAL BIN
19	STAINLESS STEEL PULL RAIL
20	ALARM RESET BUTTON
21	HAND JET SPRAY
22	FULL & HALF FLUSH BUTTON
23	KICK PLATE
24	ALARM RESET BUTTON
25	D-LEVER HANDLE

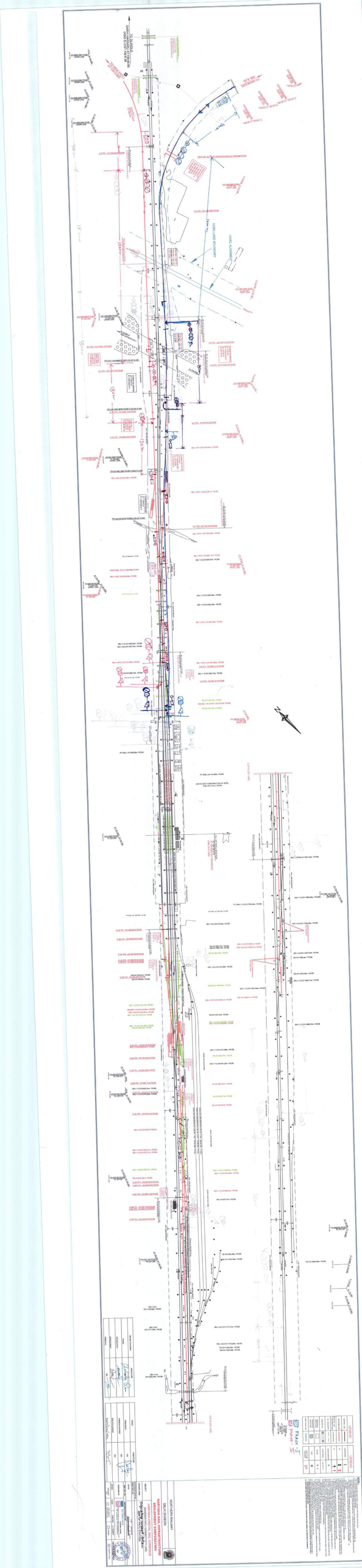
MONA SRIVASTAVA (CE/STN. DEV.)	
K.K. SHARMA (DY.CE/STN. DEV.)	
MOHD. SHARIF (PREPARED BY: SSE/ARCH.)	

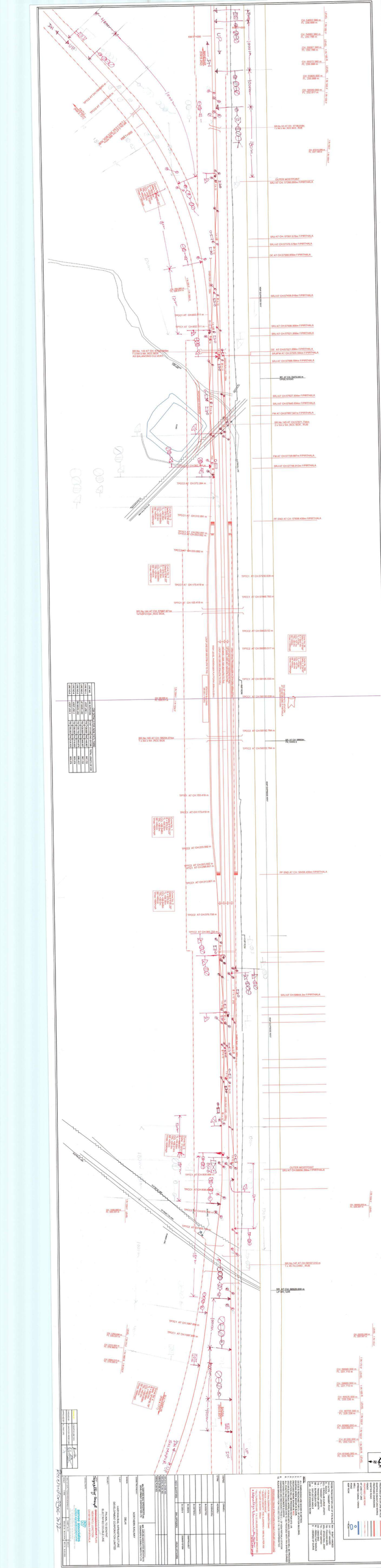
NORTHERN RAILWAY

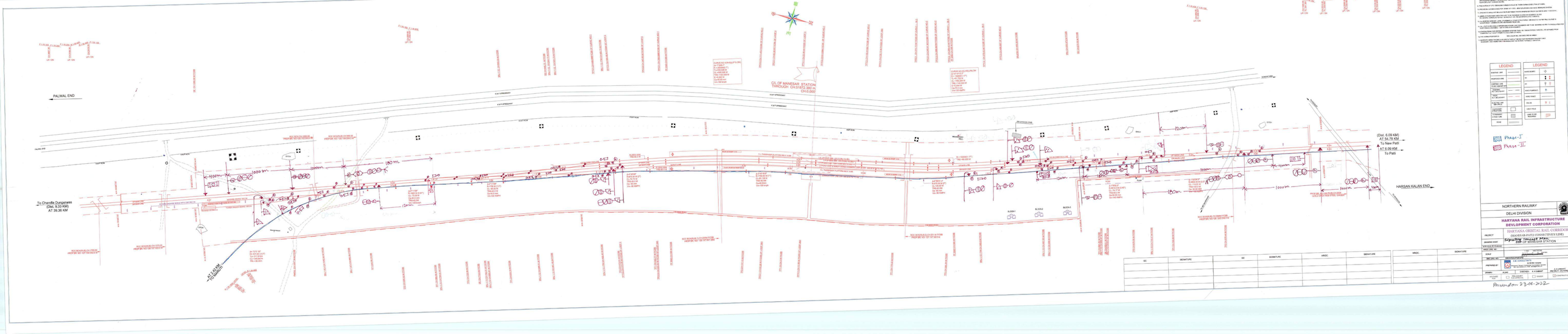
TYPE PLAN

POWDER TOILET FOR DIVYANGS

CASE NO. SD/TP/2021	CANCEL PLAN NO. : NIL
SCALE : 1:25@A3	SHEET NO.: 01 OF 01
N.R.H.Q.E. PLAN NO. :	HQ/20/11-2021






PALWAL END
To Chandla Dungeness
(Dist. 9.33 KM)
AT 39.36 KM
AT 7.42 KM
(Dist. 6.09 KM)
AT 54.78 KM
To New Patli
AT 6.09 KM
To Patli
HARSAN KALAN END
C/L OF MANESAR STATION
THROUGH CH:51872.380 m
CH:0.000
LEGEND
LEGEND
Phase-I
Phase-II
NORTHERN RAILWAY
DELHI DIVISION
HARYANA RAIL INFRASTRUCTURE
DEVLOPMENT CORPORATION
HARYANA ORBITAL RAIL CORRIDOR
(MANESAR-PATLI CONSOLIDATED LINE)
Signature Drawing
Plan of MANESAR STATION
Recession 23-06-2022

EXISTING ROAD
FENCE
EXISTING RAILWAY BOUNDARY
TO BE DISMANTLED
PROW SHOWN THUS
STREAM / CANAL / DRAIN
WELL
POND

NOTE: Connectivity with BADSA station shall be done as per interface with C-6 Package.

A P P R O V E D

CE/P&D		DRM/DLI	
DY.CE/P&D		ADRM/T	
CEDE		SR.DEN/C	
DR.CSTE/P&D		SR.DSTE/C	
CTPM		SR.DOM	
CCM/FM		SR.DEN/V	
XEN/P&D		SR.DEE/G	
		SR.DCM/DLI	
		SR.DEE/TRD	
H.Q. OFFICER'S APPROVAL		DIVN. OFFICER'S APPROVAL	

DIVN. DWG.No.
H.Q. DWG.No.

M/s HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. | M/S. AARVEE ASSOCIATES ARCHITECTS ENGINEERS & CONSULTANTS PVT LTD

CONNECTING RAILWAY: NORTHERN RAILWAY

HEAD QUARTERS: NEW DELHI

CLIENT: HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

PROJECT: HARYANA ORBITAL RAIL CORRIDOR CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

TITLE: Signalling concept PLAN SULTANPUR

CONSULTANTS: aarvee associates architects engineers & consultants pvt.ltd.

DRG NO.: AA/2245/ESP/REV-1 | SHEET No. 1
SCALE: 1:1000 | ISSUED Dt: 26.11.2019 | REV Dt: 07-06-2022

Received on 23-06-2022

Curve and Gradient Details

Gradiant Details PKG-C2(55.600-61.500)

06.06.2022

S.No.	Chainage KM		Length	Gradient	RISE/FALL	PFL		Remarks
	From	upto	metre	1 in		From	To	
1	55580	55780	207.162	LEVEL		235.98	235.984	Main Line
2	55780	56320	502.878	165	F	235.984	232.863	
3	56320	57260	908.334	150	F	232.863	226.619	
4	57260	59000	1718.833	1200	F	226.619	225.154	
5	59000	59200	198.89	LEVEL		225.154	225.152	
6	59200	59860	597.781	180	F	225.152	221.708	
7	59860	59960	115.987	LEVEL		221.708	221.708	
8	59960	60540	519.195	155	R	221.708	225.224	
9	60540	60680	154.192	LEVEL		225.224	225.224	
10	60680	60900	167.095	155	F	225.224	223.968	
11	60900	61200	279.878	165	F	223.968	222.178	
12	61200	61640	409.877	250	R	222.178	223.857	
1	0	820	820	1200	F	225.982	225.249	New Patli -Patli
2	820	1580	760	300	F	225.249	222.709	
3	1580	1800	220	250	F	222.709	221.869	
4	1800	2400	600	LEVEL		221.869	221.869	
5	2400	2960	560	220	R	221.869	224.344	
6	2960	3300	340	1545	R	224.344	224.587	
7	3300	3636	336	585	R	224.587	225.128	
1	0	1000	1000	1200	F	225.982	225.149	New Patli -Sultanpur
2	1000	1260	260	LEVEL		225.149	225.149	
3	1260	2300	1040	165	F	225.149	218.811	
4	2300	3000	700	900	R	218.811	219.543	
5	3000	4000	1000	191	F	219.543	214.336	
6	4000	4132	132	505	F	214.336	214.066	

Horizonatal Curve Details

S.No.	Curve No.	SIDE	DEGREE	RADIUS	DEF.ANGLE (Delta)	CANT {SE} (mm)	TANGENT LENGTH	Circular Curve Length(CCL)	TRANSITION LENGTH	CH. TTP-1	CH. TTP-2	TOTAL LENGTH	
1	35	RHS	01° 10' 00.00"	1500.000	11°47'23"	115.000	224.800	168.300	140.000	55830.580	56278.910	448.330	Main Line
2	36	LHS	00° 15' 00.00"	7000.000	1°02'52"	20.000	86.500	83.000	45.000	59424.816	59597.830	173.014	
3	37	RHS	00° 42' 00.00"	2500.000	3°07'27"	10.000	123.200	26.300	110.000	60911.842	61158.100	246.258	
4	38	LHS	02° 30' 00.00"	700.000	9°16'39"	100.000	96.700	33.100	80.000	61363.577	61556.641	193.064	
5	39	LHS	00° 52' 30.00"	2000.000	4°52'33"	10.000	110.100	120.200	50.000	61766.728	61986.918	220.190	
6	40	RHS	00° 47' 43.63"	2200.000	4°04'54"	65.000	143.300	26.600	130.000	62024.620	62311.222	286.602	
1	1	LHS	03° 53' 19.99"	450.000	42°05'15"	10.000	193.100	290.500	40.000	537.208	907.676	370.468	New patli to patli
2	2	RHS	02° 55' 00.00"	600.000	114°50'58"	130.000	992.300	1096.800	105.000	1316.539	2623.364	1306.825	
1	1	LHS	00° 19' 05.45"	5500.000	1°00'51"	25.000	78.700	37.300	60.000	598.212	755.556	157.344	New patli to Sultanpur
2	2	LHS	00° 19' 05.45"	5500.000	1°00'52"	25.000	78.700	37.400	60.000	863.812	1021.183	157.371	
3	3	LHS	03° 53' 19.99"	450.000	28°13'11"	10.000	133.100	181.600	40.000	1174.61	1436.162	261.552	
4	4	RHS	00° 19' 05.45"	5500.000	2°18'16"	25.000	140.600	161.200	60.000	2164.027	2445.231	281.204	
5	5	RHS	03° 34' 17.14"	490.000	113°10'52"	10.000	755.400	942.900	25.000	3107.419	4100.338	992.919	

List of Control Points

CH 55.000 KM TO CH 70.000 KM GCP'S DETAIL'S					
GCP"S	**WGS84 Latitude**	**WGS84 Longitude**	**Grid Northing (m)**	**Grid Easting (m)**	**Elevation**
SCP-34	28°26'27.1660"N	76°53'03.9408"E	3147488.043	684540.453	215.911
SCP-35	28°25'30.7392"N	76°50'25.8913"E	3145684.543	680266.856	219.896
SCP-36	28°28'09.7293"N	76°52'43.6735"E	3150636.520	683939.677	213.146
SCP-37	28°27'18.7550"N	76°50'07.4498"E	3149001.770	679714.292	220.146
SCP-38	28°29'42.9174"N	76°52'07.7145"E	3153489.785	682916.938	214.025
SCP-39	28°28'50.9803"N	76°49'32.4323"E	3151826.102	678718.550	213.476
SCP-40	28°31'23.0046"N	76°51'19.5862"E	3156550.370	681560.510	215.268
SCP-41	28°30'47.1215"N	76°48'49.0457"E	3155383.233	677484.549	215.147
TCP-121	28°24'44.9666"N	76°52'05.2477"E	3144317.248	682992.383	219.192
TCP-122	28°24'43.9123"N	76°52'08.2088"E	3144286.044	683073.473	218.608
TCP-123	28°25'12.0360"N	76°51'58.2550"E	3145147.538	682789.158	216.629
TCP-124	28°25'12.2561"N	76°52'01.6202"E	3145155.733	682880.630	216.485
TCP-125	28°25'44.3761"N	76°51'51.2001"E	3146140.046	682581.747	215.537
TCP-126	28°25'44.5441"N	76°51'55.0849"E	3146146.859	682687.377	215.975
TCP-127	28°26'14.6158"N	76°51'43.6273"E	3147067.689	682361.278	217.239
TCP-128	28°26'12.3380"N	76°51'47.4057"E	3146999.166	682465.168	218.938
TCP-129	28°26'52.0371"N	76°51'34.8424"E	3148215.885	682104.440	214.765
TCP-130	28°26'53.6477"N	76°51'38.0460"E	3148266.810	682190.830	213.613
TCP-131	28°27'22.0923"N	76°51'27.8475"E	3149138.096	681899.839	213.026
TCP-132	28°27'23.6537"N	76°51'29.6618"E	3149186.920	681948.452	212.382
TCP-133	28°27'36.8392"N	76°51'38.4657"E	3149596.499	682181.669	213.633
TCP-134	28°27'37.9196"N	76°51'45.7131"E	3149632.812	682378.301	213.769
TCP-135	28°27'59.5240"N	76°51'23.4804"E	3150288.477	681763.240	212.754
TCP-136	28°27'58.2345"N	76°51'26.5012"E	3150250.052	681846.023	213.531
TCP-137	28°28'36.0083"N	76°51'16.7447"E	3151408.700	681562.683	212.211
TCP-138	28°28'35.7799"N	76°51'20.2138"E	3151403.127	681657.146	212.179
TCP-139	28°28'57.6830"N	76°51'05.8799"E	3152071.330	681256.893	212.880
TCP-140	28°28'57.1481"N	76°51'10.2363"E	3152056.693	681375.628	212.816
TCP-141	28°29'18.8721"N	76°50'53.4692"E	3152718.372	680909.323	212.975
TCP-142	28°29'19.3493"N	76°50'57.6049"E	3152734.791	681021.569	212.681
TCP-143	28°29'54.7526"N	76°50'31.4879"E	3153813.651	680294.586	214.680
TCP-144	28°29'57.1221"N	76°50'30.5123"E	3153886.183	680266.936	214.588
TCP-145	28°30'22.3772"N	76°50'20.6217"E	3154659.458	679986.076	214.211
TCP-146	28°30'22.6226"N	76°50'23.7880"E	3154668.329	680072.053	214.134
TCP-147	28°30'53.1741"N	76°50'08.1171"E	3155602.235	679631.563	213.177
TCP-148	28°30'54.2896"N	76°50'11.2711"E	3155637.887	679716.790	212.908
TCP-149	28°31'22.3387"N	76°49'56.0802"E	3156494.973	679290.586	213.433
TCP-150	28°31'25.2632"N	76°49'57.6593"E	3156585.651	679332.140	213.002
TCP-151	28°31'59.1200"N	76°49'43.5444"E	3157621.968	678932.518	212.454
TCP-152	28°31'59.1272"N	76°49'46.9756"E	3157623.614	679025.787	212.229

Pramod Rehpade
Asst.Technical Manger

List of EHT Crossings				
Sr. No.	**Chainage**	**Capacity in kV**	**Feeder**	**Utility Owner**
1	59180	66 KV (HVPNL)	Harsaru - farukhnagar Line	HVPNL
2	59270	220 KV (BBMB)	Dadri - Samaypur - Balabhgarh Line	BBMB
3	60216	400 KV (HVPNL)	Dhanonda - Daulatabad Line	HVPNL
4	1+860 (Patli-New Patli connecting Line)	220 KV (HVPNL)	Sec-95 - Mau Line	HVPNL

APPROVED MANUFACTURES/SUPPLIERS LIST

All materials and products shall conform to the Outline Construction Specification (OCS), BIS codes and other relevant codes etc. and shall be of make as approved by HRIDC.

The list of approved makes for products and materials is given below. No Further approval is required to be taken for usage of these makes.

S. No.	Details of Materials/ Products		Manufacturer's Name
1.	Cement	OPC	ACC, Ultratech, Ambuja, JK Lakshmi, JSW, Orient Cement , JK Cement ,Lafarge
2.	Reinforcement Bars		Prequlified Manufacturers as per RDSO's latest approved list with proper approval of HRIDC
3.	***** Epoxy		FOSROC, SIKA QUALCRETE, BASF, CHRYSO, Vista, CICO, Pinnacle, MYK Schomburg, Thermax, Kunal Conchem, Sunanda, Fairmate,Berger, MC–Bauchemie, Fibrex, MAPEI, Ultracon, ECMAS, Durabuild
4(a).	***** Expansion Joints for Viaduct		Prequlified Manufacturers as per RDSO's latest approved list with proper approval of HRIDC.
4(b).	***** Expansion Joints for buildings		MYK Schomburg, Migua, CS, Sanfield, Inpro, 3R Joints & Seals, VR Engineers, Greensboro Polychem, Maruti, MC-Bauchemie, Asian Paints, ECMAS ,Z Tech
5.	***** Admixtures		Buildtech, FOSROC, SIKA, MBT, MC-Bauchemie, Pidilite, CHRYSO, MYK Schomburg, BASF, MAPEI, Kunal Conchem, UNIROCK , CICO, ECMAS, CAC, Fairmate, Vista, Thermax, TP Buildtech, Sunanda, Molecules Conchem, Pinnacle, Durabuild, Ultracon, Ado additives, Asian, Greensboro Polychem, STP, Berger, Fibrex
6.	Pile Integrity Testing		CIMEC, Spectro, ADS Labstech, ATL, Avantech, Geodynamics, AIMIL, Cengers, CBRI, EMC India, Pile Dynamic, Composites Combine Technocrats, CEG test House **(PLEASE NOTE THAT NABL ACCREDITION IS MANDATORY)**

7.	***** Anchor Fastener	HILTI, FISCHER,BIT, TRUTEK, FOSROC, Mungo, Minova, UIP, Wuerth **(Please note that ETA Certification is mandatory for using/supplying fasteners for load bearing structural members)**
8.	Structural Steel	TATA, SAIL, ESSAR, Maharashtra Pipes, Jindal Steel & Power Ltd., K.L. Steel, Steel Works & Power Engineers, SKS Ispat & Power, Shamli Steel, Topworth, Goodluck India, Rimjhim
9.	***** Pre- stressing Strand (LRPC)	TATA SSL Ltd, USHA Martin, DP Wires, Miki Steel, Kataria Group
10.	***** Pot/Elastomeric /Spherical Bearings	Prequalified Manufactures as per RDSO's latest approved list with proper approval of HRIDC
11.	***** Horizontal Tie Bars/Shear Bars	Dextra, BB Bars System, BBV Systems, Minova, Euroalloy
12.	***** HDPE Sheathing	Rex, Gwalior Polypipes Ltd, Kataria Sheathing, Tirupati, Dynamic Prestress, JK Prestressing
13.	Formwork Release Agent	FOSROC, MC Bauchemie, CICO, CHRYSO, Fibrex, BASF, Sunanda, Pinnacle, Fairmate, Durabuild, CAC, Adoadditives, MYK Schomburg, Greensboro Polychem, Thermax, STP, MAPEI, Asian Labs, ECMAS ,Ultracon, Buildtech.
14.	***** Prestressing System	Freyssinet, BBR, VSL, Dynamic, Kellick Nixon, Tensacciai (India Ltd.), JK Prestressing, Usha Martin, VSIL
15.	***** Reinforcement Couplers (cold forged paralled threads type only)	Dextra, Halfen Moment, Sanfield, Kridhan , JB Engg
16.	Hollow Sections, Pipes	Surya Pipes, Hi-Tech Pipes, JSW, Jindal Steel and Power ltd., Garg Ispat Udyog, Navratan, VMC Steel, APL Appolo, DADU Pipes Goodluck India, Sarvari Steel
17.	***** Drainage Pipes	Tirupati Plastomatics, Duraline, REX, STIPL, Kriti, Vishal, Eonn, Giga Pipes.

18.	Acrylic Textured Coatings	Spectrum, Surfa Nova, Sunanda, Jotun, Asian Paints, Berger, Hempel, DULUX, STP, Godavari Paints, MC-Bauchemie, MAPEI
19.	***** Non Shrink Grout	FOSROC, SIKA, BASF, MBT, CHRYSO, Fairmate, CICO, MYK Schomburg, Pinnacle,
		ECMAS, Minova, Durabuild, CAC, Asian Paints, STP, BERGER, Fibrex, Ado Additives, Thermax, CICO, Greensboro Polychem, Ultracon, Kunal Conchem, MC-Bauchemie, Asian Labs, MAPEI, Buildtech
20.	Bonding Coat	CICO, FOSROC, Sunanda, BASF, CHRYSO, MYK Schomburg, Minova, Fairmate, STP, SIKA, BERGER, Greensboro Polychem, Thermax, Ultracon, ECMAS, Asian Paints, Fibrex, Asian Labs, Ado Additives, MAPEI, MC-Bauchemie, Durabuild
21.	***** Polysuphide Sealant	CICO, Pidilite, BASF, FOSROC, CHRYSO, STP, SIKA, Sunanda, Fairmate, Kunal Conchem, Durabuild, Asian Paints, MYK Schomburg, Greensboro Polychem, Ultracon, ECMAS, Fibrex, MC-Bauchemie, Buildtech
22.	***** Steel Structural Fasteners	Sundram Fasteners, Pioneer Nuts & Bolts, Unbrako, Nelson, Panchsheel, LPSEJOT, UIP, Canon, Trutek, Kwality Forge, Atul Fasteners, Imperial Bolts, Pooja Forge **(Please note that ETA Certification is mandatory for using/supplying fasteners for load bearing structural members)**
23.	***** Corrosion Protection Paints	Berger, Johnson Nicholson, Nerolac, Asian Paints, Akzo Nobel, Jotun, Shalimar, 3M Fosroc, Hempel, Universal Paint, Sunanda, Kunal Conchem, STP, INM Nuvent Paints, CICO, CHRYSO, Greensboro Polychem
24.	Micro Silica	Thermal Plants, Sika Elkem, FOSROC, MAPEI, Corniche, Star Silica, CICO, Rockfit, Jaycee Build Corp LLP, Vista, Kunal Conchem, CAC, BASF, Buildtech, Ashtech, Ultracon, Alccofine
25.	***** Fire Resistant Paint	Akzo Nobel, PPG, Jotun, Sunanda, Berger Paints
26.	***** Integral Crystalline Waterproofing Method	Penetron, XYPEX, SIKA
27.	***** Water stopper/ Bar	Kanta Rubber, Greenstreak, Duron, Sunanda, Wall Grip, Asian Paints, FOSROC, Maruti, CHRYSO

28.	***** Liquid Polymer membrane waterproofing	BASF, MAPEI , NINA, CICO, Kunal Conchem, MYK Schomburg, Sunanda, ECMAS, Durabuild, Asian Paints, STP, BERGER, FOSROC, Greensboro Polychem, Ado Additives, MC-Bauchemie, Thermax, Asian Labs, CHRYSO, Ultracon, Buildtech
29.	***** Curing Compound	Clean Tech Concure, Vista, FOSROC, STP, Kunal Conchem, CHRYSO, CICO, Pinnacle, Durabuild, BERGER, Fibrex, Greensboro Polychem, UNICRETE, Ado Additives, UNIROCK, SIKA, Fairmate, MYK Schomburg, Ultracon, ECMAS, Asian Labs, Asian Paints, Molecules Conchem, MC-Bauchemie, MAPEI, Thermax, Buildtech, CAC
30.	***** Polycarbonate Sheets	Gallina Acroplus, Coxwell, Poly U, Fabic, Lexan, (SABIC Innovative Plastics), DANPALON, GE Plastics, VMI Plastics, Power Chem Plast, Super Disco Ispat
31.	Fly Ash	Thermal Plants, Ashcrete, Ultra Pozz, Star Pozz, Ashtech, Jaycee Build Corp LLP, SUPERPOZZ P500
32.	***** Pre-Coated Profiled Metal Sheethings	TATA Blue Scope, Multicolor, Kamdhenu, Essar Steel, Bhushan Steel, Ispat Profile India, Super Disco Ispat, Aditya Profiles
33.	Sodium Silicate for Grouting purposes during TBM operations	BASF, Kunal Conchem, SIKA, CHRYSO, Subham Mineral, Minova, Sunanda, Greensboro Polychem, Ado Additives, FOSROC, Ultracon, Asian Labs, Fibrex, Buildtech
34.	***** Fly Ash Block/ AAC Block	Siporex, Ascolite, J.K. Laxmi, Ashtech, UNICRETE
35.	***** Tunnel Segment EPDM	FIP, Datwyler, E.S. Rubber, Haida Rubber
36.	***** Rock Bolts/Swellex Bolts	Geo Constech, DSI, Atlas Copco, FIREP International, Minova
37.	***** Softeye GFRP	Dextra, FIREP International, Minova, Hughes Brother, Geo Constech
38.	Material Testing	ADS Labstech, Anshu Tech, Arihant, SHREE BALAJI Test House, Beauru Veritas, ShriRam, National Test House, Spectro, Indian Institute of Technology, Pioneer, Secon, Delta, CEG Test House
39.	Geotechnical Investigation	Cengers, CEG Testhouse, Delhi Test House, SHREE BALAJI Test House, Techpro, Arun Soil Labs, Indian Geotechnical, Raicon, Composite Combine Technocrats, Secon, Sai Geotech

40.	***** Polymer	WALLGRIP, TRISHUL, Shubham Minerals, Goldy Minerals, GeoPolymer

NOTE: For the categories marked as *, the enclosed undertaking performa should be duly filled and signed by authorized representatives of concerned agencies.

UNDERTAKING

Name of Contract: **Date of start of work:**

Category of work: **Date of completion of work:**

This is to certify that work of …… (Category to be mentioned) at …… (Location) of the contract.....(Name of contract) has been executed/completed in accordance with the manufacturer's/supplier's specifications and as per the approved method statement.

The work has been jointly inspected by authorised representative of …… (Manufacturer/supplier), …… (Executing agency) & …….. (Contractor) during its execution and all non-conformities observed during inspection have been complied to achieve the best industry standards.

The undersigned take full responsibility of the overall adequacy, accuracy, effectiveness & warranty (upto design life) of the completed work as per the provision of the contract ……. (Contract number) and Outline Construction Specifications of HRIDC.

(Stamp and Signature)	(Stamp and Signature)	(Stamp and Signature)
Manufacturer Representative	**Executing agency Representative**	**Contractor Representative**

Geotechnical Reports

Geotechnical Investigation Report

Ch. old	**52+518**	**53+107**	**53+282**	**53+572**	**53+982**	**54+363**	**54+496**	**55+910**	**56+403**
Ch. new	**55+719**	**56+291**	**56+466**	**56+756**	**57+169**	**57+547**	**57+672**	**59+107**	**59+587**
Ch. old	**56+701**	**56+978**	**57+400**	**58+191**	**58+497**	**58+837**	**59+071**	**59+206**	**59+270**
Ch. new	**59+886**	**60+162**	**60+603**	**61+376**	**61+676**	**62+026**	**62+256**	**62+400**	**62+546**

SR NO. : 544_21-22

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA

CLIENT

M/S. HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. (HRIDCL)

PROGRAMME

APRIL - 2022

SR. No.	Report No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/262_(44 BHs)	03	05.05.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/97_(44 BHs)	02	18.04.2022
544_21-22	CEGTH/HRIDCL/SR-544/2021-22/1685_(44 BHs)	01	30.03.2022
544_21-22	CEGTH/HRIDCL/SR-544/2021-22/1544_(38 BHs)	00	22.03.2022

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

B-11(G), Malviya Industrial Area, Jaipur-302017
Tel. : 91-141-4046599, Fax : 91-141-2751806
E-mail : info@cegtesthouse.com., www.cegtesthouse.com

CEGTH/HRIDCL/SR-544/2022-23/262 Date:- 05.05.2022

To,

Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)
SCO No.-17-19, 3rd & 4th Floor,
Sector - 17-A,
Chandigarh - 160017
Tele:- 0172-2715644
Email: hridc2017@gmail.com

Subject :- Geotechnical investigation work for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana.

Dear Sir,

We are pleased to submit this report of the subject work based on 44 borehole carried out at Old Ch. 52+518 (New ch. 55+719) to Old ch. 59+270 (New ch. 62+546) for the proposed project site.

The accompanying report presents results of various field tests and laboratory tests conducted on selected soil samples and their interpretation.

Should there be any clarifications regarding the contents please contact us at your most convenient time.

We value the opportunity to participate in this project and look forward a pleasant association on future projects.

Very truly yours,
CEG Test House & Research Centre Pvt. Ltd.

Nehal Jain
General Manager - Geotechnical
Authorized Signatory

Prepared By:-

Brijesh Jangir
Sr. Manager – Geotech Services

SR. No.	Report Ref. No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/262_(44 BHs)	03	05-05-2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/97_(44 BHs)	02	18.04.2022
544_21-22	CEGTH/HRIDCL/SR-544/2021-22/1685_(44 BHs)	01	30.03.2022
544_21-22	CEGTH/HRIDCL/SR-544/2021-22/1544_(38 BHs)	00	22.03.2022

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CHAPTER 1 GENERAL

1.0 INTRODUCTION:

The work of conducting "**Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana"** was awarded to "**CEG Test House & Research Centre Pvt. Ltd., Jaipur" by M/S.** "**Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)"** as per work order no. HRIDC/ HORC/ GT/ CEG/ 237/ 2021/ 577-M dated 29th July 2021.

Field work including drilling of boreholes, conducting field tests such as Electrical Resistivity Test, & Plate Load Test and sample collection was carried out in the presence of representative of Client. Laboratory tests were conducted on selected soil samples to determine the design parameters, confirming to relevant IS specifications and the guidelines received from time to time from representative of Client.

This report includes the details of Methodology of Investigation, collection of samples (soil/ rock), field test results, laboratory test results, analysis of results and recommendations for proposed structure carried out at Old Ch. 52+518 (New ch. 55+719) to Old ch. 59+270 (New ch. 62+546) based on soil sample collected from the locations of 44 boreholes.

2.0 SITE LOCATION & GENERAl GEOLOGICAL HISTORY:

The details of the site & test locations for the proposed project are shown in location plan attached vide **Appendix A-1**. The site of proposed project is located from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV (Zone factor=0.24) of India.

Soil of the Haryana Sub-Region have been classified and described under the following major soil types as shown below:-

- Typic Ustochrepts : Soil of old alluvial plains
- Typic Ustipsamments : Soil of Aravali plains
- Typic Ustifluvents : Soil of recent alluvial plains and flood plains
- Typic Torripsamments : Soil of Aeofluvial plains
- Rocky Outcrops : Aravali rocky hills

The district wise details of soil characteristics are described below:-

Panipat: The soils are well drained, Sandy loam to clay loam/silty clay loam in plains and loam to clay loam/ silty/ loose clay loam in relic channels/depressions/basins.

Sonipat: The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. Recent flood plains occur along the Yamuna River and clearly show fluvial features. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Rohtak: The district mainly comprises of old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface. Old meander plains are almost flat with loamy sand to silty clay loam soils. Oldest among all the land forms are old alluvial plains, which cover major areas in the district. These soils are sand to loamy sand/sandy loam (surface) to silt loam/silty clay loam (sub-surface).

Jhajjar: The district mainly comprises of old alluvial plains and some parts of the district also have soil belonging to Aravali plains.

Rewari: The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand.

Gurgaon: The district comprises of sand dunes, sandy plains, alluvial plains, salt affected areas,

low lands, lakes, hills and pediments. The soil varies from sand to loamy sand in sand dunes and sandy plain areas, sandy loam to clay loam / silty clay loam in alluvial plains, calcareous, loamy sand to loam in salt affected plains, silty loam to loam in low lands and calcareous, loamy sand to loam in hills.

Mewat: The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The upper hills are mostly barren.

Faridabad and Palwal: The district comprises of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam

(surface), clay loam/silty clay (sub-surface) in low lying plains and depressions.

3.0 SCOPE OF WORK:

The stipulated scope of work involved carrying out the following operations:-

a) Mobilisation of necessary plant equipment, men and materials for the complete Geotechnical investigation work as per specifications, drawings and instructions of the Engineer and to complete the same within the stipulated time schedule and demobilisation after completion of field work.

b) Shifting of Equipments from one structure location to another including Ereaction, installation of rigs at site and dismantling of the same after completion of field work. Shifting of setup for each borehole location and associated preparation for borehole under water

c) Making 150 mm nominal diameter boreholes at various locations in all types of soils except hard rock and large boulders using suitable approved method of boring including chiselling, cleaning, providing casing pipe as required; performing Standard Penetration Test at every 3.0m interval and at change of strata; collection of water samples and disturbed soil samples, observation such as ground water, etc., collection of undisturbed soil samples at every 3.0 m interval and at change of strata; transportation of all the collected samples to the laboratory and back filling of boreholes on completion of the same, complete as per specification and instructions of the Engineer, for depths below natural ground level.

d) Conducting Electrical resistivity tests at various locations all complete as per specification and directions of the Engineer.

e) Conducting plate load test at various locations, all complete as per specification and directions of the Engineer.

f) Drilling of Nx size boreholes (75mm dia.) in all types of hard rock, collection of core samples, maintaining continuous record of core recovery/ RQD, keeping the cores in wooden core boxes, transporting to laboratory, backfilling on completion of the same, all complete as per specification and instructions of the EIC.

g) Conducting various laboratory tests on soil samples at an approved laboratory including preparation of soil samples to determine the following properties of soil, all complete as per specification.

<u>On soil Samples</u>

- Dry density test
- Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- Liquid Limit and Plastic Limit
- Specific gravity
- Shrinkage Limit

- Free Swell Index
- Direct Shear Test
- Triaxial Shear Test
- One Dimensional consolidation test
- Chemical Analysis of soil samples (pH, chloride, Sulphate)

h) Conducting laboratory tests on rock samples including preparation of the samples to determine the following properties, all complete as per specification

<u>On Rock Samples</u>

- Moisture content, porosity & Density
- Specific gravity
- Hardness
- Unconfined compression test
- Point load strength index
- Modulus of Elasticity and Poission's Ratio
- Abrasion Test

i) Conducting chemical tests on water samples to determine the Sulphate, chloride and pH value all complete as per specification.

j) Submitting draft report in soft copy including all field records and laboratory test results, graphs, etc., all complete as per specifications.

k) Submitting final report in t0068ree hard copies in after the approval of the draft report including all field records and laboratory test results, graphs, etc., all complete as per specifications.

4.0 FIELD INVESTIGATION IN SOIL STRATA:

The investigation was planned to obtain the subsurface stratification in the proposed project site and collect soil / rock core samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum.

For geotechnical investigation work, required equipements along with rotary drilling rigs and manpower were mobilized at site to carry out various field activities as per the scope of work. These were shifted from one test location to another location during execution of field work and were demobilized on satisfactory completion of field work.

For conducting the field investigations the following practices were followed at site:

- The locations of 44 borehole carried out at Old Ch. 52+518 to ch. 59+270 (New ch. 55+719 to ch. 62+546) were marked at site at specified locations. These locations are shown in **Appendix A-1** attached subsequently.

The details of various boreholes along with their coordinates are provided herein below:

Table 1.1: Details of Borehole Locations

S. No.	Chainage Old	Chainage New	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
1.	52+518	55+719	MJB	BH-A1	22.80	40.00	683091.771	3143671.170	213.216
				BH-A2	23.50	40.00	683092.392	3143783.105	220.511
2.	53+107	56+291	MNB	BH-CL	NE	15.00	683034.675	3144302.971	218.950
3.	53+282	56+466	MNB	BH-CL	NE	10.00	682995.864	3144473.609	218.087
4.	53+572	56+756	MNB	BH-CL	NE	10.00	682931.500	3144756.380	217.532
5.	53+982	57+169	MNB	BH-CL	NE	10.00	682840.528	3145156.160	217.050
6.	54+363	57+547	MNB	BH-CL	NE	10.00	682755.991	3145527.663	216.014
7.	54+496	57+672	MNB	BH-CL	NE	15.00	682726.480	3145657.348	217.393
8.	55+910	59+107	MJB	BH-A1	16.00	40.00	682418.856	3147009.213	218.101
				BH-A2	15.60	40.00	682407.318	3147059.917	217.474
9.	56+403	59+587	MNB	BH-CL	NE	10.00	682303.349	3147516.813	215.389
10.	56+701	59+886	MNB	BH-CL	NE	15.00	682237.228	3147807.384	215.273
11.	56+978	60+162	MNB	BH-CL	NE	10.00	682175.767	3148077.480	212.389
12.	57+400	60+603	MJB	BH-A1	10.90	30.00	682111.171	3148361.347	217.941
				BH-P2	11.85	30.00	682104.781	3148389.429	213.893
				BH-P3	11.50	31.00	682101.808	3148402.495	214.414
				BH-P4	11.80	30.00	682098.835	3148415.561	214.498
				BH-P5	12.00	30.00	682095.861	3148428.627	214.548
				BH-P6	11.40	30.00	682092.888	3148441.693	214.417
				BH-P7	11.00	30.00	682089.915	3148454.759	214.599
				BH-P9	12.00	35.00	682083.968	3148480.891	214.330
				BH-P10	11.85	30.00	682080.995	3148493.957	214.021
				BH-P11	11.80	30.00	682078.022	3148507.023	213.946
				BH-P12	12.10	30.00	682075.049	3148520.089	214.402
				BH-P13	12.30	30.00	682072.075	3148533.155	214.579
				BH-P15	11.80	30.00	682066.129	3148559.287	213.460
				BH-P16	11.20	30.00	682063.156	3148572.353	212.949
				BH-P17	10.80	30.00	682060.182	3148585.419	213.184
				BH-P18	10.50	30.00	682057.209	3148598.485	213.517
				BH-P19	11.50	30.00	682054.236	3148611.551	213.504
				BH-A2	10.90	35.00	682050.819	3148626.567	213.090
13.	58+191	61+376	MNB	BH-CL	NE	10.00	681895.083	3149257.396	212.823
14.	58+497	61+676	MJB	BH-A1	11.50	40.00	681858.380	3149467.024	213.216
				BH-P1	11.60	40.00	681844.488	3149495.176	214.371
				BH-P2	10.70	40.00	681840.419	3149522.156	213.108
				BH-P3	11.00	40.0	681840.00	3149565.000	214.145
				BH-P4	11.90	40.00	681837.920	3149594.593	214.312
				BH-P5	12.00	40.00	681834.868	3149620.114	213.726
				BH-P6	11.00	40.00	681836.405	3149645.522	213.711
				BH-A2	12.00	40.00	681833.809	3149673.452	214.044
15.	58+837	62+026	MNB	BH-CL	NE	10.00	681823.952	3149897.982	213.610

S. No.	Chainage Old	Chainage New	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
16.	59+071	62+256	MNB	BH-CL	NE	10.00	681817.835	3150131.892	213.832
17.	59+206	62+400	MNB	BH-CL	12.65	15.00	681807.000	3150266.000	213.360
18.	59+270	62+546	MNB	BH-CL	NE	10.00	681801.000	3150330.000	212.593

***Not Encountered:-NE**

- In soil, boreholes of 150mm dia. were drilled as per the standard procedure laid in IS: 1892.
- Borehole was properly cleaned before taking any sample in soil.
- Casing was used as per the prevailing soil conditions, to stabilize the borehole.
- Standard Penetration Tests were conducted in bore holes at regular intervals or at every change of strata as per Technical specification.
- Undisturbed were collected wherevery feasible as per the requirements and at specified depths. The same has been discussed in detail in soil characteristics sheets attached with the report.
- Water table was met at depths varying from 10.5m to 23.5m below EGL.

The detailed procedure adopted for conducting various field tests is given here in below:

(i) Standard Penetration Test:

The Standard Penetration Test was conducted in boreholes as per IS 2131. The test was carried out using the standard split spoon sampler to measure the number of blows 'N'.

Standard split spoon sampler was attached to an 'A' rod. It was driven from borehole bottom to a distance of 45 cm using a standard hammer of 63.5 kg falling freely from a height of 75 cm to the required depth. While driving, the number of blows required to penetrate every 15 cm are recorded. The total number of blows required for the last 30 cm is taken as 'N' value at that particular depth of the borehole. Wherever the total penetration was less than 45cm, the no. of blows & the depth penetrated is recorded in the respective borelog.

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:-

Table 1.2: Soil compactness as per SPT N values (cl. 9.7, table 9.3 & 9.4, page 330_text book of V.N.S. Murthy)

Correlation for Clay / Plastic silt		Correlation for Sand / Non-Plastic silt	
Consistency	**SPT "N" Value**	**Compactness**	**SPT "N" Value**
Very Soft	0 - 2	Very Loose	0 - 4
Soft	2 - 4	Loose	4 - 10
Medium	4 - 8	Medium	10 - 30
Stiff	8 - 15	Dense	30 - 50
Very Stiff	15 - 30	Very Dense	> 50
Hard	> 30		

The field SPT N values obtained were further corrected as per the guidelines given in IS: 2131 as follows:

(a) For overburden: **-** The N value for cohesionless soil is corrected with the help of fig. 1 given in IS-2131.

(b) Due to dilatancy :- Wherever N values observed below water table in fine sand, silty sand or silt was greater than 15, then corrected N values were corrected as under:

$$N' = 15 + \tfrac{1}{2}(N-15)$$

(ii) Undisturbed Sampling (Soil) in boreholes:

Undisturbed samples were collected using MS tubes of suitable diameter and length with Area ratio as per clause 4.1.1 (c) of IS: 1892 (latest) fitted to an adopter with ball and socket arrangement. Before taking any sample, sampling tube was properly greased. Immediately after taking on undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the sample were trimmed off any wet disturbed soil. The ends were coated alternately with four layers of just molten wax. More molten wax was added to give a total thickness of min. 25 mm. The samples were carefully labeled and transported to the laboratory for testing. Undisturbed samples wherever slipped during lifting were duly marked in the field logs as well as in the soil profile.

(iii) Collection of Ground Water Samples from bore holes:

Water table was met at depths varying from 10.5m to 23.5m below EGL.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

Table 1.3: Description of Tests

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)	√	√
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)	√	-

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Atterberg Limits • Liquid Limit • Plastic Limit	 IS: 2720 (Part - 5) IS: 2720 (Part - 5)	 √ √	 √ √
Specific Gravity	IS : 2720 (Part – 3)	√	-
Direct Shear Test	IS : 2720 (Part – 13)	√	-
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)	√	-
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)	√	-

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

5.1.1 Dry density and Bulk density

For determination of bulk density and dry density, a sample of known volume 'V' was extracted from the undisturbed sampling tube and it's bulk weight 'W' was noted down.Moisture content 'Wn' was determined by oven drying method.

The bulk density and dry density were determined by following equation-

Bulk density (γ_b) = W/V

Dry density (γ_d) = γ_b/ (1+Wn)

5.1.2 Natural water content

For this test, the soil sample of known quantity (Wm) was taken in a container.The container with soil sample was placed into an oven for drying at 105-110°c temperature for 16-24 hours. After drying, the dry sample was again weighted to determine the dry weight of sample (Wd).

The natural water content was computed by the following equation-

Wn = (Wm-Wd)*100/Wd

5.1.3 Grain Size Analysis (IS: 2720- Part-4)

Wet sieve analysis:

For determination of particle sizes finer than 75 micron, wet sieve analysis test was conducted. For this test, oven dried sample of known quantity was taken in a container and soaked with dispersing agent. The soaked soil sample was washed thoroughly over 75 micron IS sieve until the water passing sieve was substantially clean.

Fraction retained on 75 micron IS sieve was carefully collected in a container without any loss in material and placed into oven for drying.

Dry sieve analysis:

For this test, the oven dried soil sample after wet sieving was sieved through the set of IS sieves 20 mm, 10 mm, 4.75 mm, 2.0 mm, 1.0 m , 425 micron , 300 micron, 150 micron and 75micron. The amounts of soil retained on each sieve were noted down. The % retained, cumulative % retained and % passing were computed accordingly. Wherever the soil sample % passing 75 micron sieve was significant, Hydrometer method was used to find the percentage of silt and clay fraction.

Grain size analysis for the fraction passing 75 micron IS Sieve (Hydrometer method)

Calibration of Hydrometer

Hydrometer was calibrated to determine a relationship (an equation) between the effective depth H_R and corresponding hydrometer reading R_h (obtained during test).

50 to 100 gm of soil sample passing through 75 micron IS Sieve was taken. It was mixed with 100 ml of sodium hexametaphesphate solution and the mixture was warmed for about 10 minutes. It was then transferred to the cup of the mechanical mixer and the soil suspension was stirred for 15 minutes. The soil suspension was transferred into 1000 ml measuring cylinder and distilled water was added to make 1000ml solution. This solution was mixed vigorously. The measuring cylinder was then allowed to stand and the stopwatch was started. Hydrometer was immersed in the solution and reading were taken after half, one, two and four minutes. The hydrometer was then removed slowly and kept in distilled water at the same temperature as the soil suspension. Readings were taken after the periods of 8, 15 and 30 minutes, and one, two and four hours. Hydrometer was removed, rinsed and placed in the distilled water after each reading. After 4 hours reading was taken once or twice within 24 hours. Finally a reading was taken at the end of 24 hours. The temperature of the suspension was observed and recorded.

Calculations

Diameter of the particles (D):

$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = M\sqrt{\frac{H_R}{t}}$$

Where,

D = diameter of particle in suspension, in mm;

μ = co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;

G = specific gravity of the soil fraction used in the sedimentations analysis;

H_R = effective depth corresponding to R_n, in cm.

t = time elapsed between the beginning of sedimentation and taking of hydrometer reading in minutes

$M = \sqrt{\frac{30\mu}{980(G-1)}}$ = a constant factor for given values of μ and G at the temperature of the suspension.

Percentage finer than diameter D:

The percentage by mass (w) of particles smaller than corresponding equivalent particle diameters (D) was calculated from the formula:

$$w = \frac{100G_s}{W_b(G_s - 1)} \times R_h$$

Where

w = percentage finer

G_s = specific gravity of soil particle

W_b = weight of soil

R_h = Hydrometer reading

5.1.4 Specific Gravity (IS: 2720-Part-3 Sec-1)

The specific gravity of soil sample was determined by density bottle method. For this test 5-10g oven dried and cooled soil sample was taken in 50ml capacity density bottle and its weight was noted down as W_2 .The soil was covered with distilled water and left for sufficient period for suitable soaking. The entrapped air was removed by vacuum. The bottle with soil was filled fully with water and its weight was noted down (W_3). The mass of empty bottle and bottle filled with distilled water were noted down as W_1 and W_4 respectively.

The Specific Gravity was determined by using following equation :

$G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$

5.1.5 Liquid Limit (IS: 2720- Part-5)

By Cone Penetrometer Method

The 'Cone Penetrometer Apparatus' is a variant of the fall-cone and consists of a cone with a smooth polished surface and angle of 30° ± 1/2°. The weight of the cone, together with its associated shaft is 80g ± 0.5g. A support assembly with an automatic cone release mechanism and cone height adjustment mechanism used to hold the cone vertically. The angle and weight of the cone were calibrated at regular intervals, and the sharpness of the cone tip was checked daily.

Distilled water was added and thoroughly mixed with the soil sample to produce a homogeneous paste. The paste was then placed in a cup with a diameter of at least 55mm and a depth of at least 40mm. The surface of the soil was smoothed off level and parallel to the base. The support assembly was used to position the tip of the cone so that it was just touching the top surface of the soil, and the automatic tripping mechanism was released. The cone was allowed to penetrate into the soil for a period of 5 (± 1) s, then the cone was locked off to stop further movement and the penetration was recorded. The cup was refilled and the test was repeated. The two recorded penetrations need to be within 0.5mm of each other, otherwise a third test is performed. when the three test vary by more than 1mm the test was repeated.

Further tests were conducted, at varying water contents, in order to produce a series of cone penetrations (usually 4) in the range 15mm to 25mm. The resulting cone penetrations were plotted verses the water content of the test specimens. The Liquid Limit (W_L) was read off the graph, being the water content at which the line of best fit through the test points crosses 20mm penetration.

5.1.6 Plastic Limit (IS: 2720-Part-5)

For this test, soil sample was prepared in the same way as for liquid limit test. A ball of soil sample weighed about 5 gm was formed. The ball was rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm was reached, soil was again remolded into a ball. The process of rolling and remolding was repeated until the thread started just crumbing at a diameter of 3 mm. The crumbled thread was immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content has been termed as plastic limit. (W_P)

5.1.7 Plasticity Index (IS: 2720-Part-5)

The plasticity index Ip was given by

$I_p=W_L-W_P$ (in percent)

5.1.8 Direct Shear Test (IS:2720-Part-13):

For this test shear box test apparatus was used. The prepared specimen from remolded/undisturbed sample was placed carefully in the box. The plain grid was kept on top of the specimen with its directions at right angles to the direction of shear. The upper porous stone was placed on the grid and loading pad on the stone. The box with specimen was gently placed in the container (water jacket). The specimen was submerged with water. The container was mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box was so adjusted that it

touchéd the proving ring. The jack was brought forward to bear up against the box container. The proving ring dial gauge was set to read zero.

The steel ball was placed in the recess of the loading pad. The loading yoke was set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load was applied and any change in thickness of specimen was recorded. Shear displacement dial gauge was also set to read zero. The locking screw was now removed and two parts of the shear box were separated by advancing the spacing screws.

The specimen was sheared at constant rate of strain. The readings of the proving ring dial gauge were noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge were also recorded at the same time interval. The test was continued until the specimen fails. The specimen was assumed to fail when the proving ring dial gauge started receding or at shear displacement of approximately 15% of the length took place.

The soil was removed from the box and test was repeated on the identical specimen under increased normal load.

The rate of strain for conducting Direct Shear Test is kept as 0.25 mm/min as per codal/literature provision based on strata.

5.1.9 Triaxial Shear Test_UUT (IS: 2720-Part-11)

For this test, Triaxial Shear Test apparatus was used. The plain disc was placed on the pedestal of the triaxial cell. The specimen was placed centrally on the disc. A correct size rubber membrane was fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum was applied to stretch the membrane to the inside surface of the stretcher which was carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane was released. Its bottom part was rolled down into the pedestal. plain disc was placed on the top of the specimen and then loading pad was placed. The top part of membrane was rolled on to the loading pad. Then the stretcher was removed and ends were sealed with ‘O’ rings. With the properly sealed specimen placed centrally on the pedestal, the cell was assembled, keeping the loading piston initially clear of the loading pad of the specimen, the assembly was placed in the loading frame.

For unconsolidated undrained test, the bottom drainage value (BDV) and top drainage value (TDV) of cell, was closed and air release valve (ARV) was opened. The cell was filled with water through the cell water value CWV. ARV was closed when water begins to escape through it. The cell pressure was raised to the desired value and kept constant till the end of the test.

When the cell pressure was applied, the load piston rises upward, the loading machine was operated at the anticipated rate to bring the load piston slightly above the loading pad of the specimen and the load measuring dial gauge on proving ring was set to zero.

The piston was brought just in contact with loading pad by hand operation of the machine. The

axial compression dial gauge was mounted and set to read zero.

The axial loading was started at 1.25 mm/min rate of strain. Simultaneous readings on the load and compression dial gauges were noted down. The test was continued until a recession of the axial load is observed or 20% of strain.

After failure, the specimen was unloaded by reversing the loading machine, cell pressure was reduced and cell water was drained out through BRV. The cell was dismantled and the specimen was taken out, rubber membrane was removed and weight of the failed sample and its water content was determined. The test was repeated on two more identical specimens with increasing cell pressure.

The rate of strain for conducting UUT is kept as 1.25 mm/min as per codal/literature provision based on strata.

5.1.10 Chemical Testing

Chemical Testing was generally performed in accordance with IS: 2720, but the different parts of method as described below:

a) Total Sulphate Content Of Soil

Samples were tested according to IS 2720 (Part 27). The dried soil was extracted with a 10% solution of hydrochloric acid. The extract was adjusted to slightly alkaline pH with ammonia, and then barium chloride solution was added to precipitate the sulphate. The barium sulphate precipitate was collected by filtration, and it was washed, dried and weighed. The mass of barium sulphate recovered was used to calculate the sulphate content of the original soil.

b) pH Value

Samples were tested according to IS: 2720 (Part 26). The soil sample (30 ± 0.1g) was extracted with 75 ml of distilled water and the pH of the resulting suspension was measured with a calibrated (by means of Standard buffer solution) pH meter.

c) Chloride Content

For the water soluble content, soil samples were extracted with a volume of water equal to twice the mass of the soil. The extract was filtered and acidified with a small amount of nitric acid. Standardized silver nitrate solution was then added to precipitate the chloride as its silver salt. The amount of precipitated silver remaining in solution was then determined by titration.

An acid-soluble version of the test was also available, with the initial extraction being with nitric acid instead of water.

CHAPTER 2 ANALYSIS OF TEST RESULTS AND INTERPRETATION

6.0 STRATIFICATION

From the study of the 44 borehole carried out at Old Ch. 52+518 (New Ch.55+719) to Old ch. 592+70 (New ch. 62+546), it is revealed that:-

At location of O.C. 52+518 & N.C. 55+719 :-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 53+107 & N.C. 56+291:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 53+282 & N.C. :-56+466

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 53+272 & N.C. :-56+756

The sub strata mainly consist of Silty Clay of low plasticity (CL).

At location of O.C. 53+982 & N.C. :-57+169

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 54+363 & N.C. :-57+547

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Clayey sand (SM-SC).

At location of O.C. 54+496 & N.C. :-57+672

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 56+978 & N.C. :-60+162

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Clayey sand (SM-SC).

At location of O.C. 55+910 & N.C. 59+107 :-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand (SM).

At location of O.C. 56+403 & N.C. 59+587:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand (SM).

At location of O.C. 56+701 & N.C. 59+886:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand (SM).

At location of O.C. 57+400 & N.C. 60+603:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand (SM).

At location of O.C. 58+191 & N.C. 61+376:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 58+497 & N.C. 61+676:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Clayey sand (SM-SC).

At location of O.C. 58+837 & N.C. 62+026:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand (SM).

At location of O.C. 59+071 & N.C. 62+256:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL).

At location of O.C. 59+206 & N.C. 62+400:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL).

At location of O.C. 59+270 & N.C. 62+546:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table was met at depths varying from 10.5 m to 23.5m below EGL, it may rise up during heavy rains / rainy season. Therefore, for the analysis of various foundations, the water table has been considered to rise by about 3.0m at the locations of boreholes, however at the locations of 13 BHs water table was not encountered, for the analysis of foundation the water table has been considered well below the depth of influence zone.

6.2 RESULTS OF CHEMICAL ANALYSIS

Results of chemical analysis of soil samples (as per **Appendix – B2**) indicates that the soil sample falls under Class I for sulphates and chlorides concentration (As per IS 456-2000 and CIRIA Sp. Publication No. 31). The results are summarized here in below :-

Summary of chemical analysis of soil samples

Chemical Property	Findings (Min. to Max.)	Remarks (Required limits as per IS 456-2000)
pH	8.06 to 9.87	> 6.0
Sulphite as SO_3^{2-} (%)	0.0017 (%) to 0.0025 (%)	< 0.2% (Class I)
Chlorides as Cl^- (%)	0.0055 (%) to 0.0097 (%)	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

6.3 COMPUTATION OF LIQUEFACTION POTENTIAL

Liquefaction is the sudden loss of shear strength of the sub soil strata due to earthquake-induced vibration under saturated conditions.

Assessment of liquefaction potential of foundation strata is made by simplified approach proposed as per IS: 1893 (Part-1)-2016, from the SPT data and peak ground acceleration likely to occur at the site. In this method, cyclic shear stress likely to be induced in the foundation strata by Design Basis Earthquake (DBE) is first evaluated.

Next threshold cyclic shear stress, which is good enough to cause liquefaction, is determined from SPT data and the empirical relations. Finally, comparison of these two stresses is used in the estimation of liquefaction susceptibility of the foundation strata.

Unsaturated soils are not subjected to liquefaction because vibratory forces from earthquakes do not cause any increase in pore water pressure in such soils.

The area of site from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV of India as per IS: 1893. Further as per the provisions of IS: 1893 in soil deposits consisting of submerged loose sands & soils falling under classification of SP with standard penetration N value less than 15, the shaking caused by earthquake ground motion may cause liquefaction or excessive total and differential settlements.

For the analysis of liquefaction potential, following constant parameters are considered:

EQ Zone	IV
Earthquake Magnitude (Mw)	7.0
Peak Horizontal Ground Acceleration (amax /g)	0.24

The ground water table was encountered at depths varying from 10.5 m to 23.50m below EGL at 31 boreholes locations and not encountered at 13 borehole locations. For the analysis of liquefaction potential, the water table has been considered to rise by about 3.0m at the location of

all boreholes. Since, water table is either very deep or not encountered, the boreholes are not likely to liquefy, as tabulated below below:-

Table 2.1: Liquefaction Analysis

S. No.	Chainage Old	Chainage New	Structure	BH.No.	Depth of Water Table below EGL (m)	Water Table Depth considered for analysis below EGL (m)	Liquefiable Depth (m)
1.	52+518	55+719	MJB	BH-A1	22.80	19.80	Non-Liquefiable
				BH-A2	23.50	20.50	Non-Liquefiable
2.	53+107	56+291	MNB	BH-CL	NE	-	Non-Liquefiable
3.	53+282	56+466	MNB	BH-CL	NE	-	Non-Liquefiable
4.	53+572	56+756	MNB	BH-CL	NE	-	Non-Liquefiable
5.	53+982	57+169	MNB	BH-CL	NE	-	Non-Liquefiable
6.	54+363	57+547	MNB	BH-CL	NE	-	Non-Liquefiable
7.	54+496	57+672	MNB	BH-CL	NE	-	Non-Liquefiable
8.	55+910	59+107	MJB	BH-A1	16.00	13.00	Non-Liquefiable
				BH-A2	15.60	12.60	Non-Liquefiable
9.	56+403	59+587	MNB	BH-CL	NE	-	Non-Liquefiable
10.	56+701	59+886	MNB	BH-CL	NE	-	Non-Liquefiable
11.	56+978	60+162	MNB	BH-CL	NE	-	Non-Liquefiable
12.	57+400	60+603	MJB	BH-A1	10.90	7.90	Non-Liquefiable
				BH-P2	11.85	8.85	Non-Liquefiable
				BH-P3	11.50	8.50	Non-Liquefiable
				BH-P4	11.80	8.80	Non-Liquefiable
				BH-P5	12.00	9.00	Non-Liquefiable
				BH-P6	11.40	8.40	Non-Liquefiable
				BH-P7	11.00	8.00	Non-Liquefiable
				BH-P9	12.00	9.00	Non-Liquefiable
				BH-P10	11.85	8.85	Non-Liquefiable
				BH-P11	11.80	8.80	Non-Liquefiable
				BH-P12	12.10	9.10	Non-Liquefiable
				BH-P13	12.30	9.30	Non-Liquefiable
				BH-P15	11.80	8.80	Non-Liquefiable
				BH-	11.20	8.20	Non-Liquefiable

S. No.	Chainage Old	Chainage New	Structure	BH.No.	Depth of Water Table below EGL (m)	Water Table Depth considered for analysis below EGL (m)	Liquefiable Depth (m)
				P16			
				BH-P17	10.80	7.80	Non-Liquefiable
				BH-P18	10.50	7.50	Non-Liquefiable
				BH-P19	11.50	8.50	Non-Liquefiable
				BH-A2	10.90	7.90	Non-Liquefiable
13.	58+191	61+376	MNB	BH-CL	NE	-	Non-Liquefiable
14.	58+497	61+676	MJB	BH-A1	11.50	8.60	Non-Liquefiable
				BH-P1	11.60	8.60	Non-Liquefiable
				BH-P2	10.70	7.70	Non-Liquefiable
				BH-P3	11.00	8.00	Non-Liquefiable
				BH-P4	11.90	8.90	Non-Liquefiable
				BH-P5	12.00	9.00	Non-Liquefiable
				BH-P6	11.00	8.00	Non-Liquefiable
				BH-A2	12.00	9.00	Non-Liquefiable
15.	58+837	62+026	MNB	BH-CL	NE	-	Non-Liquefiable
16.	59+071	62+256	MNB	BH-CL	NE	-	Non-Liquefiable
17.	59+206	62+400	MNB	BH-CL	12.65	9.65	Non-Liquefiable
18.	59+270	62+546	MNB	BH-CL	NE	-	Non-Liquefiable

***Not Encountered:-NE**

Note: To identitfy the Soil sheet, Shear curves and Log profiles, old chainages of respective bore holes are mentioned.

6.4 INTERPRETATION OF LAB TEST RESULTS

Grain Size Analysis

- **Clay content:** It generally varies from 4 to 14%.
- **Silt content:** It generally varies from 15 to 59%.
- **Sand content:** It generally varies from 23 to 85%.
- **Gravel content:** It generally varies from 1 to 12%.

Atterberg's Limit

- **Liquid limit:** The test results of liquid limit of the soil samples reveal that it generally varies from 26 to 28% in ML-CL type of soil, 30 to 34% in CL type of soil.

- **Plastic Limit*:*** The plastic limit of the soil sample varies from 19 to 21% in ML-CL type of soil, 20 to 23% in CL type of soil. However ML-CL type of soil is considered as non-plastic.
- **Plasticity index*:*** The plasticity index of the soil samples generally varies from 6 to 7% in ML-CL type of soil, 10 to 11% in CL type of soil whereas ML-CL and SM/ SM-SC/ SC type of soil are non-plastic.

Natural moisture content & Bulk density

The bulk density of soil samples generally varies from 1.63gm/cc to 1.97gm/cc whereas natural moisture content varies from 10.21% to 18.26%.

Direct shear tests:

Direct shear test under drained condition have been conducted in sandy silty (ML-CL) / sandy stratum (SM/ SM-SC/ SC) type of soil.

For Sandy strata (SM/ SM-SC/ SC), the value of angle of internal friction varies from 25° to 32°, whereas cohesion varies from 0.00 kg/cm^2 to 0.11 kg/cm^2.

For Silty strata (ML-CL), the value of angle of internal friction varies from 22° to 27°, whereas cohesion varies from 0.19 kg/cm^2 to 0.22 kg/cm^2.

Triaxial shear tests:

Triaxial shear test under undrained condition have been conducted in silty clay (CL) type of soil.

For silty clay (CL) strata, the value of angle of internal friction varies from 4° to 5°, whereas cohesion varies from 1.42kg/cm^2 to 2.24kg/cm^2.

CHAPTER 3 TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS

7.0 TYPE & DEPTH OF FOUNDATION:

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

Table 3.1 : Shallow Foundation

Type of foundation	Depth of Foundation below E.G.L. (m)	Size of Foundation (m x m)
Shallow Foundation	1.0,1.5,2.0	6.2 X 6.2 3.7 X 3.7 4.9 X 4.9 4.7 X 4.7 11.35 X 11.35 2.7 X 2.7 3.7 X 3.7 4.7 X 4.7 2.7 X 2.7
	2.0, 3.0, 4.0	7.2 X 7.2

Table 3.2 : Pile Foundation

Type of foundation	Length of Pile below E.G.L. (m)	Dia. of Pile (m)
Normal Bored Cast in-situ RCC Pile	16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0	1.0 & 1.2

The details of foundation analysis are given in the subsequent paragraph.

7.1 Analysis of SHALLOW foundation

7.1.1 From Shear Failure Criteria

Net Safe Bearing capacity from Shear Failure consideration has been computed in accordance with IS: 6403-1981, which is based on, modified Terzaghi's classical approach. The weighted average of shear strength parameters for various strata upto depth equal to 0.5*B*Tan (45+Ø/2) (where B = Width of the Foundation, Ø = Angle of internal friction) is used in the analysis. A factor of safety of 2.5 to estimate the net safe bearing capacity from ultimate net bearing capacity.

For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse

grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria.

The ultimate net bearing capacity in case of general shear failure is given by following expression,

$q_d = c\, N_c\, s_c\, d_c\, i_c + q\,(N_q\text{-}1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

The ultimate net bearing capacity in case of local shear failure is given by following expression,

$q'_d = (2/3)\, c\, N'_c\, s_c\, d_c\, i_c + q\,(N'_q\text{-}1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N'_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure $= \tan^{-1}(0.67 \tan\phi)$

7.1.2 From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure.

The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B below the base to account for the effects of energy ratio, adopted bearing pressure, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure.

Further for settlement Calculation in cohesive soil the following equation has been used.

$S_t = \Delta P\, M_v\, H$

Where,

M_v = Coefficient of volume compressibility, cm^2/kg

ΔP = Pressure increment, kg/cm^2

H = Thickness of layers

Note: - Value of Coefficient of volume compressibility (Mv) has been calculated by using the following co-relation [Ref. Stroud and Butler, 1975] :-

Coefficient of Volume Compressibility derived from SPT N-Value (after Stroud and Butler, 1975)

Plasticity Index (%)	Conversion Factor (f_2)	m_v (10^{-3} kPa^{-1}) based on N-Value: $m_v = 1/(f_2 N)$				
		N=10	N=20	N=30	N=40	N=50
10	800	0.12	0.06	0.04	0.03	0.02
20	525	0.19	0.09	0.06	0.05	0.04

Plasticity Index (%)	Conversion Factor (f_2)	m_v (10^{-3} kPa^{-1}) based on N-Value: $m_v = 1/(f_2N)$				
		N=10	N=20	N=30	N=40	N=50
30	475	0.21	0.10	0.07	0.05	0.04
40	450	0.22	0.11	0.07	0.06	0.04

$Mv = 1/(f_2 N_{corr.})$

Where f_2 = factor based on $N_{corr.}$ Value & plasticity index of soil

$N_{corr.}$ = corrected SPT 'N' value

For analysis of shallow foundation the total permissible settlement has been considered as 25mm, & 50mm as per IS 1904.

Zone of influence below foundation has been considered up to 1.5 times the width of the foundation.

For the determination of the SBC from settlement criteria, the corrected SPT N values within the influence zone are given in the table below.

NOTE:-

- Lower of the two values obtained from settlement and shear criteria is used in arriving at allowable bearing capacity of the soil.
- Structural foundations are designed based on the minimum of Safe Bearing Capacity obtained from Shear Failure Criteria and Allowable Bearing Pressure corresponding to the permissible settlement. The permissible Settlement that can be allowed for the foundation depends on the strata at the location and type of foundation (whether Isolated or Raft).

  Settlement occurs with the application of loads on foundations. It has two components, Immediate Settlement and Long Term Settlement. The immediate settlement takes place immediately as the loading is imposed on the structure and long term settlement arises due to the consolidation of the sub-soil with time under the load. Hence, the total settlement allowed for a foundation is the sum of the immediate and consolidation settlement that is expected to occur. The cohesionless strata (predominantly sandy) is primarily subjected to immediate settlement and cohesive strata (clayey) undergoes settlement in long time with the compression of the strata due to consolidation. Settlement of the foundation is determined from the relation provided in Indian standards (IS: 8009 (part-1) &/or various literatures (Bowles, BM Das, etc.).

  From the Geotechnical investigation conducted on our site along with subsequent laboratory tests on soil samples, it is observed that predominantly the strata is silty with sand (SM/SC/SM-SC/ML-CL i.e. predominantly cohesionless) with the presence of small patches of silty clay of low plasticity (CL). Since the Settlement that takes place in cohesionless strata is mostly immediate, it

takes place immediately after the imposing of load, initially during construction with the application of Dead Load and further during Live Load. The live load usually is many times lesser than the dead load, and correspondingly the post construction settlement is very less for live loads. As an example, if dead load is three times that of live load, then the settlement corresponding to live load (i.e. the post construction settlement) will be one-third of the settlement due to dead load which is comparatively lesser than 25mm for permissible settlement of 50mm.

According to the IS 1904, the permissible settlement for concrete structure having raft foundation is allowed upto 75mm, and the permissible settlement is 25mm post construction as per IRS code (Code of Practice for The Design of Sub-Structures and Foundations of Bridges). As discussed above, the settlement post construction is directly proportional to the allowable settlement. Therefore, given the importance of structure to be constructed and considering mostly cohesionless strata encountered at site, it is recommended that the maximum permissible settlement shall be restricted to 50mm for the design purpose on conservative side so that the post construction settlement can be constraint to lesser than 25mm.

As per IS- 8009 part 1 clause 9.2.2.1, If the clay layer is sandwitched between cohesionless soil layers, the immediate settlement is zero. Hence, even though the immediate settlement has been calculated during analysis, however it is ignored in the calculation of total settlement.

The sample calculations for computation of allowable bearing capacity of sub-strata for shallow foundation vide **Appendix – C-1.**

7.2 Analysis of PILE foundation

(A) Deep foundation

The safe Load Carrying Capacity of normal bored cast in-situ RCC pile is determined in compression, uplift and lateral as per IS: 2911 (Part-1/sec-2) – 2010. The axial capacity of a pile depends upon the soil skin friction along the shaft and end bearing at it's tip.

Thus Axial load = Skin Friction + End-bearing

a) For piles in granular soils (using the static formula)

$$\mathbf{Q_u = (0.5*D*\gamma*N_\gamma + P_D*N_q)*A_p + (\Sigma K_i*P_{Di}*\tan\delta_i)*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

D = dia. of pile shaft in m

γ = effective unit weight of the soil at pile tip in kN/m^3

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction Φ at pile tip (N_γ from IS 6403 for general shear failure case & N_q from Fig. 1, IS 2911)

P_D = effective overburden pressure at pile tip in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

K_i = coefficient of earth pressure applicable for the ith layer

P_{Di} = effective overburden pressure for the ith layer in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

δ_i = angle of wall friction between pile and soil for i^{th} layer, and

A_{si} = surface area of pile shaft in the ith layer in m^2

b) For piles in cohesive soils (using the static formula)

$$\mathbf{Q_u = cp*Nc*A_p + \Sigma \alpha_i * c_i * A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

A_p = cross-sectional area of pile tip in m^2

N_c = bearing capacity factor (= 9)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for i^{th} layer in kN/m^2

A_{si} = surface area for pile shaft in the ith layer in m^2

c) For computation of safe load carrying capacity of pile in lateral, the following equation has been used:

i. <u>Fixed Head Condition</u>

$$\mathbf{Q = (12 * E * I * Y) / (L_1 + L_f)^3}$$

ii. <u>Free Head Condition</u>

$$\mathbf{Q = (3 * E * I * Y) / (L_1 + L_f)^3}$$

Where,

Q = Lateral Load (in kg)

Y = Permissible lateral deflection taken as 5mm

E = Modulus of Elasticity of concrete

I = Moment of Inertia of the pile cross-section

L_1 = Length of pile above cut-off level

L_f = Length of fixity

The effective length of the pile has been considered below the cut-off level taken as 2.0m below the EGL. Normal Bored cast in-situ RCC piles having stem diameter equal to 100cm & 120cm and of effective length varying from 16.0m to 28.0m were selected.

For the analysis of the pile foundations the soil parameters used for computation of safe load carrying capacity of pile is tabulated below:-

Table 3.3 : Design Soil Parameter

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
52+518	55+719	BH-A1	0.00	4.00	4.00	Sandy Silt	12	15	1.70	0.20	29
			4.00	7.00	3.00	Sandy Silt	22	22	1.76	0.21	29
			7.00	11.50	4.50	Silty Clay	36	36	1.85	1.22	4
			11.50	16.00	4.50	Sandy Silt	44	32	1.86	0.21	30
			16.00	40.00	24.00	Sandy Silt	83	34	1.92	0.15	30
		BH-A2	0.00	5.50	5.50	Sandy Silt	13	17	1.72	0.19	29
			5.50	13.00	7.50	Silty Clay	24	24	1.78	0.74	5
			13.00	16.00	3.00	Silty Clay	39	39	1.85	1.12	4
			16.00	25.00	9.00	Sandy Silt	59	34	1.87	0.21	30
			25.00	34.00	9.00	Sandy Silt	43	18	1.84	0.23	29
			34.00	40.00	6.00	Sandy Silt	75	25	1.89	0.17	30
53+282	56+466	BH-CL	0.00	5.25	5.25	Sandy Silt	14	19	1.74	0.20	28
			5.25	8.25	3.00	Silty Clay	32	32	1.89	1.02	5
			8.25	10.00	1.75	Silty Clay	25	25	1.90	1.02	5
53+572	56+756	BH-CL	0.00	3.00	3.00	Silty Clay	9	9	1.68	0.26	5
			3.00	8.25	5.25	Silty Clay	32	32	1.91	1.09	4
			8.25	10.00	1.75	Silty Clay	47	47	1.97	1.65	4
53+982	57+169	BH-CL	0.00	2.25	2.25	Silty Clay	8	8	-	-	-
			2.25	5.25	3.00	Silty Clay	22	22	1.89	0.39	5
			5.25	7.50	2.25	Silty Clay	24	24	1.97	0.85	4
			7.50	10.00	2.50	Sandy Silt	32	25	1.90	0.20	28
54+363	57+547	BH-CL	0.00	5.25	5.25	Silty Sand	21	27	1.82	0.11	30
			5.25	8.25	3.00	Silty Clay	33	33	1.99	1.09	4
			8.25	10.00	1.75	Sandy Silt	38	28	1.90	0.20	30
54+496	57+672	BH-CL	0.00	5.25	5.25	Sandy Silt	15	19	1.79	0.21	28
			5.25	8.25	3.00	Silty Clay	32	32	1.98	1.09	5
			8.25	11.25	3.00	Silty Clay	37	37	1.99	1.26	4
			11.25	15.00	3.75	Silty Clay	44	44	2.00	1.42	4
+ 9	+ 1	BH-CL	0.00	2.25	2.25	Sandy Silt	14	20	-	-	-

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
			2.25	3.00	0.75	Sandy Silt	-	-	1.86	0.22	28
			3.00	10.00	7.00	Silty Clay	27	27	1.95	0.85	5
55+910	59+107	BH-A1	0.00	7.00	7.00	Silty Sand	13	14	1.68	0.00	30
			7.00	13.00	6.00	Silty Clay	28	28	1.81	0.85	4
			13.00	19.00	6.00	Sandy Silt	43	25	1.83	0.20	30
			19.00	25.00	6.00	Sandy Silt	53	24	1.85	0.18	30
			25.00	31.00	6.00	Sandy Silt	67	27	1.87	0.20	30
			31.00	40.00	9.00	Sandy Silt	85	30	1.89	0.18	30
		BH-A2	0.00	5.50	5.50	Silty Sand	19	24	1.75	0.00	32
			5.50	8.50	3.00	Silty Sand	26	24	1.76	0.00	32
			8.50	16.00	7.50	Silty Sand	36	27	1.77	0.00	32
			16.00	20.50	4.50	Silty Clay	39	39	1.99	1.34	4
			20.50	26.50	6.00	Sandy Silt	56	25	1.86	0.20	30
			26.50	40.00	13.50	Sandy Silt	73	28	1.95	0.16	30
57+400	60+603	BH-A1	0.00	8.50	8.50	Silty Sand	17	19	1.73	0.10	31
			8.50	13.00	4.50	Silty Clay	32	32	1.86	1.06	5
			13.00	17.50	4.50	Silty Sand	57	29	1.86	0.00	32
			17.50	30.00	12.50	Silty Clay	74	43	2.01	1.66	4
		BH-P2	0.00	5.50	5.50	Sandy Silt	20	26	1.78	0.21	30
			5.50	8.50	3.00	Silty Clay	32	32	1.83	1.10	4
			8.50	14.50	6.00	Sandy Silt	40	27	1.84	0.20	30
			14.50	20.50	6.00	Silty Clay	67	67	2.01	2.22	4
			20.50	26.50	6.00	Sandy Silt	90	35	1.90	0.21	30
			26.50	30.00	3.50	Sandy Silt	-	-	1.94	0.20	32
		BH-P3	0.00	4.00	4.00	Sandy Silt	12	15	1.71	0.16	29
			4.00	10.00	6.00	Sandy Silt	31	28	1.81	0.18	30
			10.00	19.00	9.00	Silty Sand	40	25	1.82	0.00	32
			19.00	25.00	6.00	Sandy Silt	53	25	1.88	0.21	30
			25.00	31.00	6.00	Sandy Silt	61	26	1.90	0.20	30
57+400	60+603	BH-P4	0.00	7.00	7.00	Silty Sand	16	20	1.73	0.00	31
			7.00	11.50	4.50	Sandy Silt	51	43	1.84	0.25	32
			11.50	17.50	6.00	Sandy Silt	59	29	1.90	0.21	30
			17.50	23.50	6.00	Sandy Silt	73	32	1.93	0.22	30
			23.50	30.00	6.50	Sandy Silt	80	32	1.94	0.19	30
		BH-P5	0.00	4.00	4.00	Silty Sand	11	14	1.69	0.00	31
			4.00	10.00	6.00	Silty Sand	26	24	1.75	0.00	32
			10.00	16.00	6.00	Sandy Silt	49	31	1.85	0.23	30

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
			16.00	22.00	6.00	Sandy Silt	65	30	1.88	0.22	30
			22.00	30.00	8.00	Sandy Silt	85	33	1.91	0.18	30
		BH-P6	0.00	5.50	5.50	Silty Sand	13	17	1.71	0.00	31
			5.50	8.50	3.00	Silty Sand	20	18	1.73	0.00	31
			8.50	11.50	3.00	Silty Clay	26	26	1.84	0.90	4
			11.50	14.50	3.00	Silty Clay	32	32	1.96	1.03	5
			14.50	20.50	6.00	Sandy Silt	52	26	1.90	0.19	30
			20.50	26.50	6.00	Sandy Silt	62	27	1.90	0.22	30
			26.50	30.00	3.50	Sandy Silt	73	30	1.92	0.24	30
		BH-P7	0.00	4.00	4.00	Silty Sand	14	18	1.71	0.00	31
			4.00	10.00	6.00	Silty Sand	26	24	1.74	0.00	32
			10.00	16.00	6.00	Silty Clay	38	38	1.99	1.15	4
			16.00	22.00	6.00	Sandy Silt	51	25	1.88	0.22	30
			22.00	25.00	3.00	Sandy Silt	63	28	1.91	0.20	30
			25.00	30.00	5.00	Sandy Silt	80	32	1.94	0.23	30
		BH-P9	0.00	5.50	5.50	Sandy Silt	16	20	1.74	0.22	29
			5.50	8.50	3.00	Sandy Silt	19	18	1.75	0.22	29
			8.50	11.50	3.00	Silty Clay	33	33	1.86	1.02	4
			11.50	14.50	3.00	Silty Clay	30	30	1.89	1.02	4
			14.50	17.50	3.00	Sandy Silt	66	31	1.88	0.20	30
			17.50	23.50	6.00	Silty Clay	45	45	1.98	1.42	4
			23.50	31.00	7.50	Sandy Silt	77	31	1.92	0.17	30
			31.00	35.00	4.00	Sandy Silt	97	35	1.95	0.16	30
		BH-P10	0.00	7.00	7.00	Silty Sand	26	30	1.78	0.00	32
			7.00	10.00	3.00	Silty Clay	27	27	1.83	0.92	5
			10.00	16.00	6.00	Sandy Silt	34	22	1.84	0.21	29
			16.00	22.00	6.00	Sandy Silt	46	23	1.88	0.18	29
			22.00	30.00	8.00	Sandy Silt	68	28	1.91	0.21	30
		BH-P11	0.00	5.50	5.50	Sandy Silt	14	17	1.72	0.16	29
57+400	60+603		5.50	11.50	6.00	Sandy Silt	25	22	1.78	0.21	29
			11.50	23.50	12.00	Sandy Silt	27	17	1.83	0.21	28
			23.50	25.00	1.50	Silty Clay	45	45	1.97	1.47	4
			25.00	30.00	3.00	Sandy Silt	85	33	1.94	0.19	30
		BH-P12	0.00	7.00	7.00	Silty Sand	26	29	1.77	0.11	32
			7.00	13.00	6.00	Sandy Silt	31	25	1.81	0.22	30
			13.00	23.50	10.50	Sandy Silt	36	20	1.83	0.21	29
			23.50	30.00	6.50	Sandy Silt	53	24	1.87	0.22	29

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
		BH-P13	0.00	4.00	4.00	Silty Sand	9	14	1.68	0.00	30
			4.00	11.50	7.50	Sandy Silt	38	36	1.82	0.21	31
			11.50	17.50	6.00	Sandy Silt	42	23	1.85	0.23	29
			17.50	20.50	3.00	Silty Clay	51	51	2.00	1.67	4
			20.50	30.00	9.50	Sandy Silt	64	27	1.93	0.22	30
		BH-P15	0.00	10.00	10.00	Silty Sand	19	22	1.76	0.09	31
			10.00	17.50	7.50	Sandy Silt	56	34	1.86	0.19	31
			17.50	25.00	7.50	Sandy Silt	63	29	1.87	0.22	30
			25.00	30.00	5.00	Sandy Silt	83	33	1.92	0.23	30
		BH-P16	0.00	4.00	4.00	Sandy Silt	16	20	1.75	0.21	29
			4.00	10.00	6.00	Sandy Silt	20	19	1.76	0.19	29
			10.00	16.00	6.00	Silty Sand	28	18	1.78	0.00	30
			16.00	19.00	3.00	Silty Sand	39	21	1.81	0.00	31
			19.00	26.50	7.50	Sandy Silt	77	34	1.94	0.17	30
			26.50	30.00	3.50	Silty Sand	-	-	1.94	0.17	33
		BH-P17	0.00	4.00	4.00	Silty Clay	5	5	1.66	0.20	4
			4.00	14.50	10.50	Sandy Silt	24	19	1.75	0.23	27
			14.50	17.50	3.00	Sandy Silt	36	21	1.83	0.20	28
			17.50	29.50	12.50	Sandy Silt	-	-	1.94	0.18	29
		BH-P18	0.00	4.00	4.00	Sandy Silt	15	19	1.74	0.21	29
			4.00	7.00	3.00	Sandy Silt	20	20	1.77	0.21	29
			7.00	10.00	3.00	Sandy Silt	26	22	1.80	0.19	29
			10.00	17.50	7.50	Silty Clay	32	32	1.93	1.07	30
			17.50	30.00	12.50	Sandy Silt	-	-	1.95	0.21	33
		BH-P19	0.00	8.50	8.50	Sandy Silt	15	17	1.72	0.22	29
			8.50	16.00	7.50	Sandy Silt	28	21	1.77	0.19	29
			16.00	20.50	4.50	Silty Clay	33	33	1.94	1.02	5
			20.50	30.00	9.50	Silty Sand	100	36	1.94	0.00	34
57+400	60+603	BH-A2	0.00	4.00	4.00	Sandy Silt	14	18	1.72	0.16	29
			4.00	7.00	3.00	Silty Clay	26	26	1.80	0.88	4
			7.00	10.00	3.00	Silty Clay	27	27	1.82	0.88	4
			10.00	13.00	3.00	Sandy Silt	30	19	1.80	0.20	29
			13.00	22.00	9.00	Sandy Silt	34	20	1.82	0.20	29
			22.00	35.00	13.00	Sandy Silt	88	31	1.95	0.19	29
58+497	61+676	BH-A1	0.00	5.50	5.50	Sandy Silt	21	27	1.76	0.19	29
			5.50	8.50	3.00	Sandy Silt	32	30	1.80	0.22	29

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
			8.50	20.50	12.00	Silty Clay	48	48	1.86	1.52	5
			20.50	28.00	7.50	Sandy Silt	72	37	1.86	0.21	30
			28.00	40.00	12.00	Sandy Silt	78	36	1.89	0.17	30
		BH-P1	0.00	4.00	4.00	Sandy Silt	17	22	1.75	0.23	29
			4.00	7.00	3.00	Sandy Silt	30	30	1.81	0.19	29
			7.00	10.00	3.00	Silty Clay	40	40	1.86	1.34	5
			10.00	13.00	3.00	Silty Clay	45	45	1.91	1.48	4
			13.00	16.00	3.00	Silty Clay	49	49	1.97	1.65	5
			16.00	19.00	3.00	Silty Clay	54	54	2.02	1.80	4
			19.00	28.00	9.00	Sandy Silt	70	29	1.88	0.20	30
			28.00	40.00	12.00	Sandy Silt	82	30	1.91	0.16	30
		BH-P2	0.00	4.00	4.00	Silty Sand	19	30	1.74	0.09	30
			4.00	11.50	7.50	Silty Clay	28	28	1.81	0.93	4
			11.50	20.50	9.00	Sandy Silt	49	25	1.83	0.20	30
			20.50	26.50	6.00	Sandy Silt	61	28	1.88	0.21	30
			26.50	40.00	13.50	Sandy Silt	100	36	1.95	0.17	33
		BH-P3	0.00	7.00	7.00	Silty Sand	15	17	1.69	0.00	31
			7.00	13.00	6.00	Sandy Silt	36	26	1.80	0.21	30
			13.00	19.00	6.00	Sandy Silt	47	25	1.85	0.19	30
			19.00	28.00	9.00	Sandy Silt	88	36	1.89	0.22	30
			28.00	40.00	12.00	Sandy Silt	105	36	1.94	0.18	33
		BH-P4	0.00	5.50	5.50	Sandy Silt	22	29	1.77	0.18	30
			5.50	13.00	7.50	Sandy Silt	42	34	1.82	0.20	31
			13.00	26.50	13.50	Sandy Silt	62	28	1.84	0.19	30
			26.50	31.00	4.50	Sandy Silt	78	30	1.87	0.19	30
			31.00	40.00	9.00	Sandy Silt	82	30	1.91	0.22	30
		BH-P5	0.00	4.00	4.00	Silty Sand	8	13	1.66	0.00	31
			4.00	8.50	4.50	Silty Sand	28	29	1.76	0.00	32
			8.50	17.50	9.00	Silty Clay	37	37	1.92	1.26	4
		BH-P5	17.50	23.50	6.00	Sandy Silt	54	25	1.86	0.20	30
58+497	61+676		23.50	28.00	4.50	Sandy Silt	67	28	1.89	0.22	30
			28.00	40.00	12.00	Sandy Silt	96	33	1.96	0.17	31
		BH-P6	0.00	4.00	4.00	Sandy Silt	16	20	1.74	0.24	29
			4.00	7.00	3.00	Sandy Silt	27	27	1.79	0.19	30
			7.00	10.00	3.00	Silty Clay	36	36	1.87	1.22	5
			10.00	13.00	3.00	Silty Clay	43	43	1.90	1.36	5
			13.00	16.00	3.00	Silty Clay	51	51	1.99	1.65	4

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
			16.00	19.00	3.00	Silty Clay	54	54	2.02	1.79	4
			19.00	28.00	9.00	Sandy Silt	73	30	1.87	0.18	30
			28.00	40.00	12.00	Sandy Silt	100	36	1.95	0.20	32
		BH-A2	0.00	4.00	4.00	Sandy Silt	13	21	1.74	0.22	29
			4.00	11.50	7.50	Sandy Silt	29	28	1.80	0.20	30
			11.50	20.50	9.00	Sandy Silt	34	19	1.81	0.18	29
			20.50	32.50	12.00	Sandy Silt	57	25	1.87	0.19	30
			32.50	40.00	7.50	Sandy Silt	99	34	1.91	0.17	30

Design parameter have been obtained from the laboratory test results however various depth where the shear parameter seems on the lower side with respect to SPT 'N' values those shear parameter have been judicially improved based on the SPT 'N' for the analysis purpose.

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in compression & uplift are attached vide **Appendix C-2.**

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in lateral are attached vide **Appendix C-3.**

CHAPTER 4 FOUNDATION RECOMMENDATIONS

8.0 FOUNDATION RECOMMENDATIONS

- Based on the nature & strength characteristics of the substrata and requirement of the project, shallow foundation and normal bored cast in-situ RCC pile foundation have been analyzed.
- Based on the method of analysis & design parameters given under Para 7.1 above, the recommended net allowable bearing capacity values are given in Table 4.1 to 4.4.

Table 4.1: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	52+518	55+719	BH-A1	2.0	7.2 X 7.2	32.9	20.1	20.1
				3.0		38.8	23.5	23.5
				4.0		44.9	28.1	28.1
			BH-A2	2.0	7.2 X 7.2	36.1	14.1	14.1
				3.0		42.6	15.4	15.4
				4.0		49.4	16.8	16.8
2.	53+107	56+291	BH-CL	1.0	6.2 X 6.2	23.9	18.4	18.4
				1.5		26.3	19.6	19.6
				2.0		28.8	21.1	21.1
3.	53+282	56+466	BH-CL	1.0	3.7 X 3.7	25.3	17.0	17.0
				1.5		28.8	18.5	18.5
				2.0		32.5	20.5	20.5
4.	53+572	56+756	BH-CL	1.0	3.7 X 3.7	6.3	7.5	6.3
				1.5		6.6	8.7	6.6
				2.0		6.9	10.4	6.9
5.	53+982	57+169	BH-CL	1.0	4.9 X 4.9	9.2	5.1	5.1
				1.5		9.5	5.7	5.7
				2.0		9.9	6.6	6.6
6.	54+363	57+547	BH-CL	1.0	4.7 X 4.7	34.0	23.2	23.2
				1.5		39.1	24.6	24.6
				2.0		44.4	26.5	26.5
7.	54+496	57+672	BH-CL	1.0	11.35 X 11.35	39.5	13.4	13.4
				1.5		42.6	13.5	13.5
				2.0		45.7	13.7	13.7

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
8.	55+910	59+107	BH-A1	2.0	7.2 X 7.2	27.1	11.1	11.1
				3.0		33.8	12.5	12.5
				4.0		40.8	14.4	14.4
			BH-A2	2.0	7.2 X 7.2	63.4	23.4	23.4
				3.0		77.7	24.7	24.7
				4.0		92.6	26.1	26.1
9.	56+403	59+587	BH-CL	1.0	2.7 X 2.7	18.7	12.7	12.7
				1.5		22.2	16.6	16.6
				2.0		25.8	22.5	22.5
10.	56+701	59+886	BH-CL	1.0	11.35 X 11.35	18.1	9.4	9.4
				1.5		19.4	9.8	9.8
				2.0		20.9	10.2	10.2
11.	56+978	60+162	BH-CL	1.0	4.9 X 4.9	31.8	18.4	18.4
				1.5		35.7	20.1	20.1
				2.0		39.6	22.1	22.1
12.	57+400	60+603	BH-A1	2.0	7.2 X 7.2	43.6	15.8	15.8
				3.0		51.1	17.6	17.6
				4.0		58.8	19.7	19.7
			BH-P2	2.0	7.2 X 7.2	60.4	18.2	18.2
				3.0		69.3	18.4	18.4
				4.0		78.4	18.4	18.4
			BH-P3	2.0	7.2 X 7.2	30.4	23.5	23.5
				3.0		35.4	25.7	25.7
				4.0		40.6	28.3	28.3
			BH-P4	2.0	7.2 X 7.2	44.7	28.1	28.1
				3.0		53.3	29.6	29.6
				4.0		62.3	31.2	31.2
			BH-P5	2.0	7.2 X 7.2	33.6	25.7	25.7
				3.0		40.4	27.0	27.0
				4.0		47.4	28.6	28.6
			BH-P6	2.0	7.2 X 7.2	35.5	14.1	14.1
				3.0		42.6	15.0	15.0
				4.0		49.9	16.2	16.2
			BH-P7	2.0	7.2 X 7.2	37.4	18.2	18.2
				3.0		44.8	19.4	19.4
				4.0		52.5	21.0	21.0
			BH-P9	2.0	7.2 X 7.2	43.6	15.7	15.7
				3.0		50.1	16.7	16.7
				4.0		56.7	18.1	18.1

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
	57+400	60+603	BH-P10	2.0	7.2 X 7.2	61.4	23.6	23.6
				3.0		72.8	24.8	24.8
				4.0		84.7	25.5	25.5
			BH-P11	2.0	7.2 X 7.2	30.6	15.0	15.0
				3.0		35.6	15.9	15.9
				4.0		40.8	16.8	16.8
			BH-P12	2.0	7.2 X 7.2	69.4	27.8	27.8
				3.0		80.6	28.4	28.4
				4.0		92.1	27.8	27.8
			BH-P13	2.0	7.2 X 7.2	27.0	18.4	18.4
				3.0		32.6	22.6	22.6
				4.0		38.4	28.4	28.4
			BH-P15	2.0	7.2 X 7.2	39.5	21.2	21.2
				3.0		46.3	23.6	23.6
				4.0		53.3	26.5	26.5
			BH-P16	2.0	7.2 X 7.2	45.1	21.2	21.2
				3.0		37.7	19.4	19.4
				4.0		58.7	26.5	26.5
			BH-P17	2.0	7.2 X 7.2	19.8	5.4	5.4
				3.0		22.9	7.9	7.9
				4.0		26.0	17.7	17.7
			BH-P18	2.0	7.2 X 7.2	39.2	15.7	15.7
				3.0		45.1	16.5	16.5
				4.0		51.2	17.5	17.5
			BH-P19	2.0	7.2 X 7.2	22.1	15.9	15.9
				3.0		25.2	16.8	16.8
				4.0		28.5	17.7	17.7
			BH-A2	2.0	7.2 X 7.2	34.1	16.7	16.7
				3.0		39.6	18.1	18.1
				4.0		45.3	19.0	19.0
13.	58+191	61+376	BH-CL	1.0	3.7 X 3.7	21.2	11.2	11.2
				1.5		24.1	12.1	12.1
				2.0		27.1	13.4	13.4
14.	58+497	61+676	BH-A1	2.0	7.2 X 7.2	52.4	23.8	23.8
				3.0		60.3	25.3	25.3
				4.0		68.4	27.2	27.2
			BH-P1	2.0	7.2 X 7.2	43.6	24.0	24.0
				3.0		50.0	26.0	26.0
				4.0		56.7	28.4	28.4

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
	58+497	61+676	BH-P2	2.0	7.2 X 7.2	45.5	18.4	18.4
				3.0		53.2	18.7	18.7
				4.0		61.2	18.5	18.5
			BH-P3	2.0	7.2 X 7.2	37.1	17.4	17.4
				3.0		44.4	20.0	20.0
				4.0		52.0	23.2	23.2
			BH-P4	2.0	7.2 X 7.2	63.7	32.7	32.7
				3.0		73.2	36.1	36.1
				4.0		83.0	39.0	39.0
			BH-P5	2.0	7.2 X 7.2	26.3	19.1	19.1
				3.0		31.8	20.4	20.4
				4.0		37.6	21.9	21.9
			BH-P6	2.0	7.2 X 7.2	47.2	21.5	21.5
				3.0		54.0	23.4	23.4
				4.0		61.0	25.6	25.6
			BH-A2	2.0	7.2 X 7.2	43.6	22.1	22.1
				3.0		50.0	23.3	23.3
				4.0		56.7	24.6	24.6
15.	58+837	62+026	BH-CL	1.0	4.9 X 4.9	39.1	9.3	9.3
				1.5		44.1	10.7	10.7
				2.0		49.3	12.6	12.6
16.	59+071	62+256	BH-A1	1.0	2.7 X 2.7	26.0	27.8	26.0
				1.5		30.1	29.9	29.9
				2.0		34.3	31.9	31.9
17.	59+206	62+400	BH-CL	1.0	11.5 X 11.5	32.2	19.8	19.8
				1.5		34.5	20.2	20.2
				2.0		36.7	20.5	20.5
18.	59+270	62+546	BH-CL	1.0	2.7 X 2.7	27.7	34.4	27.7
				1.5		31.9	37.0	31.9
				2.0		36.3	39.5	36.3

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m2.

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	52+518	55+719	BH-A1	2.0	7.2 X 7.2	32.9	40.2	32.9
				3.0		38.8	47.0	38.8
				4.0		44.9	56.2	44.9
			BH-A2	2.0	7.2 X 7.2	36.1	28.2	28.2
				3.0		42.6	30.7	30.7
				4.0		49.4	33.7	33.7
2.	53+107	56+291	BH-CL	1.0	6.2 X 6.2	23.9	36.8	23.9
				1.5		26.3	39.1	26.3
				2.0		28.8	42.2	28.8
3.	53+282	56+466	BH-CL	1.0	3.7 X 3.7	25.3	34.0	25.3
				1.5		28.8	37.1	28.8
				2.0		32.5	41.1	32.5
4.	53+572	56+756	BH-CL	1.0	3.7 X 3.7	6.3	15.0	6.3
				1.5		6.6	29.6	6.6
				2.0		6.9	37.3	6.9
5.	53+982	57+169	BH-CL	1.0	4.9 X 4.9	9.2	10.2	9.2
				1.5		9.5	11.4	9.5
				2.0		9.9	13.2	9.9
6.	54+363	57+547	BH-CL	1.0	4.7 X 4.7	34.0	46.5	34.0
				1.5		39.1	49.3	39.1
				2.0		44.4	53.0	44.4
7.	54+496	57+672	BH-CL	1.0	11.35 X 11.35	39.5	26.7	26.7
				1.5		42.6	27.0	27.0
				2.0		45.7	27.4	27.4
8.	55+910	59+107	BH-A1	2.0	7.2 X 7.2	27.1	22.3	22.3
				3.0		33.8	25.0	25.0
				4.0		40.8	28.7	28.7
			BH-A2	2.0	7.2 X 7.2	63.4	46.9	46.9
				3.0		77.7	49.4	49.4
				4.0		92.6	52.2	52.2
9.	56+403	59+587	BH-CL	1.0	2.7 X 2.7	18.7	25.5	18.7
				1.5		22.2	33.1	22.2
				2.0		25.8	45.0	25.8
10.	56+701	59+886	BH-CL	1.0	11.35 X 11.35	18.1	18.8	18.1
				1.5		19.4	19.6	19.4
				2.0		20.9	20.4	20.4

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
11.	56+978	60+162	BH-CL	1.0	4.9 X 4.9	31.8	36.7	31.8
				1.5		35.7	40.2	35.7
				2.0		39.6	44.2	39.6
12.	57+400	60+603	BH-A1	2.0	7.2 X 7.2	43.6	31.7	31.7
				3.0		51.1	35.2	35.2
				4.0		58.8	39.4	39.4
			BH-P2	2.0	7.2 X 7.2	60.4	36.5	36.5
				3.0		69.3	36.7	36.7
				4.0		78.4	36.8	36.8
			BH-P3	2.0	7.2 X 7.2	30.4	47.0	30.4
				3.0		35.4	51.5	35.4
				4.0		40.6	56.5	40.6
			BH-P4	2.0	7.2 X 7.2	44.7	56.1	44.7
				3.0		53.3	59.2	53.3
				4.0		62.3	62.5	62.3
			BH-P5	2.0	7.2 X 7.2	33.6	51.3	33.6
				3.0		40.4	54.1	40.4
				4.0		47.4	57.1	47.4
			BH-P6	2.0	7.2 X 7.2	35.5	28.1	28.1
				3.0		42.6	30.0	30.0
				4.0		49.9	32.5	32.5
			BH-P7	2.0	7.2 X 7.2	37.4	36.4	36.4
				3.0		44.8	38.8	38.8
				4.0		52.5	42.1	42.1
			BH-P9	2.0	7.2 X 7.2	43.6	31.4	31.4
				3.0		50.1	33.4	33.4
				4.0		56.7	36.2	36.2
			BH-P10	2.0	7.2 X 7.2	61.4	47.2	47.2
				3.0		72.8	49.6	49.6
				4.0		84.7	51.0	51.0
			BH-P11	2.0	7.2 X 7.2	30.6	30.1	30.1
				3.0		35.6	31.7	31.7
				4.0		40.8	33.5	33.5
			BH-P12	2.0	7.2 X 7.2	69.4	55.7	55.7
				3.0		80.6	56.7	56.7
				4.0		92.1	55.5	55.5
			BH-P13	2.0	7.2 X 7.2	27.0	36.8	27.0
				3.0		32.6	45.3	32.6
				4.0		38.4	56.7	38.4

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
	57+400	60+603	BH-P15	2.0	7.2 X 7.2	39.5	42.5	39.5
				3.0		46.3	47.2	46.3
				4.0		53.3	53.0	53.0
			BH-P16	2.0	7.2 X 7.2	45.1	42.5	42.5
				3.0		37.7	38.9	37.7
				4.0		58.7	53.0	53.0
			BH-P17	2.0	7.2 X 7.2	19.8	10.8	10.8
				3.0		22.9	15.9	15.9
				4.0		26.0	35.5	26.0
			BH-P18	2.0	7.2 X 7.2	39.2	31.5	31.5
				3.0		45.1	33.0	33.0
				4.0		51.2	35.1	35.1
			BH-P19	2.0	7.2 X 7.2	22.1	31.9	22.1
				3.0		25.2	33.6	25.2
				4.0		28.5	35.5	28.5
			BH-A2	2.0	7.2 X 7.2	34.1	33.4	33.4
				3.0		39.6	36.1	36.1
				4.0		45.3	38.0	38.0
13.	58+191	61+376	BH-CL	1.0	3.7 X 3.7	21.2	22.5	21.2
				1.5		24.1	24.3	24.1
				2.0		27.1	26.8	26.8
14.	58+497	61+676	BH-A1	2.0	7.2 X 7.2	52.4	47.7	47.7
				3.0		60.3	50.7	50.7
				4.0		68.4	54.3	54.3
			BH-P1	2.0	7.2 X 7.2	43.6	47.9	43.6
				3.0		50.0	52.1	50.0
				4.0		56.7	56.9	56.7
			BH-P2	2.0	7.2 X 7.2	45.5	36.9	36.9
				3.0		53.2	37.5	37.5
				4.0		61.2	37.1	37.1
			BH-P3	2.0	7.2 X 7.2	37.1	34.9	34.9
				3.0		44.4	40.0	40.0
				4.0		52.0	46.4	46.4
			BH-P4	2.0	7.2 X 7.2	63.7	65.3	63.7
				3.0		73.2	72.2	72.2
				4.0		83.0	78.0	78.0
			BH-P5	2.0	7.2 X 7.2	26.3	38.3	26.3
				3.0		31.8	40.8	31.8
				4.0		37.6	43.8	37.6

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
	58+497	61+676	BH-P6	2.0	7.2 X 7.2	47.2	43.1	43.1
				3.0		54.0	46.7	46.7
				4.0		61.0	51.1	51.1
			BH-A2	2.0	7.2 X 7.2	43.6	44.2	43.6
				3.0		50.0	46.6	46.6
				4.0		56.7	49.2	49.2
15.	58+837	62+026	BH-CL	1.0	4.9 X 4.9	39.1	18.6	18.6
				1.5		44.1	21.4	21.4
				2.0		49.3	25.2	25.2
16.	59+071	62+256	BH-A1	1.0	2.7 X 2.7	26.0	55.7	26.0
				1.5		30.1	59.9	30.1
				2.0		34.3	63.8	34.3
17.	59+206	62+400	BH-CL	1.0	11.5 X 11.5	32.2	39.6	32.2
				1.5		34.5	40.3	34.5
				2.0		36.7	41.1	36.7
18.	59+270	62+546	BH-CL	1.0	2.7 X 2.7	27.7	68.9	27.7
				1.5		31.9	74.1	31.9
				2.0		36.3	79.0	36.3

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m2.

Based on the method of analysis given under Para 7.2 above, The values of Safe Load Carrying Capacity of piles in compression, uplift and lateral under static conditions have been tabulated below:-

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm (Replaced Soil)

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from 25mm settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	53+572	56+756	BH-CL	1.0	3.7 X 3.7	32.1	26.6	26.6
				1.5		34.4	28.2	28.2
				2.0		36.8	34.6	30.0
2.	53+982	57+169	BH-CL	1.0	4.9 X 4.9	24.0	19.9	19.9
				1.5		26.5	21.1	21.1
				2.0		28.5	24.2	24.2

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm (Replaced Soil)

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from 50 mm settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	53+572	56+756	BH-CL	1.0	3.7 X 3.7	32.1	53.3	30.0
				1.5		34.4	56.5	30.0
				2.0		36.8	69.3	30.0
2.	53+982	57+169	BH-CL	1.0	4.9 X 4.9	24.0	39.8	24.0
				1.5		26.5	42.2	26.5
				2.0		28.5	48.3	28.5

Note:- The sub-strata at the location of Ch (Old) 53+572 & 53+982 consist of cohesive soil upto a depth of 10 m and 6 m below EGL, respectively. Therefore before laying the open foundation at 1.0, 1.5 m & 2.0m depth it is recommended to replace & compact the soil up to 1.5m depth below the foundation level.

As per the Morth guidelines the gradation of fill soil shall be as per following limits. The effective angle of friction not less than 30º. The gradation of fill soil shall be as per following limits.

Sieve Size	Percentage Passing
75 mm	100%
425 micron	0-60%
75 micron	less than 15 %
PI	≤6

1. *The density of backfill soil should be more than 95% of proctor density. The replaced /compacted soil should be lay down layer wise for each 300mm.*
2. *The design parameters considered for replaced/compacted Soil for calculating the SBC from shear criteria are as follows;*

C=0, Phi = 32 degree, Sp. Gravity= 2.63 Moisture content= 8%, Dry density=1.58 t/m^2, N = 25.

Table 4.3: Safe Load Carrying Capacity of normal bored cast in-situ RCC Pile in Soil

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
1.	O.C._52+518 N.C._55+719	BH-A1	1.0	22.0	2.0	437.0	275.0	26.22
				24.0		480.0	315.0	
				26.0		523.0	355.0	
				28.0		565.0	394.0	
			1.2	22.0	2.0	644.0	370.0	35.10
				24.0		706.0	427.0	
				26.0		766.0	483.0	
				28.0		827.0	540.0	
2.		BH-A2	1.0	22.0	2.0	437.0	275.0	26.22
				24.0		480.0	315.0	
				26.0		523.0	355.0	
				28.0		565.0	394.0	
			1.2	22.0	2.0	644.0	370.0	35.10
				24.0		706.0	427.0	
				26.0		766.0	483.0	
				28.0		827.0	540.0	
3.	O.C._55+910 N.C._59+107	BH-A1	1.0	22.0	2.0	426.0	270.0	24.91
				24.0		463.0	305.0	
				26.0		501.0	340.0	
				28.0		538.0	375.0	
			1.2	22.0	2.0	589.0	349.0	33.35
				24.0		638.0	395.0	
				26.0		688.0	442.0	
				28.0		736.0	488.0	
4.		BH-A2	1.0	22.0	2.0	419.0	263.0	28.10
				24.0		455.0	298.0	
				26.0		492.0	333.0	
				28.0		529.0	367.0	
			1.2	22.0	2.0	576.0	334.0	37.62
				24.0		625.0	382.0	
				26.0		674.0	428.0	
				28.0		723.0	474.0	
		BH-A1	1.0	16.0	2.0	214.0	163.0	23.56
				18.0		228.0	179.0	
				20.0		243.0	195.0	
				22.0		258.0	205.0	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._57+400 N.C._60+603	BH-A1	1.2	16.0	2.0	274.0	226.0	31.54
				18.0		293.0	247.0	
				20.0		311.0	268.0	
				22.0		329.0	205.0	
5.		BH-P2	1.0	16.0	2.0	240.0	171.0	29.31
				18.0		258.0	190.0	
				20.0		288.0	219.0	
				22.0		393.0	252.0	
			1.2	16.0	2.0	307.0	213.0	39.23
				18.0		330.0	238.0	
				20.0		371.0	277.0	
				22.0		545.0	322.0	
6.		BH-P3	1.0	16.0	2.0	331.0	192.0	28.71
				18.0		363.0	223.0	
				20.0		397.0	255.0	
				22.0		431.0	287.0	
			1.2	16.0	2.0	458.0	241.0	38.43
				18.0		501.0	283.0	
				20.0		546.0	326.0	
				22.0		591.0	369.0	
7.		BH-P4	1.0	16.0	2.0	343.0	201.0	25.57
				18.0		378.0	234.0	
				20.0		412.0	267.0	
				22.0		447.0	299.0	
			1.2	16.0	2.0	476.0	252.0	34.23
				18.0		523.0	296.0	
				20.0		568.0	340.0	
				22.0		614.0	384.0	
8.		BH-P5	1.0	16.0	2.0	327.0	190.0	24.91
				18.0		359.0	222.0	
				20.0		393.0	254.0	
				22.0		426.0	285.0	
			1.2	16.0	2.0	453.0	238.0	33.35
				18.0		497.0	282.0	
				20.0		542.0	325.0	
				22.0		586.0	367.0	
9.		BH-P6	1.0	16.0	2.0	284.0	153.0	23.56
				18.0		318.0	185.0	
				20.0		352.0	217.0	
				22.0		387.0	250.0	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._57+400 N.C._60+603	BH-P6	1.2	16.0	2.0	404.0	194.0	31.54
				18.0		449.0	237.0	
				20.0		495.0	281.0	
				22.0		542.0	325.0	
10.		BH-P7	1.0	16.0	2.0	282.0	148.0	25.57
				18.0		316.0	181.0	
				20.0		351.0	214.0	
				22.0		385.0	247.0	
			1.2	16.0	2.0	234.0	189.0	34.23
				18.0		448.0	233.0	
				20.0		495.0	278.0	
				22.0		541.0	322.0	
11.		BH-P9	1.0	20.0	2.0	235.0	194.0	24.91
				22.0		255.0	215.0	
				24.0		378.0	246.0	
				26.0		411.0	278.0	
			1.2	20.0	2.0	300.0	246.0	33.35
				22.0		325.0	272.0	
				24.0		523.0	315.0	
				26.0		568.0	358.0	
12.		BH-P10	1.0	16.0	2.0	299.0	179.0	28.10
				18.0		331.0	210.0	
				20.0		364.0	241.0	
				22.0		417.0	274.0	
			1.2	16.0	2.0	413.0	225.0	37.62
				18.0		456.0	267.0	
				20.0		499.0	309.0	
				22.0		545.0	353.0	
13.		BH-P11	1.0	16.0	2.0	298.0	193.0	24.91
				18.0		329.0	223.0	
				20.0		360.0	254.0	
				22.0		392.0	284.0	
			1.2	16.0	2.0	403.0	242.0	33.35
				18.0		445.0	283.0	
				20.0		487.0	323.0	
				22.0		529.0	364.0	
14.		BH-P12	1.0	16.0	2.0	325.0	201.0	28.10
				18.0		358.0	233.0	
				20.0		391.0	264.0	
				22.0		424.0	296.0	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._57+400 N.C._60+603	BH-P12	1.2	16.0	2.0	443.0	252.0	37.62
				18.0		487.0	294.0	
				20.0		530.0	336.0	
				22.0		574.0	379.0	
15.		BH-P13	1.0	16.0	2.0	256.0	198.0	31.06
				18.0		271.0	214.0	
				20.0		300.0	242.0	
				22.0		418.0	275.0	
			1.2	16.0	2.0	325.0	247.0	41.58
				18.0		343.0	268.0	
				20.0		382.0	306.0	
				22.0		571.0	350.0	
16.		BH-P15	1.0	16.0	2.0	341.0	200.0	24.91
				18.0		376.0	232.0	
				20.0		410.0	265.0	
				22.0		445.0	298.0	
			1.2	16.0	2.0	472.0	250.0	33.35
				18.0		518.0	294.0	
				20.0		563.0	338.0	
				22.0		609.0	382.0	
17.		BH-P16	1.0	16.0	2.0	318.0	184.0	24.24
				18.0		349.0	214.0	
				20.0		381.0	245.0	
				22.0		414.0	276.0	
			1.2	16.0	2.0	433.0	231.0	32.45
				18.0		482.0	271.0	
				20.0		525.0	313.0	
				22.0		569.0	355.0	
18.		BH-P17	1.0	16.0	2.0	308.0	192.0	22.86
				18.0		448.0	225.0	
				20.0		483.0	259.0	
				22.0		519.0	292.0	
			1.2	16.0	2.0	421.0	241.0	30.61
				18.0		640.0	286.0	
				20.0		688.0	331.0	
				22.0		735.0	377.0	
19.		BH-P18	1.0	16.0	2.0	397.0	223.0	24.91
				18.0		505.0	259.0	
				20.0		543.0	295.0	
				22.0		582.0	331.0	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._57+400 N.C._60+603	BH-P18	1.2	16.0	2.0	547.0	279.0	33.35
				18.0		718.0	328.0	
				20.0		770.0	376.0	
				22.0		821.0	425.0	
20.		BH-P19	1.0	16.0	2.0	219.0	182.0	24.24
				18.0		234.0	198.0	
				20.0		262.0	226.0	
				22.0		515.0	257.0	
			1.2	16.0	2.0	274.0	226.0	32.45
				18.0		294.0	248.0	
				20.0		332.0	285.0	
				22.0		743.0	328.0	
21.		BH-A2	1.0	22.0	2.0	392.0	270.0	23.56
				24.0		424.0	300.0	
				26.0		456.0	331.0	
				28.0		489.0	362.0	
			1.2	22.0	2.0	535.0	347.0	31.54
				24.0		578.0	388.0	
				26.0		621.0	430.0	
				28.0		664.0	471.0	
22.	O.C._58+497 N.C._61+676	BH-A1	1.0	22.0	2.0	353.0	220.0	29.31
				24.0		386.0	253.0	
				26.0		421.0	285.0	
				28.0		454.0	317.0	
			1.2	22.0	2.0	492.0	282.0	39.23
				24.0		536.0	326.0	
				26.0		582.0	370.0	
				28.0		627.0	413.0	
23.		BH-P1	1.0	22.0	2.0	362.0	225.0	26.22
				24.0		396.0	259.0	
				26.0		432.0	292.0	
				28.0		466.0	324.0	
			1.2	22.0	2.0	513.0	292.0	35.10
				24.0		558.0	338.0	
				26.0		606.0	383.0	
				28.0		652.0	427.0	
24.		BH-P2	1.0	22.0	2.0	408.0	267	28.71
				24.0		442.0	300	
				26.0		479.0	334	
				28.0		607.0	368	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._58+497 N.C._61+676	BH-P2	1.2	22.0	2.0	564.0	345	38.43
				24.0		609.0	388	
				26.0		658.0	434	
				28.0		855.0	481	
25.		BH-P3	1.0	22.0	2.0	428.0	286	26.22
				24.0		461.0	318	
				26.0		495.0	350	
				28.0		620.0	384	
			1.2	22.0	2.0	587.0	368	35.10
				24.0		632.0	411	
				26.0		677.0	454	
				28.0		725.0	500	
26.		BH-P4	1.0	22.0	2.0	452.0	304	29.31
				24.0		486.0	336	
				26.0		520.0	368	
				28.0		554.0	400	
			1.2	22.0	2.0	617.0	389	39.23
				24.0		662.0	432	
				26.0		707.0	475	
				28.0		753.0	518	
27.		BH-P5	1.0	22.0	2.0	361.0	227	29.90
				24.0		396.0	260	
				26.0		431.0	293	
				28.0		490.0	326	
			1.2	22.0	2.0	508.0	296	40.03
				24.0		556.0	341	
				26.0		602.0	385	
				28.0		648.0	429	
28.		BH-P6	1.0	22.0	2.0	360.0	224	27.48
				24.0		395.0	257	
				26.0		429.0	290	
				28.0		525.0	325	
			1.2	22.0	2.0	510.0	291	36.79
				24.0		557.0	336	
				26.0		603.0	380	
				28.0		654.0	428	
29.		BH-A2	1.0	22.0	2.0	439.0	294	28.10
				24.0		472.0	326	
				26.0		506.0	358	
				28.0		539.0	390	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
		BH-A2	1.2	22.0	2.0	599.0	376	37.62
				24.0		643.0	419	
				26.0		688.0	462	
				28.0		732.0	504	

Notes : -

1. Permissible lateral deflection has been taken as 5mm.
2. The self weight of the pile has been taken into account while computing the Safe Load Carrying Capacity of Pile in uplift only and not considered for vertical load capacity in compression.
3. The safe load carrying capacity of piles have been worked out on the basis of IS: 2911 (Part-1/sec-2) – 2010 as per provisions / assumptions provided therein & are only an assessment based on characteristics of the sub-strata obtained at the locations of the above BHs. The safe load carrying capacities as tabulated above will further depend substantially on the piling technique adopted and equipment used for making the piles in the field. However, for the final designs & constructions, the safe/allowable load carrying capacities of these piles should be taken by conducting actual initial load tests on these piles by casting them in the respective areas.
4. While erecting normal bored cast in-situ pile, utmost care should be taken while flushing/cleaning the bottom of pile particularly prior to start of pouring of concrete so as o rest the pile in virgin soil only for obtaining full point bearing as while computing safe load carrying capacity of pile no bottom softening during erection of pile has been considered.
5. Further the pile should have necessary structural strength to transmit / sustain the design load.

***Notes:* -**

All The above recommendations are based on the field and laboratory tests conducted on selected soil/ rock core samples and our experience in this regard. If the actual substrata conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations.

REFERENCES

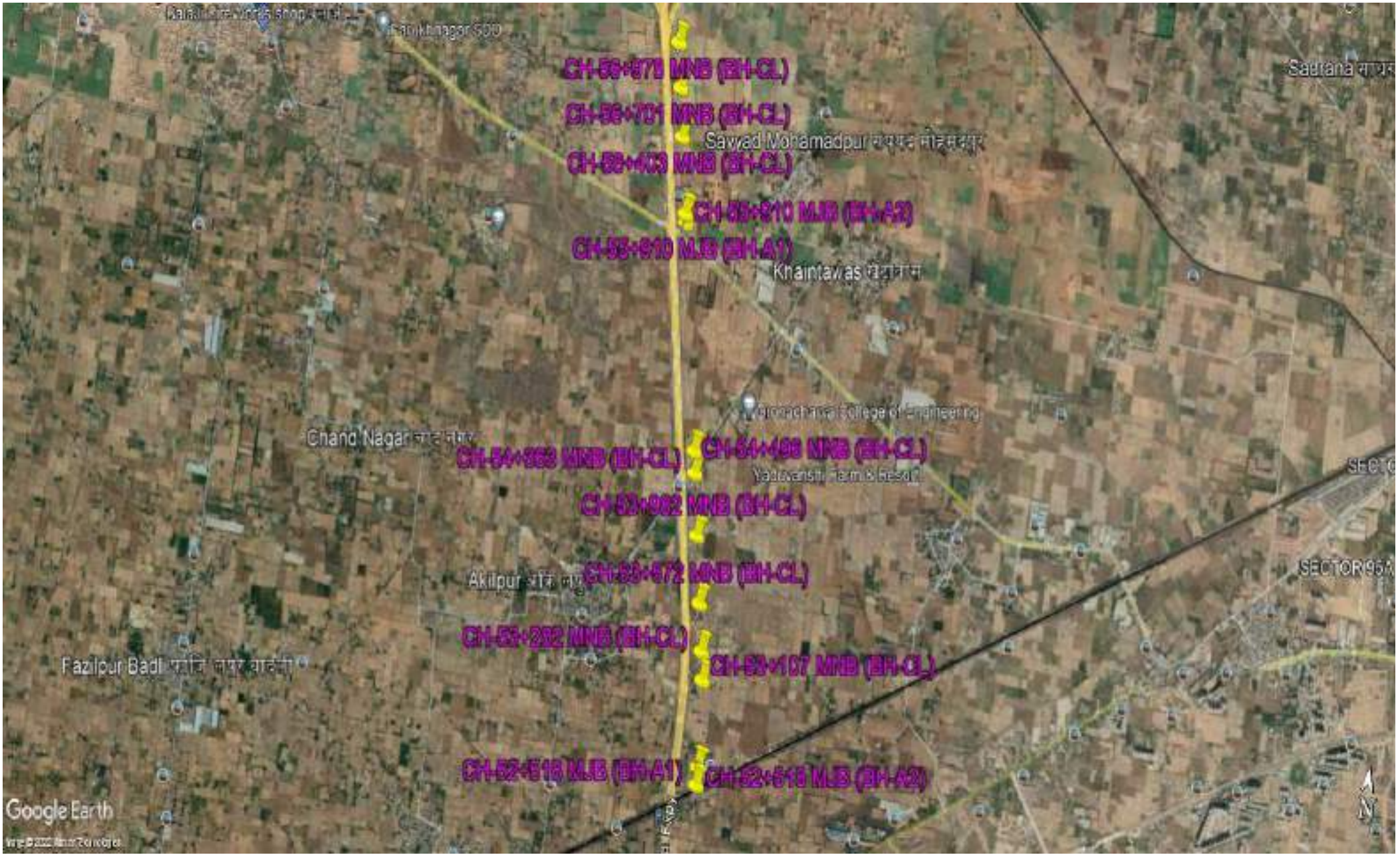
1. IS 2911: Part 1 : Sec 2 : 2010 (Reaffirmed Year : 2020) Design And construction Of pile foundations - Code Of Practice Part 1 Concrete Piles Section 2 Bored Cast In-situ Concrete Piles.
2. IS 2911 : Part 4 : 2013 (Reaffirmed Year : 2018) Design and construction of pile foundations - Code of practice : Part 4 Load test on piles .
3. IS 6403 : 1981 (Reaffirmed Year : 2016), Amd. 2 : 2018 Code of practice for determination of bearing capacity of shallow foundations.
4. IS 8009 : Part 1 : 1976 (Reaffirmed Year : 2018) Code of practice for calculation of settlements of foundations: Part 1 Shallow foundations subjected to symmetrical static vertical loads.
5. IS 8009 : Part 2 : 1980 (Reaffirmed Year : 2020) Code of practice for calculation of settlement of foundations: Part 2 Deep foundations subjected to symmetrical static vertical loading.
6. IS 1893 : Part 1 : 2016 (Reaffirmed Year : 2021) Criteria for Earthquake Resistant Design of Structures - Part 1 : General Provisions and Buildings.
7. IS 1904 : 2021 Draft Indian Standard for General requirements for design and construction of foundations in soils Code of practice third revision of IS 1904.
8. IS 456 : 2000 (Reaffirmed Year : 2021) Plain and Reinforced Concrete - Code of Practice (Including Amendment 1, 2, 3,& 4).
9. BS – 118 : 2015 Final Seismic Design of Bridges.
10. IS 2131 : 1981 (Reaffirmed Year : 2016) Method for standard penetration test for soils.
11. IS 2132 : 1986 (Reaffirmed Year : 2016) Code of practice for thin-walled tube sampling of soils.
12. IS 1892 : 1979 (Reaffirmed Year : 2016) Code of practice for subsurface investigation for foundations.
13. Bowles, J.E., 1982. Foundation design and analysis.
14. IS. 2720 (Part 3)-1980. Determination of Specific Gravity of Soil.
15. IS. 2720 (Part 4). 1985. Methods of Test for Soils: Grain Size Analysis.
16. IS. IS 2131, 1981. Method for standard penetration test for soils.
17. IS: 2720 (Part 11)–(1993). Determination of the shear strength parameters of a specimen tested in unconsolidated undrained triaxial compression without the measurement of pore water pressure.
18. IS: 2720 (Part 13) 1986 Method of test for soils, direct shear test. New Delhi, India.
19. IS: 2720 (Part 3/See 1)–(1980) Methods of test for soils, determination of specific gravity of soil. New Delhi, India.
20. IS: 2720 (Part 5) 1985 Methods of test for soils, determination of liquid and plastic limit of soils. New Delhi, India.

Abbreviations

BH	Borehole
ERT	Electrical Resistivity Test
EGL	Existing Ground Level
GWT	Ground Water Table
IS	Indian Standards
SPT	Standard Penetration Test
DS	Disturbed Soil
R.L.	Reduced Level
m	Metre
sp. gr.	Specific Gravity
%	Percentage
mg /l	Milligram per litre
mg /kg	Milligram per kilogram

APPENDIX – A (FIELD DATA RESULTS)

Appendix No.	ITEMS
A-1	LOCATION PLAN
A-2	FIELD BORE HOLE LOGS
A-3	SUB SOIL PROFILE DIAGRAM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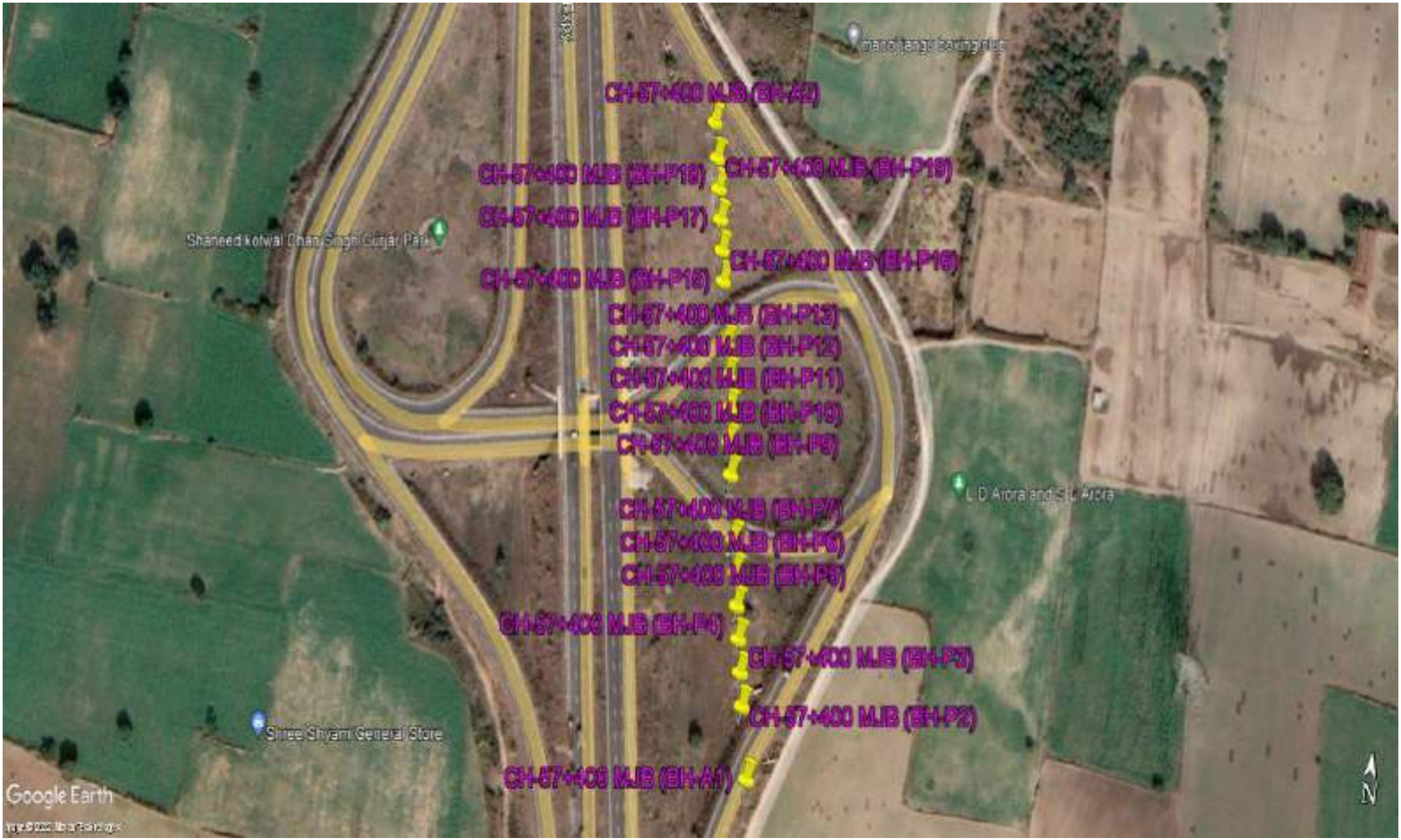
CH-56+701 MNB (BH-CL)
Sayyad Mohamadpur
CH-56+403 MNB (BH-CL)
CH-55+910 MJB (BH-A2)
CH-55+610 MJB (BH-A1)
Khaintawas
Chand Nagar
CH-54+958 MNB (BH-CL)
CH-54+498 MNB (BH-CL)
CH-52+982 MNB (BH-CL)
SECTOR95
CH-53+472 MNB (BH-CL)
CH-53+282 MNB (BH-CL)
CH-53+107 MNB (BH-CL)
Fazilpur Badi
CH-52+618 MJB (BH-A1)
CH-52+518 MJB (BH-A2)
Google Earth


CH-67+400 MJB (BH-A2)
CH-67+400 MJB (BH-P18)
CH-67+400 MJB (BH-P17)
CH-67+400 MJB (BH-P16)
CH-67+400 MJB (BH-P15)
CH-67+400 MJB (BH-P13)
CH-67+400 MJB (BH-P12)
CH-67+400 MJB (BH-P11)
CH-67+400 MJB (BH-P10)
CH-67+400 MJB (BH-P9)
CH-67+400 MJB (BH-P7)
CH-67+400 MJB (BH-P6)
CH-67+400 MJB (BH-P5)
CH-67+400 MJB (BH-P4)
CH-67+400 MJB (BH-P3)
CH-67+400 MJB (BH-P2)
CH-67+400 MJB (BH-A1)
Shaheed Kotwal Dhan Singh Gujar Park
L D Arora and Sons Arora
Shree Shyam General Store
Google Earth
N

CH-58+487 MJB (BH-A2)
CH-58+487 MJB (BH-P5)
CH-58+487 MJB (BH-P3)
CH-58+487 MJB (BH-P4)
CH-58+487 MJB (BH-P2)
CH-58+487 MJB (BH-P1)
CH-58+487 MJB (BH-A1)
Google Earth
N

Chauhan tea stop/dhaba
CH-59+270 MNB (BH-CL)
Chauhan dhaba and tea stall
Bharat kamla smadhi
CH-59+206 MNB (BH-CL)
CH-59+071 MNB (BH-CL)
Crotitech Engineering
CH-59+077 MNB (BH-CL)
Google Earth
N

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143671.17 m	*Easting :*683091.771 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*22.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	3	5	7	12					
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	5	9	13	22					
6.0											
6.5											
7.0	7	UDS*									
7.5											
8.0											
8.5	8.5	SPT-3	7	15	21	36	Brown, Hard, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-3									

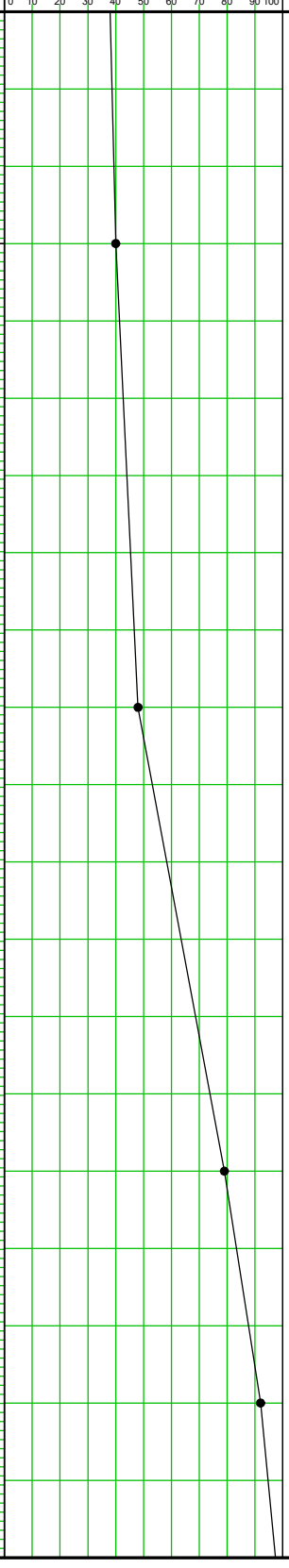
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143671.17 m	*Easting :*683091.771 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*22.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Hard, Silty clay of low plasticity	CL			
11.0											
11.5	11.5	SPT-4	9	16	24	40					
12.0											
12.5											
13.0	13	UDS-4									
13.5											
14.0											
14.5	14.5	SPT-5	10	20	28	48					
15.0											
15.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
16.0	16	UDS-5									
16.5											
17.0											
17.5	17.5	SPT-6	13	29	50	79					
18.0											
18.5											
19.0	19	SPT-7	15	32	60	92					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143671.17 m	*Easting :*683091.771 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*22.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	30	60	40 (8cm)	>100					
21.0											
21.5											
22.0	22	SPT-9	26	57	43 (7cm)	>100					
22.5											
23.0									22.80m		
23.5	23.5	SPT-10	24	49	51 (5cm)	>100					
24.0											
24.5											
25.0	25	SPT-11	27	62	38 (3cm)	>100	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-12	28	48	52 (12cm)	>100					
27.0											
27.5											
28.0	28	SPT-13	25	43	56	99					
28.5											
29.0											
29.5	29.5	SPT-14	20	40	60 (13cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143671.17 m	*Easting :*683091.771 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*22.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-15	26	44	56 (9cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-16	17	29	41	70					
33.0											
33.5											
34.0	34	SPT-17	21	36	45	81					
34.5											
35.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-18	19	30	47	77					
36.0											
36.5											
37.0	37	SPT-19	20	38	44	82					
37.5											
38.0											
38.5	38.5	SPT-20	27	62	38 (9cm)	>100					
39.0											
39.5											
40.0	40	SPT-21	29	69	31 (8cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143783.105 m	*Easting :*683092.392 m
Reduced Level (m):(+)220.511	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*23.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	6	7	13	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	7	9	13	22					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
8.5	8.5	SPT-3	6	8	14	22					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143783.105 m	*Easting :*683092.392 m
Reduced Level (m):(+)220.511	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*23.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*27-08-2021	

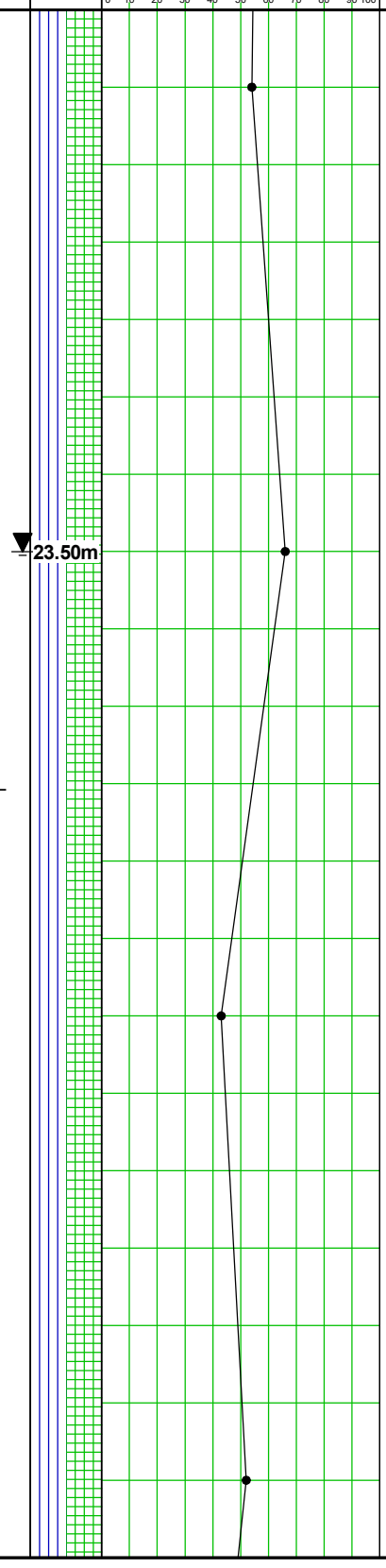
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	8	13	16	29					
12.0											
12.5											
13.0	13	UDS-5					Brown, Very stiff to hard, Silty clay of low plasticity	CL			
13.5											
14.0											
14.5	14.5	SPT-5	12	17	22	39					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	14	22	34	56					
18.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143783.105 m	*Easting :*683092.392 m
Reduced Level (m):(+)220.511	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*23.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	12	21	33	54					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	13	29	37	66			23.50m		
24.0											
24.5											
25.0	25	UDS-9					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	9	17	26	43					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	11	19	33	52					
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143783.105 m	*Easting :*683092.392 m
Reduced Level (m):(+)220.511	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*23.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	9	13	21	34					
33.0											
33.5											
34.0	34	UDS-12									
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-12	19	30	39	69					
36.0											
36.5											
37.0	37	SPT-13	24	38	43	81					
37.5											
38.0											
38.5	38.5	SPT-14	29	35	43	78					
39.0											
39.5											
40.0	40	SPT-15	27	40	53	93					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+107 km	*Northing :*3144302.971 m	*Easting :*683034.675 m
Reduced Level (m):(+)218.950	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-01-2022	*Date of Completion :*15-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1				15					
1.0											
1.5	1.5	SPT-2				15					
2.0											
	2.25	UDS*									
2.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3				13					
3.5											
4.0											
4.5	4.5	SPT-4				17					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5				40					
6.5											
7.0											
7.5	7.5	SPT-6				45	Brown, Hard, Silty clay of low plasticity	CL			
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7				45					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+107 km	*Northing :*3144302.971 m	*Easting :*683034.675 m
Reduced Level (m):(+)218.950	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-01-2022	*Date of Completion :*15-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0							Brown, Hard, Silty clay of low plasticity	CL			
10.5	10.5	SPT-8				50					
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9				50					
12.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
13.0											
13.5	13.5	SPT-10				51					
14.0											
	14.25	UDS-4									
14.5											
15.0	15	SPT-11				62					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+282 km	*Northing :*3144473.609 m	*Easting :*682995.864 m
Reduced Level (m):(+)218.087	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-01-2022	*Date of Completion :*14-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	4	5	5	10					
1.0											
1.5	1.5	SPT-2	5	6	7	13					
2.0											
	2.25	UDS*									
2.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	6	6	8	14					
3.5											
4.0											
4.5	4.5	SPT-4	7	8	11	19					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	11	13	16	29					
6.5											
7.0											
7.5	7.5	SPT-6	14	15	19	34	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	10	11	14	25					
9.5											
10.0	10	SPT-8	12	13	17	30					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+572 km	*Northing :*3144756.38 m	*Easting :*682931.5 m
Reduced Level (m):(+)217.532	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-01-2022	*Date of Completion :*14-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	3	6					
1.0											
1.5	1.5	SPT-2	3	4	7	11	Brown, Medium stiff to stiff, Silty clay of low plasticity	CL			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	8	11	15	26					
3.5											
4.0											
4.5	4.5	SPT-4	11	13	16	29					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	13	15	19	34					
6.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
7.0											
7.5	7.5	SPT-6	15	18	21	39					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	17	20	27	47					
9.5											
10.0	10	SPT-8	19	22	30	52					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+982 km	*Northing :*3145156.16 m	*Easting :*682840.528 m
Reduced Level (m):(+)217.050	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-01-2022	*Date of Completion :*12-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	5	5	6	11					
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	7	8	9	17					
3.5											
4.0							Brown, Medium stiff to very stiff, Silty clay of low plasticity	CL			
4.5	4.5	SPT-4	12	12	15	27					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	10	11	13	24					
6.5											
7.0											
7.5	7.5	SPT-6	13	15	17	32					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	15	18	24	42	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	15	17	21	38					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*54+363 km	*Northing :*3145527.663 m	*Easting :*682755.991 m
Reduced Level (m):(+)216.014	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-01-2022	*Date of Completion :*11-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	9	11	13	24					
1.0											
1.5	1.5	SPT-2	8	9	10	19					
2.0											
	2.25	UDS*									
2.5							Brown, Medium dense, Silty sand with clay	SM-SC			
3.0	3	SPT-3	7	9	9	18					
3.5											
4.0											
4.5	4.5	SPT-4	8	10	12	22					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	11	14	17	31					
6.5											
7.0							Brown, Hard, Silty clay of low plasticity	CL			
7.5	7.5	SPT-6	13	15	19	34					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	11	17	21	38	Brown, Dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	12	19	23	42					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*54+496 km	*Northing :*3145657.348 m	*Easting :*682726.48 m
Reduced Level (m):(+)217.393	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-01-2022	*Date of Completion :*12-01-2022	

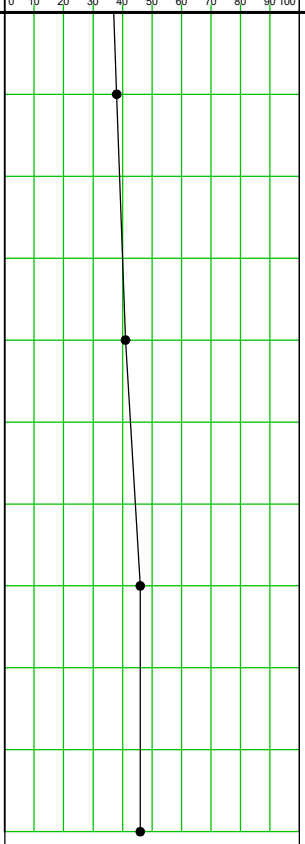
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	4	5	9					
1.0											
1.5	1.5	SPT-2	5	6	7	13					
2.0											
2.5	2.25	UDS*					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	6	8	9	17					
3.5											
4.0											
4.5	4.5	SPT-4	7	9	11	20					
5.0											
5.5	5.25	UDS-1									
6.0	6	SPT-5	12	14	16	30					
6.5											
7.0											
7.5	7.5	SPT-6	13	15	19	34	Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.0											
8.5	8.25	UDS-2									
9.0	9	SPT-7	12	16	19	35					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*54+496 km	*Northing :*3145657.348 m	*Easting :*682726.48 m
Reduced Level (m):(+)217.393	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-01-2022	*Date of Completion :*12-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	15	17	21	38					
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9	13	19	22	41					
12.5											
13.0											
13.5	13.5	SPT-10	15	21	25	46					
14.0											
	14.25	UDS-4									
14.5											
15.0	15	SPT-11	18	20	26	46					

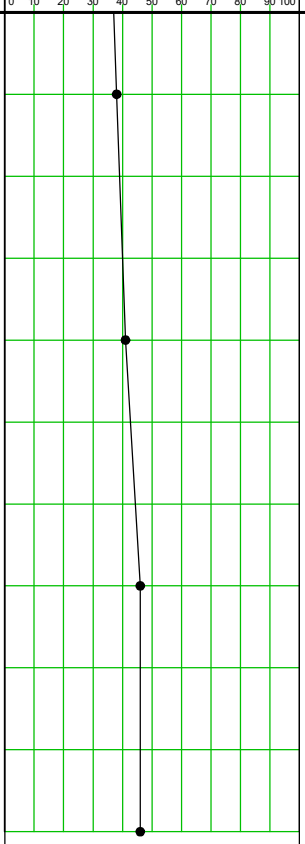


UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*54+496 km	*Northing :*3145657.348 m	*Easting :*682726.48 m
Reduced Level (m):(+)217.393	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.36	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-01-2022	*Date of Completion :*12-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	15	17	21	38					
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9	13	19	22	41					
12.5											
13.0											
13.5	13.5	SPT-10	15	21	25	46					
14.0											
	14.25	UDS-4									
14.5											
15.0	15	SPT-11	18	20	26	46					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147009.213 m	*Easting :*682418.856 m
Reduced Level (m):(+)218.101	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	2	4	5	9					
3.0											
3.5							Brown, loose to medium dense, Silty sand	SM			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	7	9	16					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	7	10	14	24	Brown, Very stiff to Hard, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147009.213 m	*Easting :*682418.856 m
Reduced Level (m):(+)218.101	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	12	15	17	32	Brown, Very stiff to Hard, Silty clay of low plasticity	CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	15	18	21	39					
15.0											
15.5											
16.0	16	UDS-6							16.00m		
16.5							Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL			
17.0											
17.5	17.5	SPT-6	17	22	24	46					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147009.213 m	*Easting :*682418.856 m
Reduced Level (m):(+)218.101	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	18	24	27	51					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	19	25	29	54					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	21	28	37	65					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	24	30	39	69					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147009.213 m	*Easting :*682418.856 m
Reduced Level (m):(+)218.101	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	27	38	47	85					
33.0											
33.5											
34.0	34	UDS-12									
34.5											
35.0							Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-12	37	48	54 (4cm)	>100					
36.0											
36.5											
37.0	37	SPT-13	39	50	50 (10cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-14	65	85	15 (12cm)	>100					
39.0											
39.5											
40.0	40	SPT-15	67	59	41 (7cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147059.917 m	*Easting :*682407.318 m
Reduced Level (m):(+)217.474	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*21-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	5	7	8	15					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	10	12	22					
4.5											
5.0							Brown, Medium dense to dense, Silty sand	SM			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	12	14	26					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	11	15	17	32					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147059.917 m	*Easting :*682407.318 m
Reduced Level (m):(+)217.474	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*21-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	14	18	21	39	Brown, Medium dense to dense, Silty sand	SM			
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5									15.60m		
16.0	16	SPT-6	12	16	19	35					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0							Brown, Hard, Silty clay of low plasticity	CL			
18.5											
19.0	19	SPT-7	15	20	23	43					
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147059.917 m	*Easting :*682407.318 m
Reduced Level (m):(+)217.474	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*21-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Hard, Silty clay of low plasticity	CL			
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	20	24	29	53					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	21	27	31	58	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	24	32	41	73					
28.5											
29.0											
29.5	29.5	UDS*									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147059.917 m	*Easting :*682407.318 m
Reduced Level (m):(+)217.474	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*21-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-11	40	54	46 (4cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-12	44	62	38 (3cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	38	58	42 (5cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-14	33	65	35 (6cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	39	73	27 (3cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	42	69	31 (4cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	48	70	30 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*56+403 km	*Northing :*3147516.813 m	*Easting :*682303.349 m
Reduced Level (m):(+)215.389	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-09-2021	*Date of Completion :*25-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	4	7					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	10	12	22					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	11	14	25	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	11	15	27	42					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*56+701 km	*Northing :*3147807.384 m	*Easting :*682237.228 m
Reduced Level (m):(+)215.273	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-01-2022	*Date of Completion :*10-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification
0.0		DS					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL
0.5	0.5	SPT-1	3	4	4	8		
1.0								
1.5	1.5	SPT-2	5	7	9	16		
2.0								
	2.25	UDS-1						
2.5								
3.0	3	SPT-3	4	6	8	14		
3.5								
4.0								
4.5	4.5	SPT-4	7	9	10	19		
5.0								
	5.25	UDS-2						
5.5							Brown, Medium dense to dense, Silty sand	SP-SM
6.0	6	SPT-5	10	13	16	29		
6.5								
7.0								
7.5	7.5	SPT-6	11	14	19	33		
8.0								
	8.25	UDS-3						
8.5								
9.0	9	SPT-7	12	15	20	35		
9.5								
10.0	10	SPT-8	10	13	16	29		

Graphic Log: ▼ 1.40m

(Depth v/s SPT N Value): 0 10 20 30 40 50 60 70 80 90 100

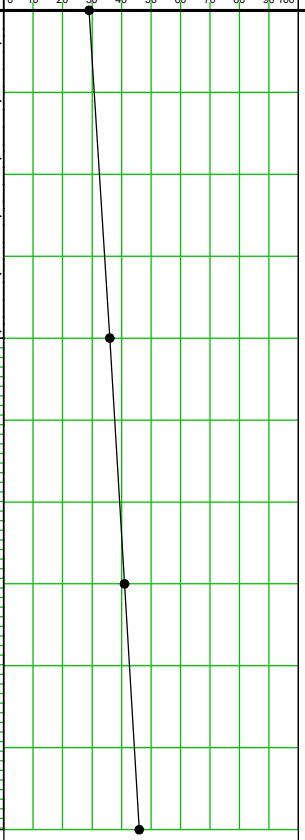
Special Observations

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*56+701 km	*Northing :*3147807.384 m	*Easting :*682237.228 m
Reduced Level (m):(+)215.273	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-01-2022	*Date of Completion :*10-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0							Brown, Medium dense to dense, Silty sand	SP-SM			
	11.25	UDS*									
11.5											
12.0	12	SPT-9	11	15	21	36					
12.5											
13.0											
13.5	13.5	SPT-10	14	19	22	41	Brown, Hard, Silty clay of low plasticity	CL			
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	16	21	25	46					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*56+978 km	*Northing :*3148077.48 m	*Easting :*682175.767 m
Reduced Level (m):(+)212.389	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-01-2022	*Date of Completion :*10-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	5	6	11					
1.0											
1.5	1.5	SPT-2	7	8	8	16	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	7	9	11	20					
3.5											
4.0											
4.5	4.5	SPT-4	8	10	12	22					
5.0											
	5.25	UDS-2									
5.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
6.0	6	SPT-5	9	12	14	26					
6.5											
7.0											
7.5	7.5	SPT-6	11	13	16	29					
8.0											
	8.25	UDS*									
8.5											
9.0	9	SPT-7	9	11	19	30	Brown, Medium dense, Silty sand with clay	SM-SC			
9.5											
10.0	10	SPT-8	13	15	22	37					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148361.347 m	*Easting :*682111.171 m
Reduced Level (m):(+)217.941	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	5	7	12					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	7	9	16	Brown, Medium dense, Silty sand with clay	SM-SC			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	10	12	22					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	12	15	17	32					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148361.347 m	*Easting :*682111.171 m
Reduced Level (m):(+)217.941	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									10.90m		
11.5	11.5	UDS-4					Brown, Hard, Silty clay of low plasticity	CL			
12.0											
12.5											
13.0	13	SPT-5	18	23	29	52					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5							Brown, Very dense, Silty sand	SM			
16.0	16	SPT-6	23	28	34	62					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	16	24	27	51	Brown, Hard, Silty clay of low plasticity	CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148361.347 m	*Easting :*682111.171 m
Reduced Level (m):(+)217.941	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	21	28	32	60	Brown, Hard, Silty clay of low plasticity	CL			
22.5											
23.0											
23.5	23.5	SPT-9	27	34	41	75					
24.0											
24.5											
25.0	25	SPT-10	29	36	49	85					
25.5											
26.0											
26.5	26.5	SPT-11	34	48	51	99	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
27.0											
27.5											
28.0	28	SPT-12	40	55	45 (4cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-13	46	66	34 (13cm)	>100					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148389.429 m	*Easting :*682104.781 m
Reduced Level (m):(+)213.893	*BH. No. :*BH-P2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	6	7	8	15					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	8	10	14	24					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	14	18	32	Brown, Hard, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
10.0	10	SPT-4	12	16	21	37					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148389.429 m	*Easting :*682104.781 m
Reduced Level (m):(+)213.893	*BH. No. :*BH-P2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									11.85m		
12.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
13.0	13	SPT-5	10	19	23	42					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	18	26	38	64					
16.5											
17.0											
17.5	17.5	UDS-6					Brown, Hard, Silty clay of low plasticity	CL			
18.0											
18.5											
19.0	19	SPT-7	24	29	41	70					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148389.429 m	*Easting :*682104.781 m
Reduced Level (m):(+)213.893	*BH. No. :*BH-P2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7					Brown, Hard, Silty clay of low plasticity	CL			
21.0											
21.5											
22.0	22	SPT-8	27	36	48	84					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.0	25	SPT-9	26	38	58	96					
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	32	58	42 (6cm)	>100					
28.5											
29.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
29.5	29.5	SPT-11	42	62	38 (7cm)	>100					
30.0	30										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148402.495 m	*Easting :*682101.808 m
Reduced Level (m):(+)214.414	*BH. No. :*BH-P3	*BH Termination Depth (m):*31
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	2	5	7	12					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	7	11	15	26					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	13	16	19	35					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148402.495 m	*Easting :*682101.808 m
Reduced Level (m):(+)214.414	*BH. No. :*BH-P3	*BH Termination Depth (m):*31
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	15	17	20	37			11.50m		
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	16	18	21	39	Brown, Dense, Silty sand	SM			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	17	20	24	44					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148402.495 m	*Easting :*682101.808 m
Reduced Level (m):(+)214.414	*BH. No. :*BH-P3	*BH Termination Depth (m):*31
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	SPT-7	19	23	25	48					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	22	27	30	57					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	24	29	32	61					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	31	37	42	79					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148402.495 m	*Easting :*682101.808 m
Reduced Level (m):(+)214.414	*BH. No. :*BH-P3	*BH Termination Depth (m):*31
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
31.0	31	UDS-11									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148415.561 m	*Easting :*682098.835 m
Reduced Level (m):(+)214.498	*BH. No. :*BH-P4	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	5	7	12					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5							Brown, Medium dense, Silty sand	SM			
4.0	4	SPT-2	5	8	11	19					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	15	32	47					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
9.0											
9.5											
10.0	10	SPT-4	11	17	37	54					

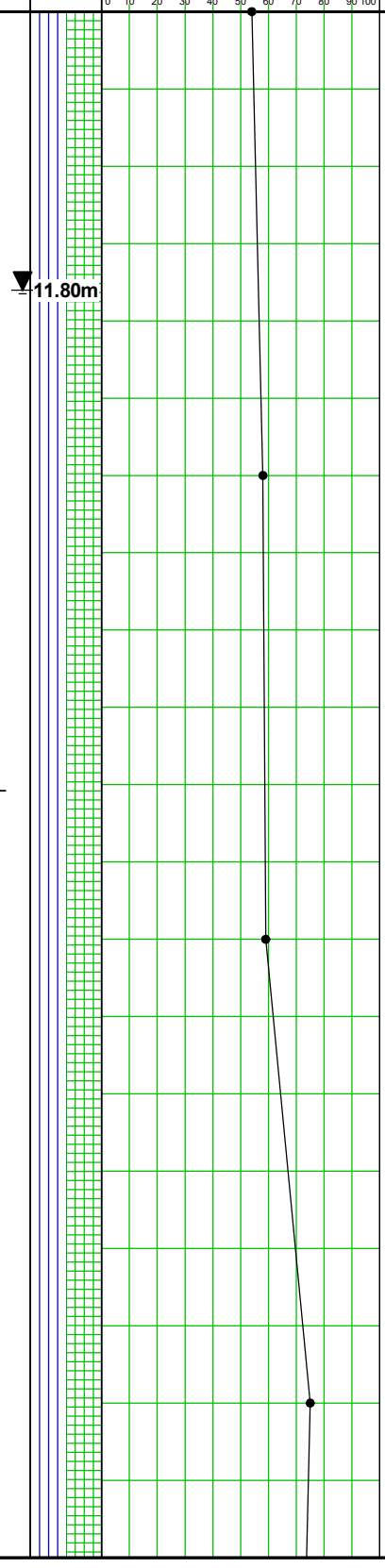
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148415.561 m	*Easting :*682098.835 m
Reduced Level (m):(+)214.498	*BH. No. :*BH-P4	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									11.80m		
12.5											
13.0	13	SPT-5	10	19	39	58					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	13	21	38	59					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	15	35	40	75					
19.5											
20.0											

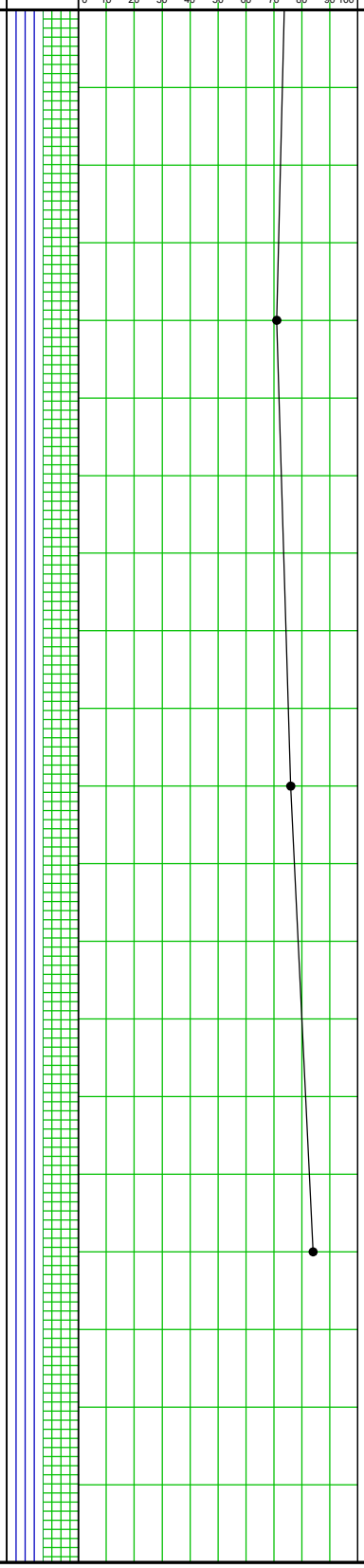


UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148415.561 m	*Easting :*682098.835 m
Reduced Level (m):(+)214.498	*BH. No. :*BH-P4	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	17	29	42	71					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	20	31	45	76	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS*									
27.0											
27.5											
28.0	28	SPT-10	28	36	48	84					
28.5											
29.0											
29.5	29.5	UDS-9									
30.0	30	-									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148428.627 m	*Easting :*682095.861 m
Reduced Level (m):(+)214.548	*BH. No. :*BH-P5	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	3	5	6	11					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Silty sand	SM			
5.5	5.5	SPT-2	7	9	11	20					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	12	14	17	31					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148428.627 m	*Easting :*682095.861 m
Reduced Level (m):(+)214.548	*BH. No. :*BH-P5	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	15	20	25	45					
12.0									12.00m		
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	18	24	29	53					
15.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	22	28	33	61					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148428.627 m	*Easting :*682095.861 m
Reduced Level (m):(+)214.548	*BH. No. :*BH-P5	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	SPT-7	19	31	37	68					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	27	36	43	79					
24.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
24.5											
25.0	25	UDS*									
25.5											
26.0											
26.5	26.5	SPT-9	28	43	47	90					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
29.5	29.5	SPT-10	26	45	59	94					
30.0	30										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148441.693 m	*Easting :*682092.888 m
Reduced Level (m):(+)214.417	*BH. No. :*BH-P6	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	4	6	10					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	7	9	16	Brown, Medium dense, Silty sand	SM			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	4	8	12	20					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	6	10	16	26					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148441.693 m	*Easting :*682092.888 m
Reduced Level (m):(+)214.417	*BH. No. :*BH-P6	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4							11.40m		
12.0											
12.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
13.0	13	SPT-5	9	13	19	32					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	15	21	29	50					
16.5											
17.0											
17.5	17.5	UDS-6					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
18.0											
18.5											
19.0	19	SPT-7	14	22	31	53					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148441.693 m	*Easting :*682092.888 m
Reduced Level (m):(+)214.417	*BH. No. :*BH-P6	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	16	25	35	60					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	17	26	37	63	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	19	31	42	73					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148454.759 m	*Easting :*682089.915 m
Reduced Level (m):(+)214.599	*BH. No. :*BH-P7	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	6	8	14					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Silty sand	SM			
5.5	5.5	SPT-2	7	10	11	21					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	9	14	16	30					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148454.759 m	*Easting :*682089.915 m
Reduced Level (m):(+)214.599	*BH. No. :*BH-P7	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									11.00m		
11.5	11.5	SPT-4	13	19	23	42					
12.0											
12.5											
13.0	13	UDS-5					Brown, hard, Silty clay of low plasticity	CL			
13.5											
14.0											
14.5	14.5	SPT-5	12	15	18	33					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	14	20	23	43					
18.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148454.759 m	*Easting :*682089.915 m
Reduced Level (m):(+)214.599	*BH. No. :*BH-P7	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	25	27	32	59					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	24	29	34	63					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	27	35	45	80					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	31	42	51	93					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148480.891 m	*Easting :*682083.968 m
Reduced Level (m):(+)214.330	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*28.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	6	7	13					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	8	10	18	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	9	10	19					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	9	14	19	33					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148480.891 m	*Easting :*682083.968 m
Reduced Level (m):(+)214.330	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*28.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									12.00m		
12.5							Brown, Hard, Silty clay of low plasticity	CL			
13.0	13	SPT-5	8	13	17	30					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	16	30	36	66	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	12	17	25	42	Brown, Hard, Silty clay of low plasticity	CL			
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148480.891 m	*Easting :*682083.968 m
Reduced Level (m):(+)214.330	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*28.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	13	20	28	48	Brown, Hard, Silty clay of low plasticity	CL			
22.5											
23.0											
23.5	23.5	SPT-9	18	24	36	60					
24.0											
24.5											
25.0	25	SPT-10	29	32	39	71					
25.5											
26.0											
26.5	26.5	SPT-11	30	36	41	77	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
27.0											
27.5											
28.0	28	SPT-12	35	40	48	88					
28.5											
29.0											
29.5	29.5	SPT-13	37	41	50	91					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148480.891 m	*Easting :*682083.968 m
Reduced Level (m):(+)214.330	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*28.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-14	32	45	52	97					
31.5											
32.0											
32.5	32.5	SPT-15	29	52	48 (10cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
33.0											
33.5											
34.0	34	SPT-16	31	58	42 (8cm)	>100					
34.5											
35.0	35	SPT-17	33	67	33 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148493.957 m	*Easting :*682080.995 m
Reduced Level (m):(+)214.021	*BH. No. :*BH-P10	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	9	12	15	27					
3.0											
3.5							Brown, Medium dense, Silty sand	SM			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	6	11	14	25					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	11	16	27	Brown, Very stiff, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148493.957 m	*Easting :*682080.995 m
Reduced Level (m):(+)214.021	*BH. No. :*BH-P10	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

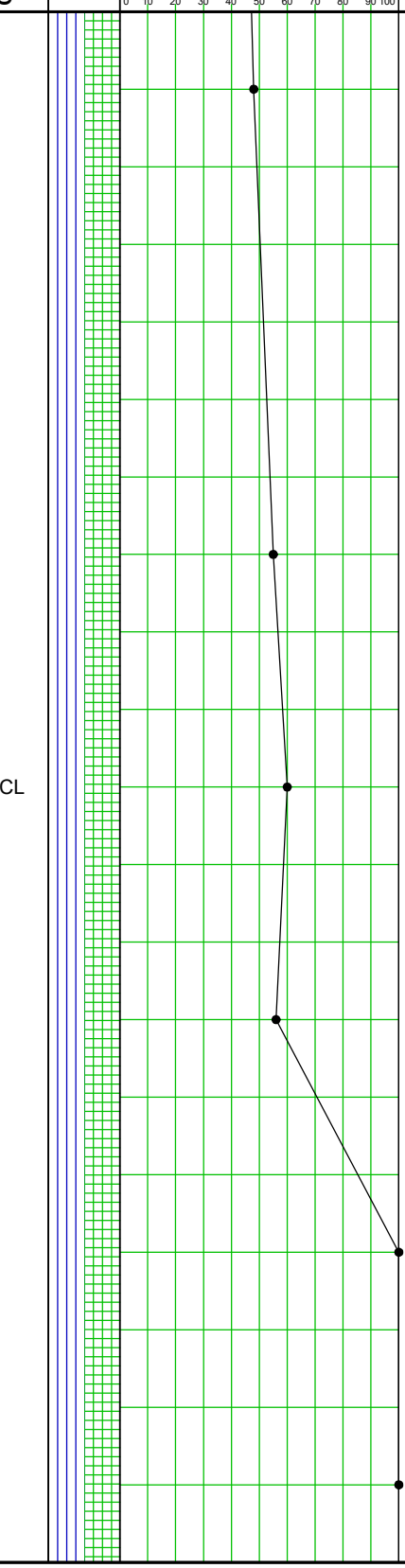
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	9	13	18	31					
12.0									11.85m		
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	10	15	22	37					
15.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	13	18	25	43					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148493.957 m	*Easting :*682080.995 m
Reduced Level (m):(+)214.021	*BH. No. :*BH-P10	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	14	20	28	48					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	15	24	31	55					
24.0											
24.5											
25.0	25	SPT-9	16	28	32	60	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-10	14	23	33	56					
27.0											
27.5											
28.0	28	SPT-11	16	42	58	>100					
28.5											
29.0											
29.5	29.5	SPT-12	52	64	36 (4cm)	>100					
30.0	30										



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148507.023 m	*Easting :*682078.022 m
Reduced Level (m):(+)213.946	*BH. No. :*BH-P11	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	4	5	9					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	8	10	18					
4.5											
5.0							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	10	12	22					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	12	15	27					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148507.023 m	*Easting :*682078.022 m
Reduced Level (m):(+)213.946	*BH. No. :*BH-P11	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									11.80m		
12.5											
13.0	13	SPT-5	10	14	16	30					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	7	9	13	22					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	8	10	15	25					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148507.023 m	*Easting :*682078.022 m
Reduced Level (m):(+)213.946	*BH. No. :*BH-P11	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	9	13	17	30	Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
22.5											
23.0											
23.5	23.5	SPT-9	11	25	20	45					
24.0											
24.5											
25.0	25	SPT-10	12	20	24	44	Brown, Hard, Silty clay of low plasticity	CL			
25.5											
26.0											
26.5	26.5	SPT-11	20	35	50	85					
27.0											
27.5											
28.0	28	SPT-12	21	50	50 (10cm)	>100	Brown, Very dense, Sandy silt of low plastic	ML-CL			
28.5											
29.0											
29.5	29.5	SPT-13	40	80	20 (3cm)	>100					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148520.089 m	*Easting :*682075.049 m
Reduced Level (m):(+)214.402	*BH. No. :*BH-P12	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.10	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	8	11	14	25					
3.0											
3.5							Brown, Medium dense, Silty sand	SM-SC			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	10	12	14	26					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	12	13	16	29	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148520.089 m	*Easting :*682075.049 m
Reduced Level (m):(+)214.402	*BH. No. :*BH-P12	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.10	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	13	15	18	33					
12.0									12.10m		
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	14	17	20	37					
15.0							Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	12	16	19	35					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

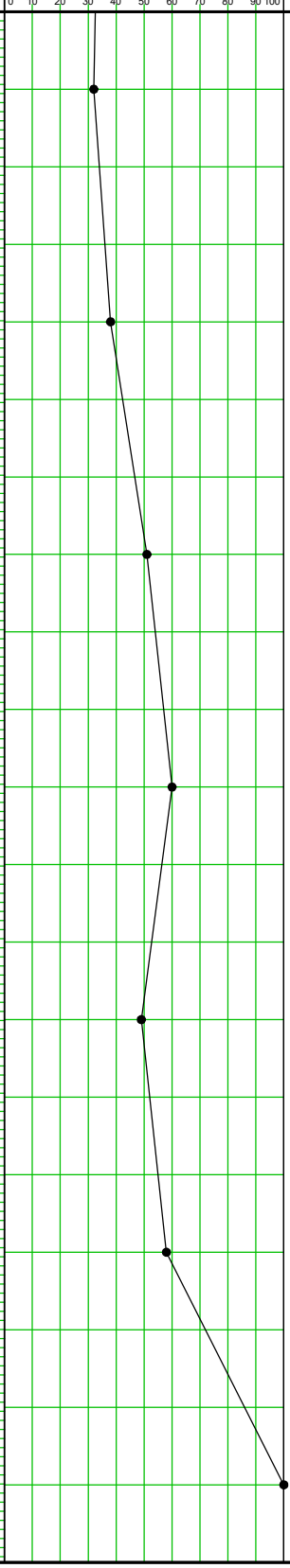
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148520.089 m	*Easting :*682075.049 m
Reduced Level (m):(+)214.402	*BH. No. :*BH-P12	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.10	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	11	13	19	32					
21.0											
21.5											
22.0	22	SPT-8	13	16	22	38					
22.5											
23.0											
23.5	23.5	SPT-9	15	20	31	51					
24.0											
24.5											
25.0	25	SPT-10	16	26	34	60	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-11	17	22	27	49					
27.0											
27.5											
28.0	28	SPT-12	20	25	33	58					
28.5											
29.0											
29.5	29.5	SPT-13	38	70	30 (4cm)	>100					
30.0	30	-									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148533.155 m	*Easting :*682072.075 m
Reduced Level (m):(+)214.579	*BH. No. :*BH-P13	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	5	9					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	10	15	19	34					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	17	21	38	Brown, Dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	12	19	23	42					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148533.155 m	*Easting :*682072.075 m
Reduced Level (m):(+)214.579	*BH. No. :*BH-P13	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

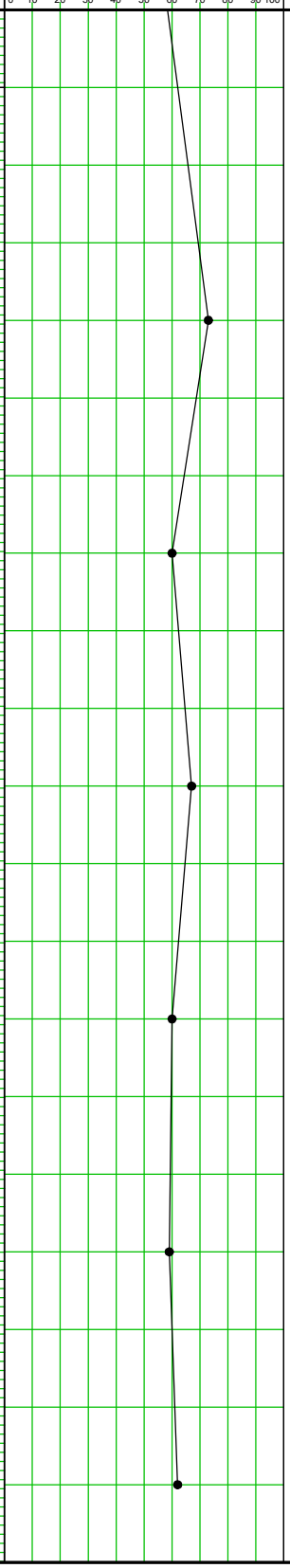
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5									12.30m		
13.0	13	SPT-5	14	21	25	46					
13.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	10	16	22	38					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5							Brown, Hard, Silty clay of low plasticity	CL			
19.0	19	SPT-7	12	18	33	51					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148533.155 m	*Easting :*682072.075 m
Reduced Level (m):(+)214.579	*BH. No. :*BH-P13	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Hard, Silty clay of low plasticity	CL			
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	15	33	40	73					
22.5											
23.0											
23.5	23.5	SPT-9	14	25	35	60					
24.0											
24.5											
25.0	25	SPT-10	15	27	40	67	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-11	14	25	35	60					
27.0											
27.5											
28.0	28	SPT-12	15	24	35	59					
28.5											
29.0											
29.5	29.5	SPT-13	19	28	34	62					
30.0	30	-									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148559.287 m	*Easting :*682066.129 m
Reduced Level (m):(+)213.460	*BH. No. :*BH-P15	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-08-2021	*Date of Completion :*26-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	7	8	15					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	6	8	10	18					
4.5											
5.0							Brown, Medium dense, Silty sand	SM-SC			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	11	14	25					
7.5											
8.0											
8.5	8.5	UDS*									
9.0											
9.5											
10.0	10	SPT-4	18	25	31	56					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148559.287 m	*Easting :*682066.129 m
Reduced Level (m):(+)213.460	*BH. No. :*BH-P15	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-08-2021	*Date of Completion :*26-08-2021	

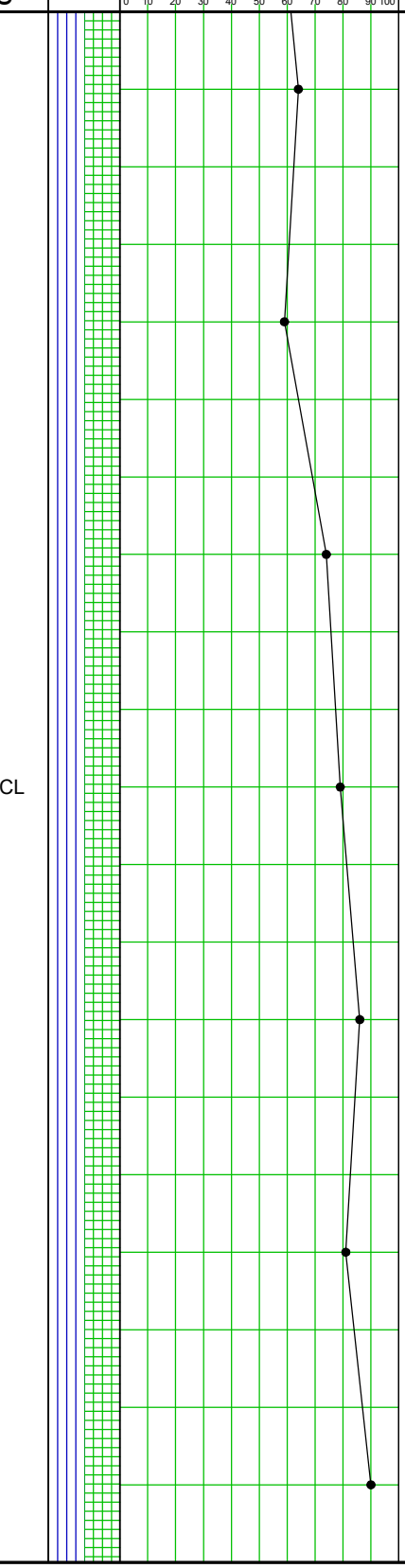
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-3									
12.0									11.80m		
12.5											
13.0	13	SPT-5	20	28	33	61					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	18	23	28	51					
16.5											
17.0											
17.5	17.5	UDS-5									
18.0											
18.5											
19.0	19	SPT-7	21	26	30	56					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148559.287 m	*Easting :*682066.129 m
Reduced Level (m):(+)213.460	*BH. No. :*BH-P15	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-08-2021	*Date of Completion :*26-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	24	29	35	64					
21.0											
21.5											
22.0	22	SPT-9	22	27	32	59					
22.5											
23.0											
23.5	23.5	SPT-10	28	35	39	74					
24.0											
24.5											
25.0	25	SPT-11	26	37	42	79	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-12	29	40	46	86					
27.0											
27.5											
28.0	28	SPT-13	32	38	43	81					
28.5											
29.0											
29.5	29.5	SPT-14	35	41	49	90					
30.0	30	-									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148572.353 m	*Easting :*682063.156 m
Reduced Level (m):(+)212.949	*BH. No. :*BH-P16	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.20	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	7	9	16					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	6	8	11	19					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	7	9	12	21					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148572.353 m	*Easting :*682063.156 m
Reduced Level (m):(+)212.949	*BH. No. :*BH-P16	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.20	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									11.20m		
11.5	11.5	SPT-4	7	10	14	24					
12.0											
12.5											
13.0	13	UDS*									
13.5											
14.0											
14.5	14.5	SPT-5	9	13	18	31	Brown, Medium dense to dense, Silty sand	SM			
15.0											
15.5											
16.0	16	UDS-5									
16.5											
17.0											
17.5	17.5	SPT-6	12	16	23	39					
18.0											
18.5											
19.0	19	SPT-7	22	34	43	77					
19.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148572.353 m	*Easting :*682063.156 m
Reduced Level (m):(+)212.949	*BH. No. :*BH-P16	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.20	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	29	63	37 (9cm)	>100					
21.0											
21.5											
22.0	22	SPT-9	31	65	35 (8cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-10	30	67	33 (11cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
24.0											
24.5											
25.0	25	SPT-11	27	55	45 (8cm)	>100					
25.5											
26.0											
26.5	26.5	SPT-12	38	62	38 (11cm)	>100					
27.0											
27.5											
28.0	28	SPT-13	33	60	40 (9cm)	>100	Brown, Very dense, Silty sand	SM			
28.5											
29.0											
29.5	29.5	SPT-14	33	46	44	90					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148585.419 m	*Easting :*682060.182 m
Reduced Level (m):(+)213.184	*BH. No. :*BH-P17	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	3	2	5					
1.5											
2.0							Brown, Medium stiff, Silty clay of low plasticity	CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	7	10	17					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	8	12	20	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	10	14	24					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148585.419 m	*Easting :*682060.182 m
Reduced Level (m):(+)213.184	*BH. No. :*BH-P17	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									10.80m		
11.5	11.5	SPT-5	9	11	16	27					
12.0											
12.5											
13.0	13	SPT-6	9	13	18	31					
13.5							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
14.0											
14.5	14.5	SPT-7	11	14	20	34					
15.0											
15.5											
16.0	16	SPT-8	12	15	21	36					
16.5											
17.0											
17.5	17.5	UDS-4									
18.0											
18.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.0	19	SPT-9	43	68	32 (3cm)	>100					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148585.419 m	*Easting :*682060.182 m
Reduced Level (m):(+)213.184	*BH. No. :*BH-P17	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
20.0											
20.5	20.5	SPT-10	35	55	45 (10cm)	>100					
21.0											
21.5											
22.0	22	SPT-11	33	53	47 (9cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-12	36	62	38 (5cm)	>100					
24.0											
24.5											
25.0	25	SPT-13	38	65	35 (9cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-14	34	67	33 (9cm)	>100					
27.0											
27.5											
28.0	28	SPT-15	30	75	25 (5cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-16	39	68	32 (3cm)	>100					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148598.485 m	*Easting :*682057.209 m
Reduced Level (m):(+)213.517	*BH. No. :*BH-P18	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	6	9	15					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	7	9	11	20					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	12	14	26					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148598.485 m	*Easting :*682057.209 m
Reduced Level (m):(+)213.517	*BH. No. :*BH-P18	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5									10.50m		
11.0											
11.5	11.5	SPT-4	10	14	16	30					
12.0											
12.5											
13.0	13	SPT-5	8	13	17	30					
13.5							Brown, Hard, Silty clay of low plasticity	CL			
14.0											
14.5	14.5	SPT-6	11	15	19	34					
15.0											
15.5											
16.0	16	SPT-7	9	14	20	34					
16.5											
17.0											
17.5	17.5	SPT-8	37	67	33 (5cm)	>100					
18.0											
18.5											
19.0	19	SPT-9	35	65	35 (7cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148598.485 m	*Easting :*682057.209 m
Reduced Level (m):(+)213.517	*BH. No. :*BH-P18	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-10	36	65	35 (3cm)	>100					
21.0											
21.5											
22.0	22	SPT-11	36	66	34 (10cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-12	38	68	32 (6cm)	>100					
24.0											
24.5											
25.0	25	SPT-13	31	59	41 (9cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-14	39	59	44 (11cm)	>100					
27.0											
27.5											
28.0	28	SPT-15	32	58	42 (8cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-16	48	69	31 (12cm)	>100					
30.0	30	-									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148611.551 m	*Easting :*682054.236 m
Reduced Level (m):(+)213.504	*BH. No. :*BH-P19	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	5	6	11					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	7	7	14					
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	9	10	19					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	7	10	13	23					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148611.551 m	*Easting :*682054.236 m
Reduced Level (m):(+)213.504	*BH. No. :*BH-P19	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-5	8	11	20	31			11.50m		
12.0											
12.5											
13.0	13	SPT-6	9	13	18	31	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
13.5											
14.0											
14.5	14.5	SPT-7	7	11	16	27					
15.0											
15.5											
16.0	16	SPT-8	8	12	19	31					
16.5											
17.0											
17.5	17.5	UDS-4									
18.0							Brown, Hard, Silty clay of medium plasticity	CL			
18.5											
19.0	19	SPT-9	11	14	21	35					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148611.551 m	*Easting :*682054.236 m
Reduced Level (m):(+)213.504	*BH. No. :*BH-P19	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-10	64	36 (9cm)	-	>100	Brown, Hard, Silty clay of medium plasticity	CL			
21.0											
21.5											
22.0	22	SPT-11	56	44 (8cm)	-	>100					
22.5											
23.0											
23.5	23.5	SPT-12	59	41 (7cm)	-	>100					
24.0											
24.5											
25.0	25	SPT-13	54	46 (5cm)	-	>100					
25.5							Brown, Very dense, Silty sand	SM			
26.0											
26.5	26.5	SPT-14	22	56	44 (3cm)	>100					
27.0											
27.5											
28.0	28	SPT-15	24	51	49 (10cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-16	33	64 (10cm)	-	>100					
30.0	30										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148626.567 m	*Easting :*682050.819 m
Reduced Level (m):(+)213.090	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	SPT-1	4	6	8	14					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	8	11	15	26					
6.0											
6.5											
7.0	7	UDS-3					Brown, Very stiff, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	SPT-3	7	10	17	27					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148626.567 m	*Easting :*682050.819 m
Reduced Level (m):(+)213.090	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									10.90m		
11.5	11.5	SPT-4	8	11	19	30					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	9	13	21	34					
15.0							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	11	14	19	33					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148626.567 m	*Easting :*682050.819 m
Reduced Level (m):(+)213.090	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	12	15	21	36	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
21.0											
21.5											
22.0	22	SPT-8	70	30 (9cm)	-	>100					
22.5											
23.0											
23.5	23.5	SPT-9	66	34 (7cm)	-	>100					
24.0											
24.5											
25.0	25	SPT-10	19	25	29	54					
25.5											
26.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
26.5	26.5	SPT-11	24	45	55 (13cm)	>100					
27.0											
27.5											
28.0	28	SPT-12	29	49	50	99					
28.5											
29.0											
29.5	29.5	SPT-13	25	79	21 (3cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148626.567 m	*Easting :*682050.819 m
Reduced Level (m):(+)213.090	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-14	26	76	34 (5cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-15	28	71	29 (4cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
33.0											
33.5											
34.0	34	SPT-16	31	69	31 (7cm)	>100					
34.5											
35.0	35	SPT-17	37	76	34 (8cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+191 km	*Northing :*3149257.396 m	*Easting :*681895.083 m
Reduced Level (m):(+)212.823	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	3	6					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	5	7	9	16					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	14	17	31					
7.5											
8.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	13	20	26	46					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149467.024 m	*Easting :*681858.38 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*100 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	7	10	17					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	8	11	13	24	Brown, Medium dense TO DENSE, Sandy silt of low plasticity	ML-CL			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	14	18	32					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	18	21	25	46					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149467.024 m	*Easting :*681858.38 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*100 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS*									
12.0											
12.5											
13.0	13	SPT-5	17	22	26	48					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0							Brown, Hard, Silty clay of low plasticity	CL			
15.5											
16.0	16	SPT-6	20	24	28	52					
16.5											
17.0											
17.5	17.5	UDS-5									
18.0											
18.5											
19.0	19	SPT-7	18	21	24	45					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149467.024 m	*Easting :*681858.38 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*100 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Hard, Silty clay of low plasticity	CL			
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-8	25	34	41	75					
22.5											
23.0											
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-9	23	31	38	69	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-8									
27.0											
27.5											
28.0	28	SPT-10	21	34	41	75					
28.5											
29.0											
29.5	29.5	UDS-9									
30.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149467.024 m	*Easting :*681858.38 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*100 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	24	35	45	80					
31.5											
32.0											
32.5	32.5	UDS-10									
33.0											
33.5											
34.0	34	SPT-12	34	55	45 (5cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-13	30	64	36 (8cm)	>100					
36.0											
36.5											
37.0	37	SPT-14	38	70	30 (11cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-15	22	29	38	67					
39.0											
39.5											
40.0	40	UDS-11									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149495.176 m	*Easting :*681844.488 m
Reduced Level (m):(+)214.371	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	8	9	17					
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	10	14	16	30					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	15	18	22	40	Brown, Hard, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149495.176 m	*Easting :*681844.488 m
Reduced Level (m):(+)214.371	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-08-2021	*Date of Completion :*18-08-2021	

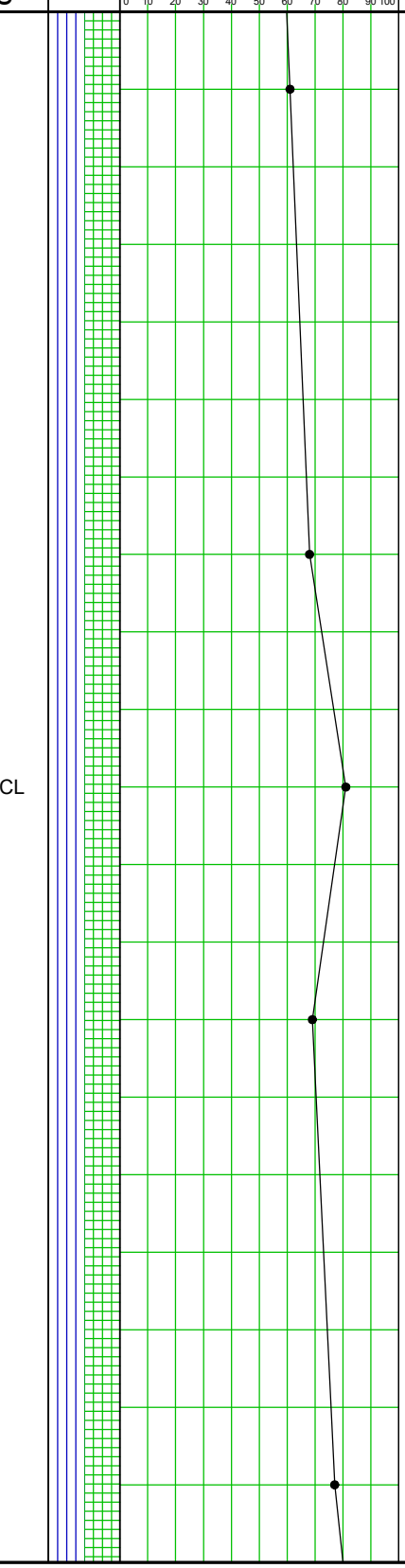
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	17	21	24	45			11.60m		
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	19	23	26	49	Brown, Hard, Silty clay of low plasticity	CL			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	18	25	29	54					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149495.176 m	*Easting :*681844.488 m
Reduced Level (m):(+)214.371	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	15	28	33	61					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	20	30	38	68					
24.0											
24.5											
25.0	25	UDS*	28	39	42	81	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-10	23	32	37	69					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0											
29.5	29.5	SPT-11	27	36	41	77					
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149495.176 m	*Easting :*681844.488 m
Reduced Level (m):(+)214.371	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	UDS*	24	39	47	86					
31.5											
32.0											
32.5	32.5	SPT-13	34	51	49 (2cm)	>100					
33.0											
33.5											
34.0	34	UDS*	40	65	35 (10cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	UDS*	31	72	28 (11cm)	>100					
36.0											
36.5											
37.0	37	UDS*	36	67	33 (10cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-14	23	32	41	73					
39.0											
39.5											
40.0	40	UDS-10									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149522.156 m	*Easting :*681840.419 m
Reduced Level (m):(+)213.108	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.70	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	5	8	11	19					
1.5											
2.0							Brown, Medium dense, Silty sand with clay	SM-SC			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	6	10	16	26					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	12	15	27	Brown, Very stiff, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	7	13	17	30					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149522.156 m	*Easting :*681840.419 m
Reduced Level (m):(+)213.108	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.70	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Very stiff, Silty clay of low plasticity	CL	▼10.70m		
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	8	16	22	38					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
16.0	16	SPT-6	12	19	26	45					
16.5											
17.0											
17.5	17.5	UDS*									
18.0											
18.5											
19.0	19	SPT-7	20	27	36	63					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149522.156 m	*Easting :*681840.419 m
Reduced Level (m):(+)213.108	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.70	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-8	18	26	32	58					
22.5											
23.0											
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-9	21	27	37	64	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-8									
27.0											
27.5											
28.0	28	SPT-10	80	20 (12cm)	-	>100					
28.5											
29.0											
29.5	29.5	SPT-11	42	62	38 (5cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149522.156 m	*Easting :*681840.419 m
Reduced Level (m):(+)213.108	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.70	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
30.0											
30.5											
31.0	31	SPT-12	70	30 (8cm)	-	>100					
31.5											
32.0											
32.5	32.5	SPT-13	48	72	28 (10cm)	>100					
33.0											
33.5											
34.0	34	SPT-14	36	52	48 (10cm)	>100					
34.5											
35.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-15	77	23 (9cm)	-	>100					
36.0											
36.5											
37.0	37	SPT-16	59	41 (12cm)	-	>100					
37.5											
38.0											
38.5	38.5	SPT-17	60	40 (8cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-18	73	27 (6cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149565 m	*Easting :*681840 m
Reduced Level (m):(+)214.145	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	6	8	14					
3.0											
3.5							Brown, Medium dense, Silty sand	SM			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	6	7	9	16					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	10	15	18	33	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149565 m	*Easting :*681840 m
Reduced Level (m):(+)214.145	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									11.00m		
11.5	11.5	SPT-4	12	18	20	38					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	13	19	21	40					
15.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	18	24	29	53					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149565 m	*Easting :*681840 m
Reduced Level (m):(+)214.145	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	26	38	42	80					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	24	36	48	84					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	28	42	58	100					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	36	68	32 (10cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149565 m	*Easting :*681840 m
Reduced Level (m):(+)214.145	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-11	58	58	42 (8cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-12	62	58	42 (10cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	68	48	52 (5cm)	>100					
34.5											
35.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	43	63	42	105					
36.0											
36.5											
37.0	37	SPT-15	39	72	35 (4cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	42	80	20 (8cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	65	76	24 (10cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149594.593 m	*Easting :*681837.92 m
Reduced Level (m):(+)214.312	*BH. No. :*BH-P4	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	6	8	11	19					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	8	10	14	24					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	16	19	35					
7.5											
8.0							Brown, Dense, Sandy silt of low plasticity	ML-CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	17	20	23	43					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149594.593 m	*Easting :*681837.92 m
Reduced Level (m):(+)214.312	*BH. No. :*BH-P4	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-5	19	22	26	48	Brown, Dense, Sandy silt of low plasticity	ML-CL			
12.0									11.90m		
12.5											
13.0	13	SPT-6	18	25	29	54					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0											
15.5											
16.0	16	SPT-7	21	27	31	58					
16.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
17.0											
17.5	17.5	UDS-5									
18.0											
18.5											
19.0	19	SPT-8	14	24	29	53					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149594.593 m	*Easting :*681837.92 m
Reduced Level (m):(+)214.312	*BH. No. :*BH-P4	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-9	26	30	36	66					
22.5											
23.0											
23.5	23.5	UDS*									
24.0											
24.5											
25.0	25	SPT-10	22	35	43	78	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-7									
27.0											
27.5											
28.0	28	SPT-11	24	38	40	78					
28.5											
29.0											
29.5	29.5	UDS-8									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149594.593 m	*Easting :*681837.92 m
Reduced Level (m):(+)214.312	*BH. No. :*BH-P4	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-12	26	34	48	82					
31.5											
32.0											
32.5	32.5	UDS-9									
33.0											
33.5											
34.0	34	SPT-13	38	55	45 (9cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	43	70	30 (4cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	32	53	47 (11cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	30	58	42 (8cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	26	41	48	89					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149620.114 m	*Easting :*681834.868 m
Reduced Level (m):(+)213.726	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	5	8					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	10	15	25					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Brown, Medium dense, Silty sand	SM			
7.0	7	SPT-3	9	13	18	31					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Hard, Silty clay of low plasticity	CL			
10.0	10	SPT-4	12	18	21	39					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149620.114 m	*Easting :*681834.868 m
Reduced Level (m):(+)213.726	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									12.00m		
12.5											
13.0	13	SPT-5	14	17	20	37					
13.5							Brown, Hard, Silty clay of low plasticity	CL			
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	11	15	19	34					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.0	19	SPT-7	17	24	27	51					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149620.114 m	*Easting :*681834.868 m
Reduced Level (m):(+)213.726	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	20	26	30	56					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	28	31	36	67	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	34	40	49	89					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149620.114 m	*Easting :*681834.868 m
Reduced Level (m):(+)213.726	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-11	42	52	48 (10cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-12	40	54	46 (10cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	36	47	53	100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	40	49	51	100					
36.0											
36.5											
37.0	37	SPT-15	42	45	55 (11cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	37	47	53 (9cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	52	48 (10cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149645.522 m	*Easting :*681836.405 m
Reduced Level (m):(+)213.711	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	9	7	9	16					
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	9	11	16	27					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	14	17	19	36	Brown, Hard, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149645.522 m	*Easting :*681836.405 m
Reduced Level (m):(+)213.711	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

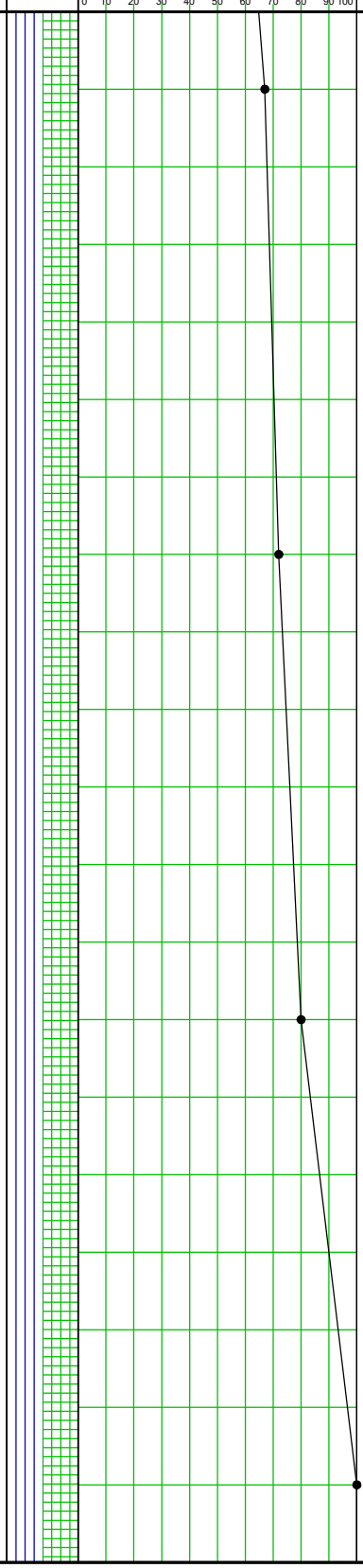
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0									11.00m		
11.5	11.5	SPT-4	16	19	24	43					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	19	24	27	51	Brown, Hard, Silty clay of low plasticity	CL			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	21	25	29	54					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149645.522 m	*Easting :*681836.405 m
Reduced Level (m):(+)213.711	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	25	30	37	67					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	29	38	39	72					
24.0											
24.5											
25.0	25	UDS-9					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	30	35	45	80					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	54	46 (10cm)	-	>100					
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149645.522 m	*Easting :*681836.405 m
Reduced Level (m):(+)213.711	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-11	58	42 (8cm)	-	>100					
31.5											
32.0											
32.5	32.5	SPT-12	50	50 (9cm)	-	>100					
33.0											
33.5											
34.0	34	SPT-13	54	46 (8cm)	-	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	41	53	47 (10cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	45	57	43 (7cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	55	45 (10cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-17	57	43 (9cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149673.452 m	*Easting :*681833.809 m
Reduced Level (m):(+)214.044	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

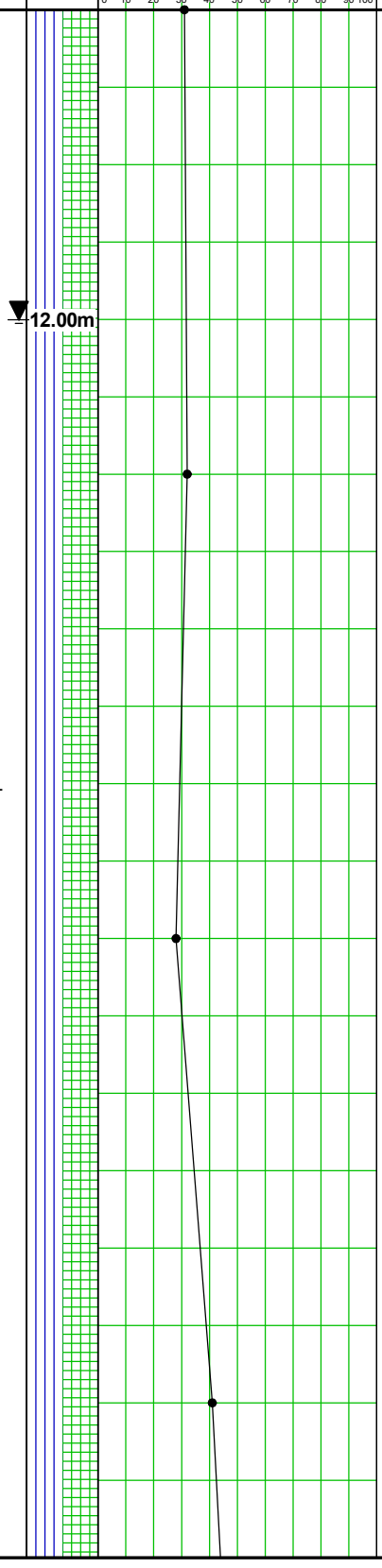
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	5	6	7	13					
1.5											
2.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	8	12	14	26					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	9	13	18	31	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	12	19	31					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149673.452 m	*Easting :*681833.809 m
Reduced Level (m):(+)214.044	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									12.00m		
12.5											
13.0	13	SPT-5	7	14	18	32					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	9	11	17	28					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	12	18	23	41					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149673.452 m	*Easting :*681833.809 m
Reduced Level (m):(+)214.044	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	UDS-7					Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
21.0											
21.5											
22.0	22	SPT-8	17	21	29	50					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	20	24	31	55	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	21	24	34	58					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149673.452 m	*Easting :*681833.809 m
Reduced Level (m):(+)214.044	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	22	27	38	65					
31.5											
32.0											
32.5	32.5	UDS-11									
33.0											
33.5											
34.0	34	SPT-12	27	48	51	99					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-13	38	54	46 (6cm)	>100					
36.0											
36.5											
37.0	37	SPT-14	48	60	40 (8cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-15	53	47 (11cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-16	30 (3cm)	-	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+837 km	*Northing :*3149897.982 m	*Easting :*681823.952 m
Reduced Level (m):(+)213.610	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	2	4	6					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	8	14	22					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	12	20	32	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	11	19	28	47					

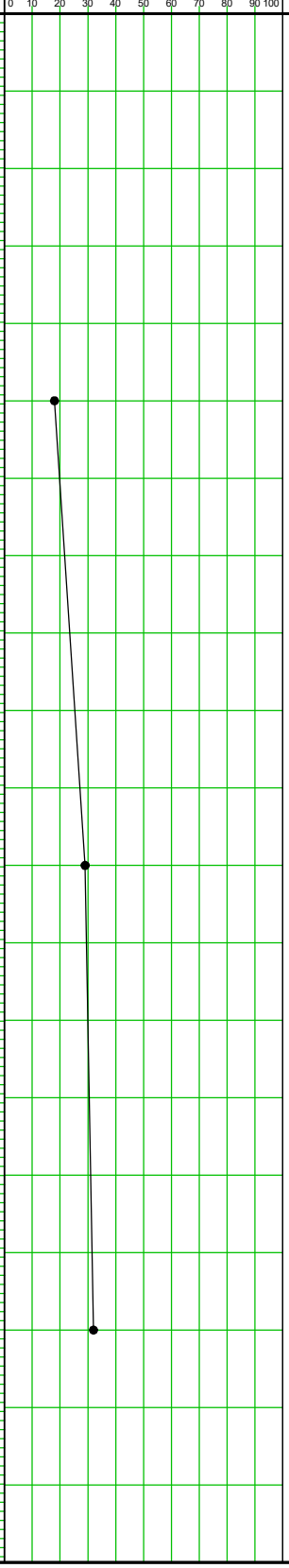
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*59+071 km	*Northing :*3150131.892 m	*Easting :*681817.835 m
Reduced Level (m):(+)213.832	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	7	11	18					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
5.5	5.5	SPT-2	6	12	17	29					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	9	13	19	32					
9.0											
9.5											
10.0	10	UDS-4									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*59+206 km	*Northing :*3150266 m	*Easting :*681807 m
Reduced Level (m):(+)213.360	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*12.65	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	8	12	20					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	7	12	14	26					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	10	14	24					
9.0											
9.5											
10.0	10	UDS-4									

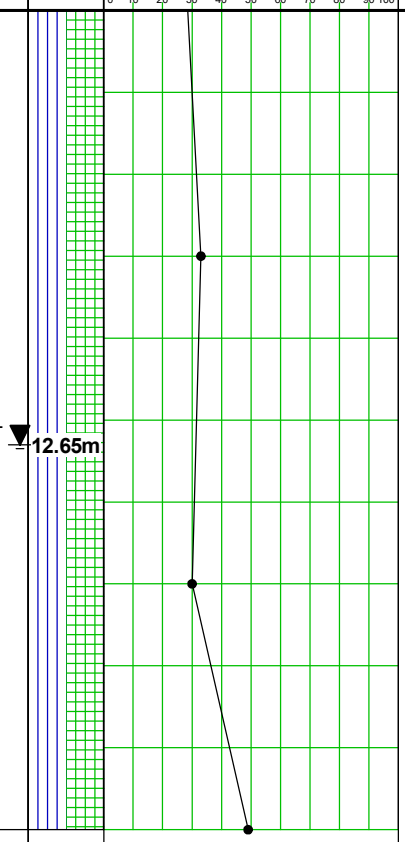
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*59+206 km	*Northing :*3150266 m	*Easting :*681807 m
Reduced Level (m):(+)213.360	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*12.65	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	12	15	18	33					
12.0											
12.5							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL	12.65m		
13.0	13	UDS*									
13.5	13.5	SPT-5	12	14	16	30					
14.0											
14.5											
15.0	15	SPT-6	17	22	27	49					



UDS*-UDS not recovered

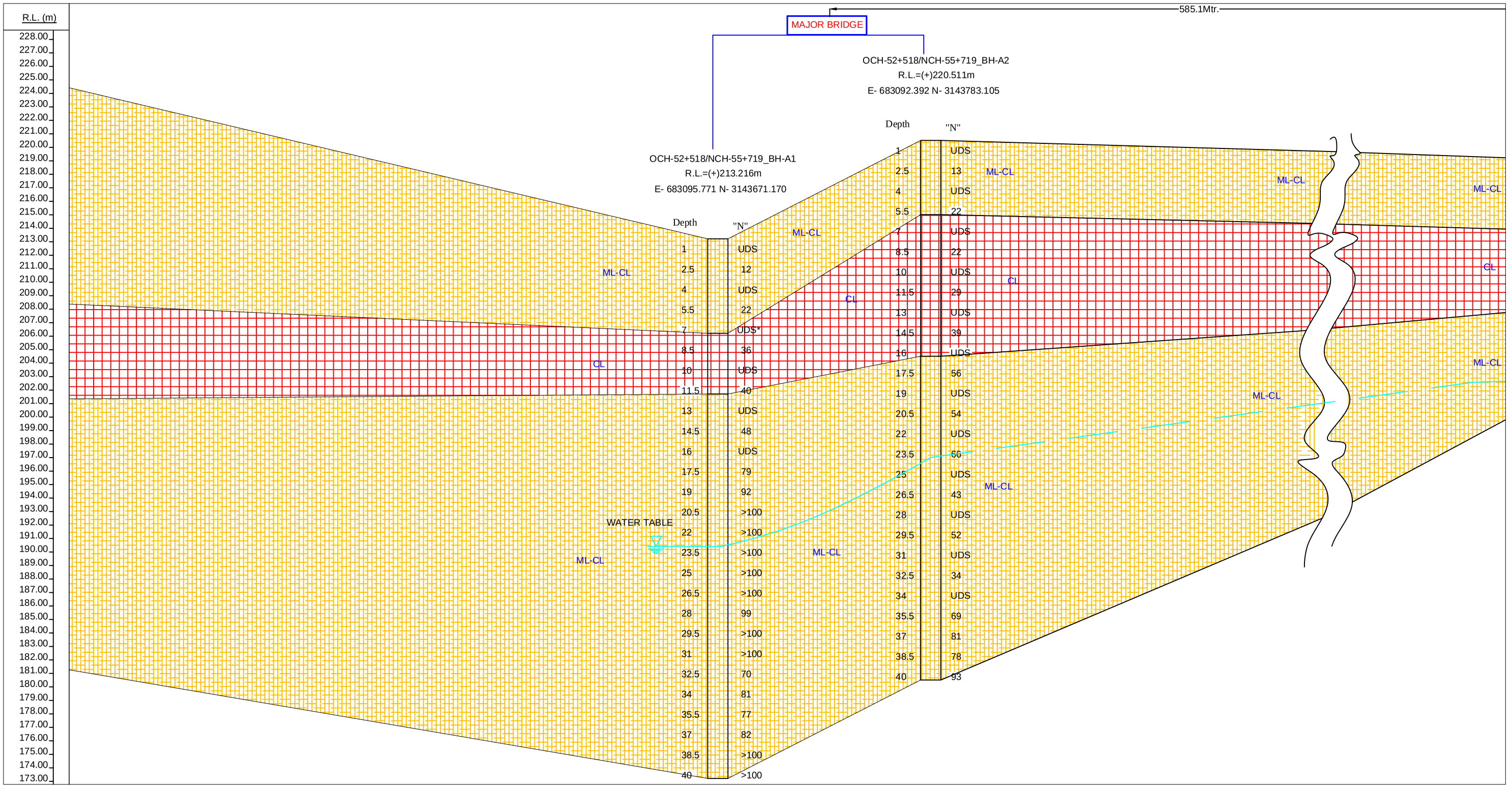
FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*59+270 km	*Northing :*3150330 m	*Easting :*681801 m
Reduced Level (m):(+)212.593	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-09-2021	*Date of Completion :*23-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	7	9	11	20					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	8	12	14	26					
4.5											
5.0							Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	15	19	20	39					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	19	20	22	42					

UDS*-UDS not recovered

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



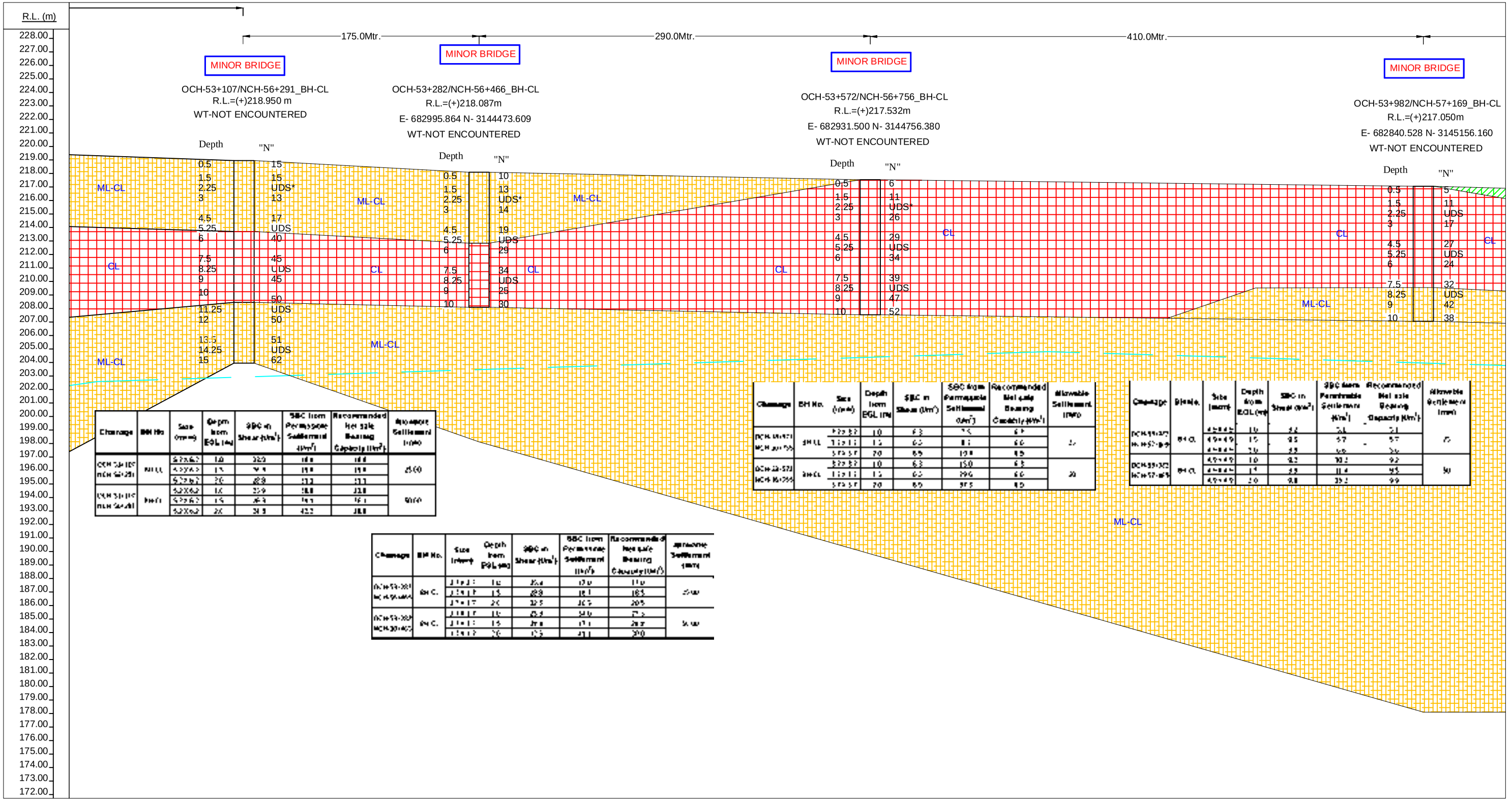
Chainage	BH no	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net Safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH 52+518 NCH 55+719	BH A1	7.2X7.2	2.0	32.0	28.1	28.1	25.00
		7.2X7.2	3.1	38.8	21.5	21.5	
		7.2X7.2	4.0	44.9	28.1	28.1	
OCH 52+518 NCH 55+719	BH A1	7.2X7.2	2.0	32.0	48.3	36.0	50.00
		7.2X7.2	3.0	35.8	47.0	36.0	
OCH 52+518 NCH 55+719	BH A2	7.2X7.2	3.0	48.0	56.3	36.0	25.00
		7.2X7.2	0.7	23.3	38.1	23.5	
		7.2X7.2	1.0	37.7	56.6	37.3	
		7.2X7.2	1.5	33.0	34.5	30.0	
OCH 52+518 NCH 55+719	BH A2	7.2X7.2	0.7	35.5	47.6	35.5	50.00
		7.2X7.2	1.0	27.2	48.2	37.2	
		7.2X7.2	1.5	33.0	48.3	40.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED
	WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-53+107/NCH-56+291	BH-CL	150x150	10	32.9	18.8	18.8	25.00
		150x150	15	34.3	19.6	19.6	
		150x150	20	38.8	22.2	22.2	
OCH-53+282/NCH-56+466	BH-CL	150x150	10	32.9	18.8	18.8	50.00
		150x150	15	36.3	19.1	19.1	
		150x150	20	38.8	22.2	18.8	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-53+572/NCH-56+756	BH-CL	150x150	10	63	35	63	25
		150x150	15	63	81	63	
		150x150	20	85	108	85	
OCH-53+982/NCH-57+169	BH-CL	150x150	10	63	150	63	50
		150x150	15	63	296	63	
		150x150	20	85	395	85	

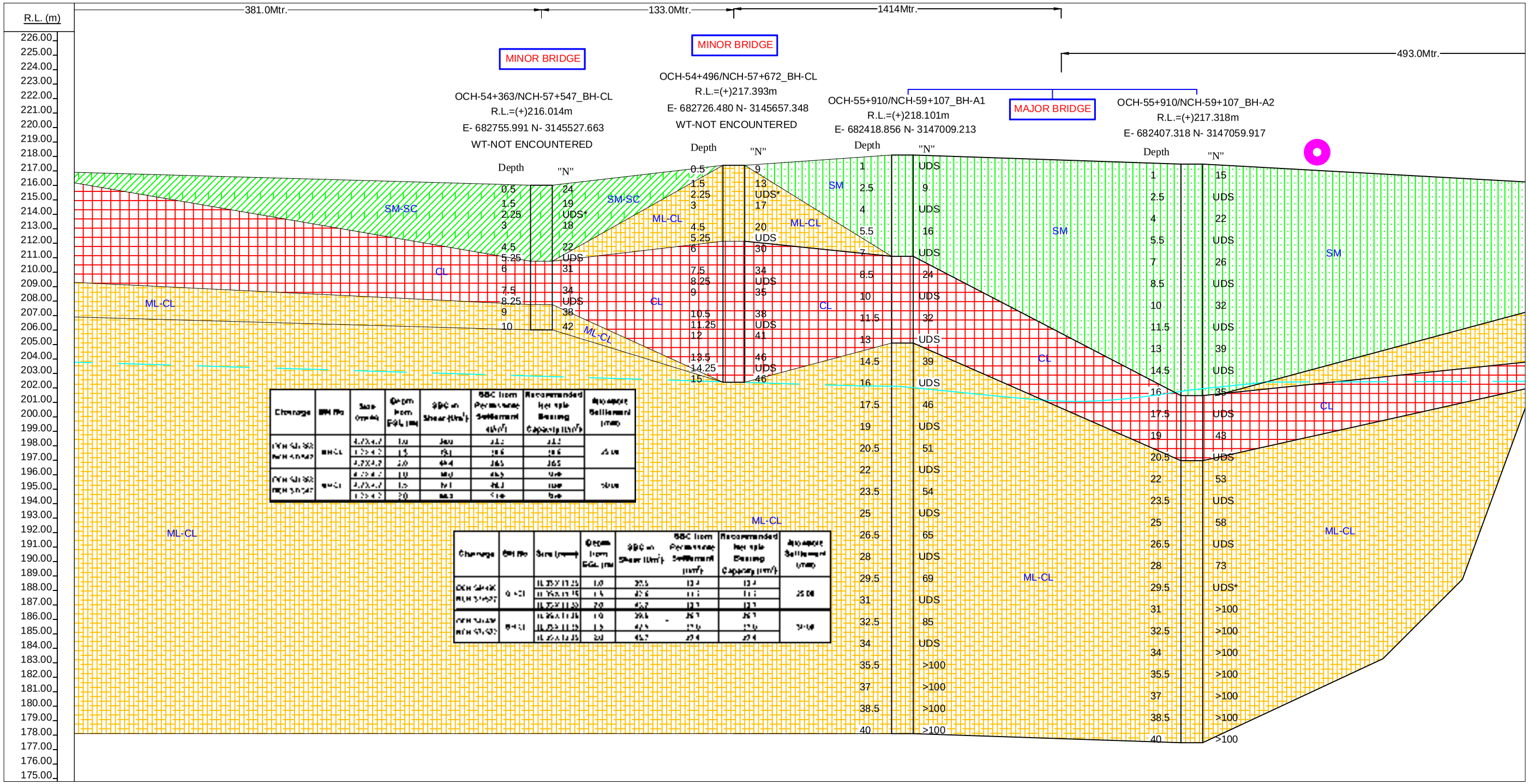
Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-53+107/NCH-56+291	BH-CL	150x150	10	32.9	18.8	18.8	25.00
		150x150	15	36.3	19.1	18.5	
		150x150	20	38.8	22.2	20.5	
OCH-53+282/NCH-56+466	BH-CL	150x150	10	32.9	18.8	17.5	50.00
		150x150	15	36.3	19.1	20.2	
		150x150	20	38.8	22.2	20.0	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-53+572/NCH-56+756	BH-CL	150x150	10	63	35	63	25
		150x150	15	63	81	63	
		150x150	20	85	108	85	
OCH-53+982/NCH-57+169	BH-CL	150x150	10	63	150	63	50
		150x150	15	63	296	63	
		150x150	20	85	395	85	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Anticipate Settlement (mm)
OCH-54+363 NCH-57+547	BH-CL	4.7X4.7	1.0	36.0	11.2	11.2	25.00
		4.7X4.7	1.5	39.1	10.6	10.6	
		4.7X4.7	2.0	40.4	16.5	16.5	
OCH-54+496 NCH-57+672	BH-CL	4.7X4.7	1.0	40.0	16.5	16.5	30.00
		4.7X4.7	1.5	39.1	16.1	16.1	
		4.7X4.7	2.0	40.3	16.6	16.6	

Chainage	BH No	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Anticipate Settlement (mm)
OCH-54+496 NCH-57+672	BH-CL	11.35X11.35	1.0	37.5	13.4	13.4	25.00
		11.35X11.35	1.5	42.6	11.1	11.1	
		11.35X11.35	2.0	45.2	13.7	13.7	
OCH-54+496 NCH-57+672	BH-CL	11.35X11.35	1.0	39.6	26.7	26.7	30.00
		11.35X11.35	1.5	42.5	27.0	27.0	
		11.35X11.35	2.0	45.7	27.4	27.4	

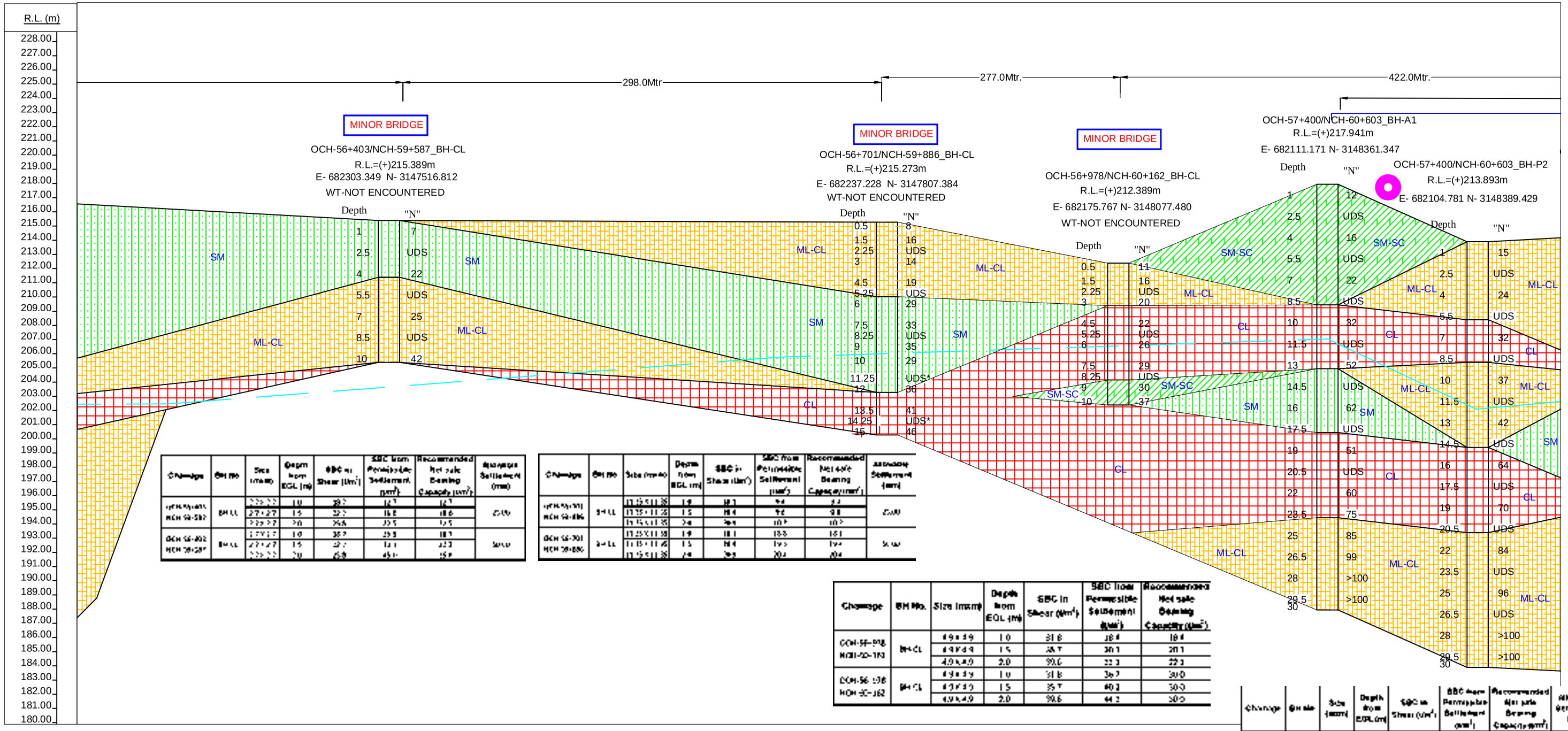
Chainage	BH No	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Anticipate Settlement (mm)
OCH-55+910 NCH-59+107	BH-A1	2.2X2.2	2.0	37.8	11.1	11.1	25.00
		2.2X2.2	3.0	39.5	12.6	12.6	
		2.2X2.2	4.0	40.8	14.4	14.4	
OCH-55+910 NCH-59+107	BH-A1	2.2X2.2	2.0	27.8	12.1	12.1	30.00
		2.2X2.2	3.0	33.8	15.0	15.0	
		2.2X2.2	4.0	40.4	16.1	16.1	
OCH-55+910 NCH-59+107	BH-A2	2.2X2.2	2.0	65.4	33.4	33.4	25.00
		2.2X2.2	3.0	77.2	26.7	26.7	
		2.2X2.2	4.0	97.5	25.1	25.1	
OCH-55+910 NCH-59+107	BH-A2	2.2X2.2	2.0	68.8	46.6	16.0	30.00
		2.2X2.2	3.0	77.2	49.4	37.0	
		2.2X2.2	4.0	82.5	52.3	16.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED
	WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-56+403/NCH-59+587	BH-CL	150 x 150	1.0	38.0	14.7	14.7	25.00
		227 x 227	1.5	38.5	18.8	18.8	
		300 x 300	2.0	39.6	19.5	19.5	
OCH-56+701/NCH-59+886	BH-CL	177 x 177	1.0	38.7	19.3	19.3	50.00
		227 x 227	1.5	39.2	19.1	19.3	
		300 x 300	2.0	39.8	19.5	19.5	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-56+701/NCH-59+886	BH-CL	177.8 x 177.8	1.0	38.7	9.4	9.4	25.00
		177.8 x 177.8	1.5	39.4	9.8	9.8	
		177.8 x 177.8	2.0	39.9	10.0	10.0	
OCH-56+701/NCH-59+886	BH-CL	177.8 x 177.8	1.0	38.7	18.3	18.3	50.00
		177.8 x 177.8	1.5	39.4	19.0	19.0	
		177.8 x 177.8	2.0	39.9	20.0	20.0	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)
OCH-56+978/NCH-60+162	BH-CL	150 x 150	1.0	38.8	18.4	18.4
		150 x 150	1.5	38.7	20.1	20.1
		150 x 150	2.0	39.6	22.3	22.3
OCH-56+978/NCH-60+162	BH-CL	150 x 150	1.0	38.8	30.0	30.0
		150 x 150	1.5	38.7	40.1	30.0
		150 x 150	2.0	39.6	44.2	30.0

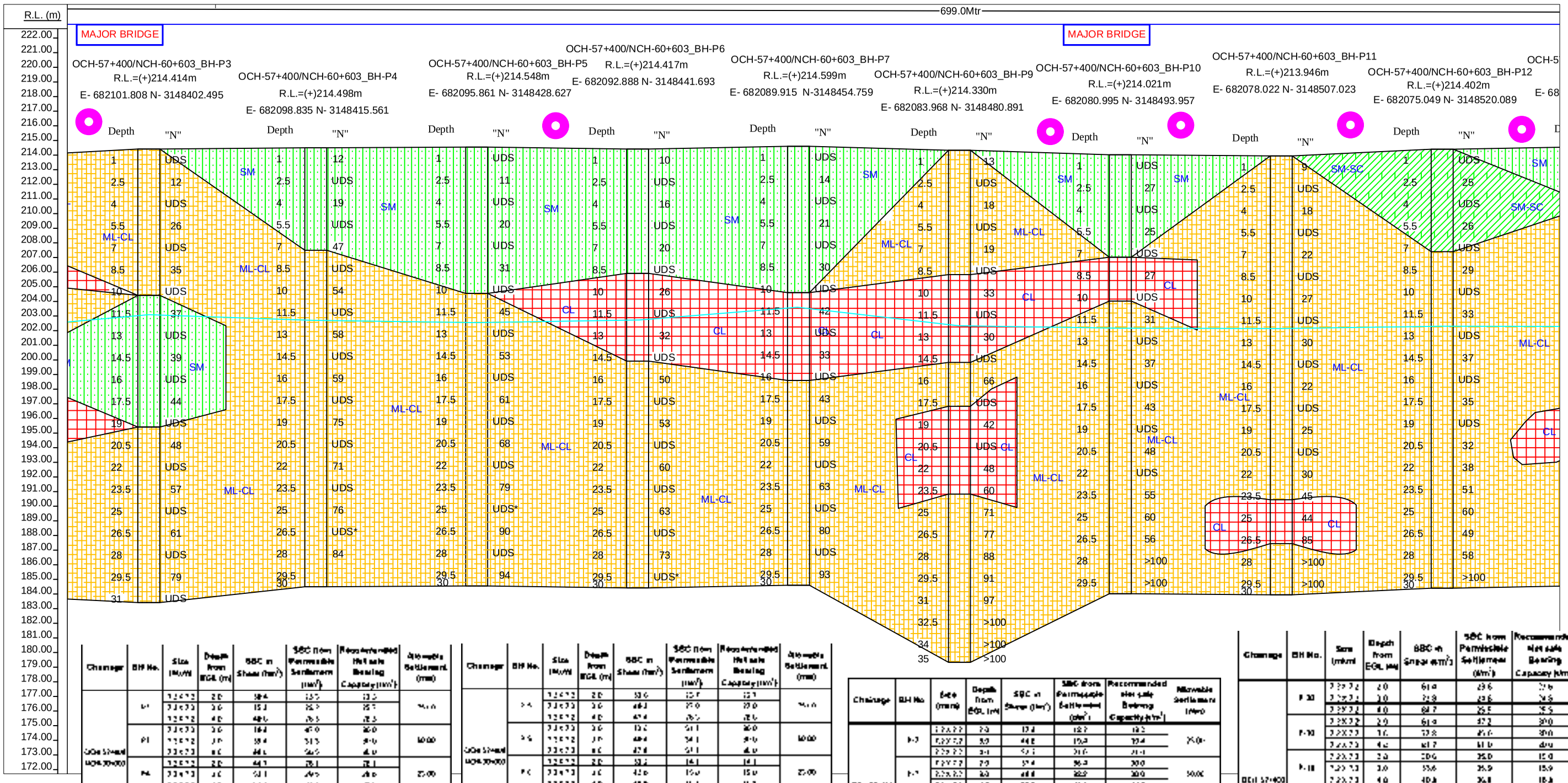
Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57+400/NCH-60+603	A1	150 x 150	1.0	38.8	18.9	18.9	25.00
		227 x 227	1.5	39.1	12.6	12.6	
		300 x 300	2.0	39.6	19.8	19.8	
	A1	150 x 150	1.0	38.8	30.0	30.0	50.00
		227 x 227	1.5	39.1	30.2	30.0	
		300 x 300	2.0	39.6	30.0	30.0	
	P2	150 x 150	1.0	38.8	18.2	18.2	25.00
		227 x 227	1.5	39.1	18.8	18.8	
		300 x 300	2.0	39.6	18.4	18.4	
	P2	150 x 150	1.0	38.8	30.0	30.0	50.00
		227 x 227	1.5	39.1	30.0	30.0	
		300 x 300	2.0	39.6	30.0	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (tm²)	SBC from Permissible Settlement (tm²)	Recommended Net safe Bearing Capacity (tm²)	Allowable Settlement (mm)
OCH-57+400 NCH-60+603	P-1	1200 CFA	2.0	18.4	13.5	13.5	50.00
			3.0	15.1	10.3	10.3	
			4.0	48.6	28.5	28.5	
	P-2		2.0	18.4	48.0	30.0	50.00
			3.0	38.4	31.5	31.5	
			4.0	44.1	36.5	36.5	
	P-4		2.0	44.1	28.1	28.1	25.00
			3.0	50.1	34.0	34.0	
			4.0	58.4	41.1	41.0	
	P-5		2.0	44.1	56.1	30.0	50.00
			3.0	50.1	32.1	32.0	
			4.0	62.1	43.5	30.0	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (tm²)	SBC from Permissible Settlement (tm²)	Recommended Net safe Bearing Capacity (tm²)	Allowable Settlement (mm)
OCH-57+400 NCH-60+603	P-6	1200 CFA	2.0	53.6	15.7	15.7	50.00
			3.0	68.3	27.0	27.0	
			4.0	87.4	38.2	38.2	
	P-7		2.0	53.6	51.1	30.0	50.00
			3.0	68.4	34.1	34.0	
			4.0	87.4	51.1	46.0	
	P-9		2.0	53.2	14.1	14.1	25.00
			3.0	42.6	15.0	15.0	
			4.0	49.9	16.1	16.1	
	P-10		2.0	15.7	28.1	28.1	50.00
			3.0	42.6	30.0	30.0	
			4.0	48.9	32.5	30.0	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (tm²)	SBC from Permissible Settlement (tm²)	Recommended Net safe Bearing Capacity (tm²)	Allowable Settlement (mm)
OCH-57+400 NCH-60+603	P-3	1200 CFA	2.0	13.4	12.7	12.7	25.00
			3.0	44.8	15.3	13.4	
			4.0	52.1	21.6	21.6	
	P-7		2.0	57.4	36.3	30.0	50.00
			3.0	68.8	38.2	30.0	
			4.0	85.3	41.1	30.0	
	P-9		2.0	41.6	15.2	15.2	25.00
			3.0	48.1	16.7	16.7	
			4.0	56.1	18.1	18.1	
	P-5		2.0	42.6	31.4	30.0	50.00
			3.0	48.1	33.3	30.0	
			4.0	56.0	36.2	30.0	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (tm²)	SBC from Permissible Settlement (tm²)	Recommended Net safe Bearing Capacity (tm²)	Allowable Settlement (mm)
OCH-57+400 NCH-60+603	P-10	1200 CFA	2.0	61.8	23.6	23.6	25.00
			3.0	71.8	23.6	23.6	
			4.0	84.7	25.5	25.5	
	P-11		2.0	61.8	37.2	30.0	50.00
			3.0	73.8	45.0	30.0	
			4.0	81.7	61.0	45.0	
	P-12		2.0	20.6	35.0	15.0	25.00
			3.0	53.6	35.9	15.9	
			4.0	40.8	36.8	16.8	
	P-13		2.0	50.6	30.1	30.0	50.00
			3.0	53.6	31.1	30.0	
			4.0	40.8	31.9	30.0	
	P-14		2.0	65.3	27.6	27.6	25.00
			3.0	80.6	28.4	28.4	
			4.0	91.1	27.6	27.6	
	P-15		2.0	69.3	35.1	30.0	50.00
			3.0	80.6	35.7	30.0	
			4.0	91.1	35.5	30.0	

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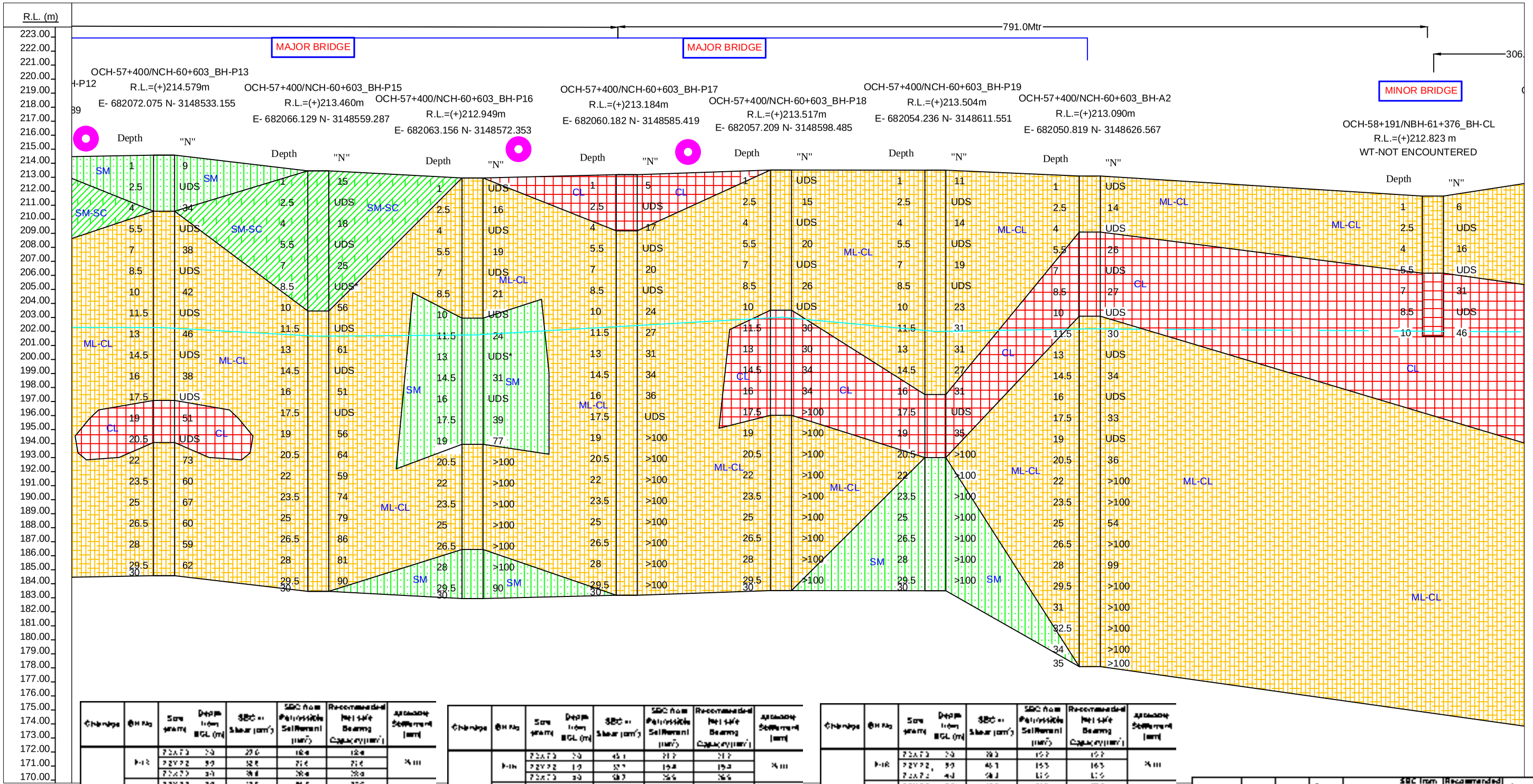
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	Cl- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No	Sample from	Depth from EGL (m)	SBC w.r. Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Anticipated Settlement (mm)
OCH-57+400/NCH-60+603	P-13	2.0 x 2.0	3.0	20.6	18.4	18.4	25.00
		2.0 x 2.0	6.0	32.8	21.6	21.6	
		2.0 x 2.0	9.0	38.8	28.8	28.8	
	P-14	2.0 x 2.0	3.0	17.6	16.2	16.2	50.00
		2.0 x 2.0	6.0	13.6	09.2	09.2	
		2.0 x 2.0	9.0	38.4	36.7	36.7	
	P-15	2.0 x 2.0	3.0	20.5	21.3	21.3	25.00
		2.0 x 2.0	6.0	26.1	24.6	24.6	
		2.0 x 2.0	9.0	30.1	26.5	26.5	
	P-16	2.0 x 2.0	3.0	38.5	40.5	30.0	50.00
		2.0 x 2.0	6.0	46.1	32.7	30.0	
		2.0 x 2.0	9.0	58.3	52.0	30.0	

Chainage	BH No	Sample from	Depth from EGL (m)	SBC w.r. Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Anticipated Settlement (mm)
OCH-57+400/NCH-60+603	P-16	2.0 x 2.0	3.0	45.1	21.7	21.7	25.00
		2.0 x 2.0	6.0	32.7	19.8	19.8	
		2.0 x 2.0	9.0	58.3	36.6	36.6	
	P-17	2.0 x 2.0	3.0	44.1	31.5	30.0	50.00
		2.0 x 2.0	6.0	38.3	38.9	30.0	
		2.0 x 2.0	9.0	58.3	50.0	30.0	
	P-18	2.0 x 2.0	3.0	18.8	9.6	9.6	25.00
		2.0 x 2.0	6.0	22.8	7.9	7.8	
		2.0 x 2.0	9.0	26.6	12.7	12.7	
	P-19	2.0 x 2.0	3.0	13.8	10.2	10.2	50.00
		2.0 x 2.0	6.0	20.8	15.9	15.9	
		2.0 x 2.0	9.0	25.5	25.5	25.5	

Chainage	BH No	Sample from	Depth from EGL (m)	SBC w.r. Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Anticipated Settlement (mm)
OCH-57+400/NCH-60+603	P-18	2.0 x 2.0	3.0	28.3	19.2	19.2	25.00
		2.0 x 2.0	6.0	32.8	16.5	16.5	
		2.0 x 2.0	9.0	58.3	41.5	41.5	
	P-19	2.0 x 2.0	3.0	38.2	31.5	30.0	50.00
		2.0 x 2.0	6.0	45.1	30.0	30.0	
		2.0 x 2.0	9.0	58.3	50.1	30.0	
	A2	2.0 x 2.0	3.0	23.7	15.9	15.9	25.00
		2.0 x 2.0	6.0	5.2	15.9	15.9	
		2.0 x 2.0	9.0	29.9	17.7	17.7	
	A-1	2.0 x 2.0	3.0	32.1	31.9	22.1	50.00
		2.0 x 2.0	6.0	35.2	35.6	25.7	
		2.0 x 2.0	9.0	39.5	35.5	38.5	
	A2	2.0 x 2.0	3.0	58.1	13.7	16.7	25.00
		2.0 x 2.0	6.0	22.6	18.1	18.1	
		2.0 x 2.0	9.0	45.3	19.0	19.0	
	A-1	2.0 x 2.0	3.0	58.1	31.4	30.0	50.00
		2.0 x 2.0	6.0	58.3	35.1	30.0	
		2.0 x 2.0	9.0	45.3	40.0	40.0	

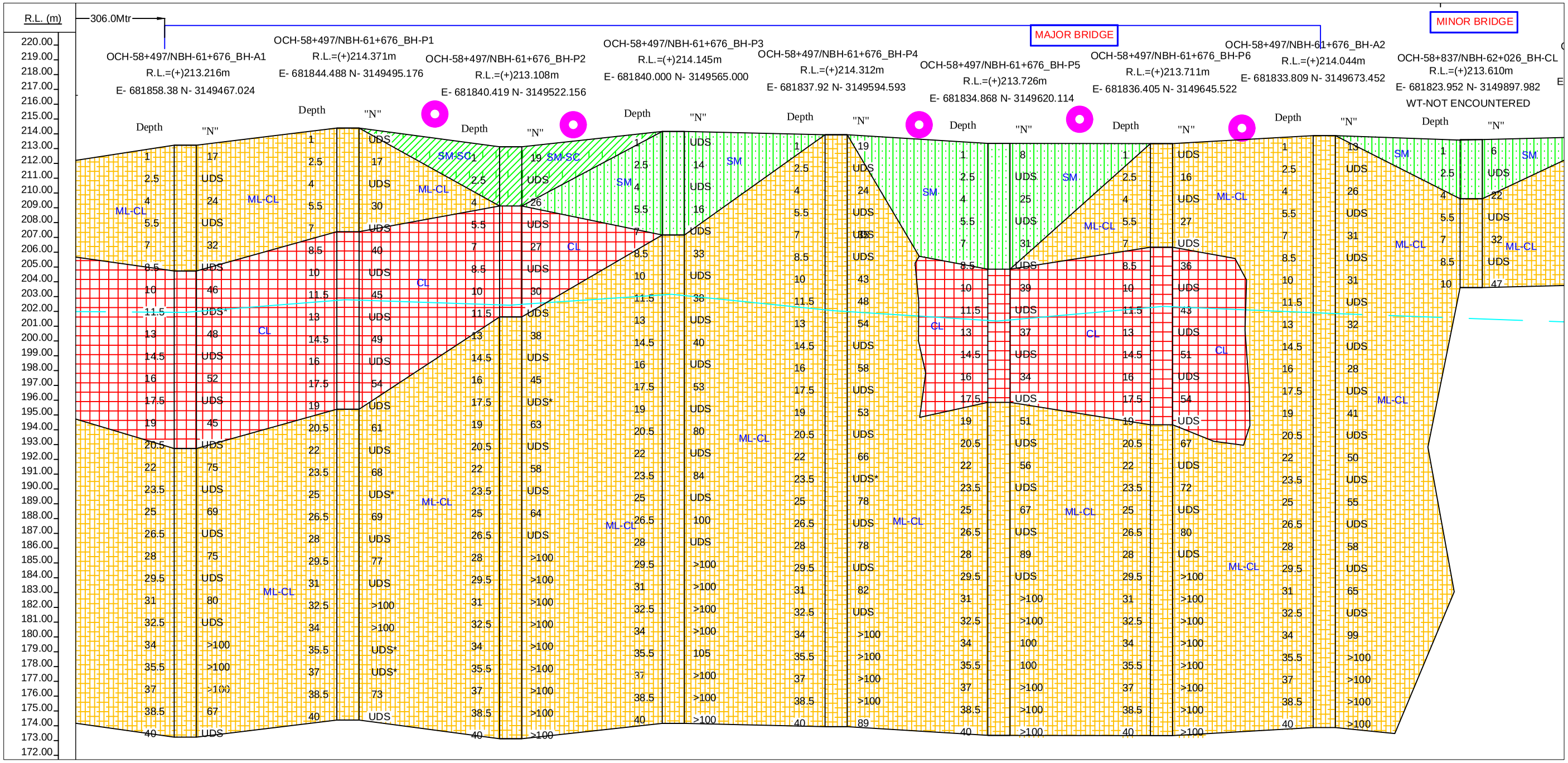
Chainage	BH No	Sample from	Depth from EGL (m)	SBC w.r. Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Anticipated Settlement (mm)
OCH-58+191/NBH-61+376	BH-CL	2.0 x 2.0	3.0	31.2	11.3	11.3	25.00
		2.0 x 2.0	6.0	23.1	12.1	12.1	
		2.0 x 2.0	9.0	32.1	13.4	13.4	
OCH-58+191/NBH-61+376	BH-CL	2.0 x 2.0	3.0	21.7	12.9	11.2	50.00
		2.0 x 2.0	6.0	34.1	24.1	24.1	
		2.0 x 2.0	9.0	42.1	25.8	25.8	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



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	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

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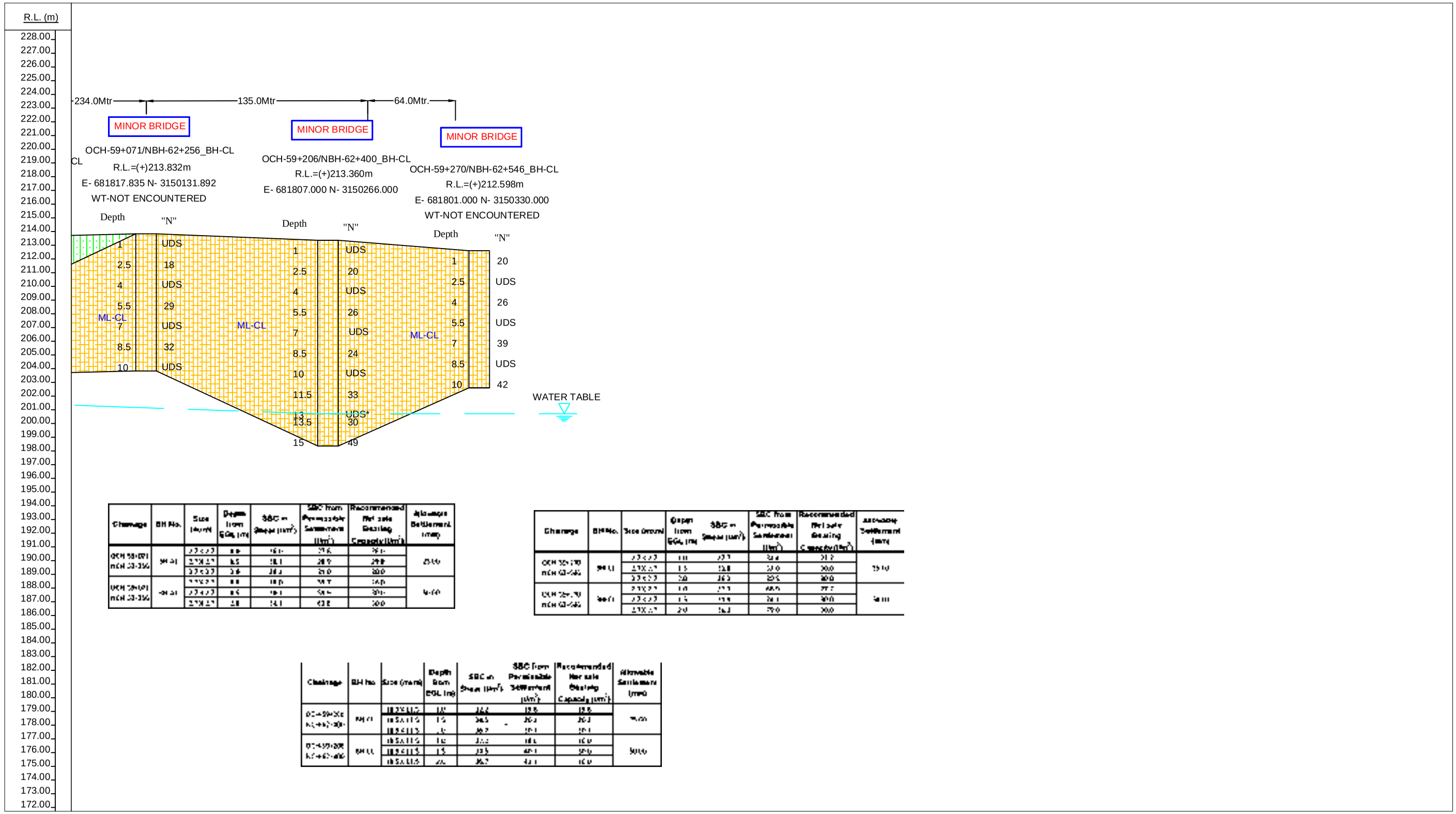

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-59+071 NBH-62+256	BH-01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
OCH-59+071 NBH-62+256	BH-01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-59+270 NBH-62+546	BH-01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
OCH-59+270 NBH-62+546	BH-01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Chainage	BH No.	Size (mm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-59+206 NBH-62+400	BH-01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
OCH-59+206 NBH-62+400	BH-01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
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	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED
	WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

APPENDIX – B (LAB TEST RESULTS)

Appendix No.	ITEMS
B-1	SOIL CHARACTERISTICS SHEETS
B-2	RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES
B-3	RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLES
B-4	GSD CURVES
B-5	SAMPLE SHEAR CURVE
B-6	CONSOLIDATION CURVE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-08-2021	to	24-08-2021	52+518	BH-A1	22.80 m	40.00 m	683095.771 m	3143671.170 m	(+)213.216 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		5	63	31	1	0	0	0	26	21	5	-	1.70	12.06	1.52	2.67	DST	0.20	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	12	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	58	26	2	1	7	0	26	20	6	-	1.76	12.64	1.56	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	7.00	-	-	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	10.00	-	-		CL		11	54	31	2	0	2	0	30	20	10	-	1.85	14.63	1.61	2.68	UUT	1.22	4	-	-	-	-	-	-	-	-	-
SPT-4	11.50	40	31	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	13.00	-	-		ML-CL		6	60	26	3	1	4	0	26	20	6	-	1.86	15.67	1.61	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-5	14.50	48	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	16.00	-	-		ML-CL		8	59	22	5	1	5	0	27	21	6	-	1.92	17.10	1.64	2.66	DST	0.15	27	-	-	-	-	-	-	-	-	-
SPT-6	17.50	79	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	92	54		ML-CL		7	63	24	3	1	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	100 (20cm)	-		ML-CL		6	52	30	2	3	7	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-08-2021	to	24-08-2021	52+518	BH-A1	22.80 m	40.00 m	683095.771 m	3143671.170 m	(+)213.216 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
SPT-13	28.00	99	32	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	100 (28cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	31.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	32.50	70	24		ML-CL		5	47	41	2	1	4	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	34.00	81	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	35.50	77	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	37.00	82	26		ML-CL		8	51	35	2	1	3	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	38.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-21	40.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	27-08-2021	52+518	BH-A2	23.50 m	40.00 m	683092.392 m	3143783.105 m	(+)220.511 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	50	38	2	2	1	0	27	20	7	-	1.72	12.11	1.53	2.66	DST	0.19	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		8	46	43	1	1	1	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22	Brown, Very stiff to hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		11	62	17	4	4	2	0	31	20	11	-	1.78	14.16	1.56	2.68	UUT	0.74	5	-	-	-	-	-	-	-	-	-
SPT-3	8.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		10	73	16	0	0	1	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		12	58	19	5	3	3	0	32	21	11	-	1.85	15.78	1.60	2.67	UUT	1.12	4	-	-	-	-	-	-	-	-	-
SPT-5	14.50	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	55	23	5	3	6	0	28	21	7	-	1.87	16.04	1.61	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-6	17.50	56	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	44	37	2	1	9	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	54	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	65	22	1	0	5	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	66	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	51	29	3	4	6	1	26	20	6	-	1.84	17.32	1.57	2.65	DST	0.23	25	-	-	-	-	-	-	-	-	-
SPT-9	26.50	43	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CGG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	27-08-2021	52+518	BH-A2	23.50 m	40.00 m	683092.392 m	3143783.105 m	(+)220.511 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	57	26	2	0	9	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	52	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		7	50	25	5	2	11	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	32.50	34	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-12	34.00	-	-		ML-CL		8	53	26	3	4	6	0	29	22	7	-	1.89	18.29	1.60	2.66	DST	0.17	27	-	-	-	-	-	-	-	-	-
SPT-12	35.50	69	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	37.00	81	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	38.50	78	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	40.00	93	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		15-01-2022	to	15-01-2022	53+107	BH-CL	Not Encountered	15.00 m	683034.675 m	3144302.971 m	(+)218.950 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	15	27		ML-CL	-	7	49	36	4	2	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	15	22		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	13	16		ML-CL	-	6	46	38	5	3	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	17	18		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity	CL	-	11	46	30	6	2	5	0	31	20	11	-	1.89	16.23	1.63	2.67	UUT	1.42	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	40	40		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	45	45		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL	-	12	48	24	7	3	6	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	45	45		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	50	39	Brown, Very dense, Sandy silt of low plasticity	ML-CL	-	8	44	34	5	1	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		ML-CL	-	7	45	35	4	2	7	0	26	19	7	-	1.90	17.13	1.62	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-9	12.00	50	37		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	51	36		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.25	-	-		ML-CL	-	6	46	33	4	3	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	62	41		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							14-01-2022	to	14-01-2022	53+282	BH-CL	Not Encountered	10.00 m	682995.864 m	3144473.609 m	(+)218.087 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure ($kg/cm^{2)}$	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	10	18		ML-CL		7	49	37	4	2	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	13	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	14	17		ML-CL		8	47	34	6	3	2	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	19	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	50	28	3	4	4	0	31	20	11	-	1.89	18.23	1.60	2.67	UUT	1.02	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		10	49	31	5	2	3	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	25	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	30	30		CL		11	41	37	4	3	4	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-01-2022	to	14-01-2022	53+572	BH-CL	Not Encountered	10.00 m	682931.500 m	3144756.380 m	(+)217.532 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium stiff to stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	6	6		CL		12	55	26	4	2	1	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	11	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	26	26	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	49	29	5	3	3	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		CL		13	54	22	6	1	4	0	34	23	11	-	1.91	19.34	1.60	2.67	UUT	1.09	4	-	-	-	-	-	-	-	-	-
SPT-5	6.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		11	49	25	7	2	6	0	31	20	11	-	1.97	20.26	1.64	2.68	UUT	1.65	4	-	-	-	-	-	-	-	-	-
SPT-7	9.00	47	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		12-01-2022	to	12-01-2022	53+982	BH-CL	0.60 m	10.00 m	682840.528 m	3145156.160 m	(+)217.050 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium stiff to very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	5		CL		12	56	25	5	2	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	11	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		CL		10	50	31	4	3	2	0	30	20	10	-	1.89	27.45	1.48	2.67	UUT	0.39	5	-	-	-	-	-	-	-	-	-
SPT-3	3.00	17	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	51	27	6	2	3	0	31	20	11	-	1.97	24.74	1.58	2.68	UUT	0.85	4	-	-	-	-	-	-	-	-	-
SPT-5	6.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	32	25	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL		7	45	38	3	2	5	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		ML-CL		8	43	36	6	1	6	0	28	21	7	-	1.90	19.74	1.59	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-7	9.00	42	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	38	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						11-01-2022	to	11-01-2022	54+363	BH-CL	1.48 m	10.00 m	682755.991 m	3145527.663 m	(+)216.014 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	24	43		SM-SC		5	36	46	7	3	3	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	19	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	18	20		SM-SC		6	35	44	8	4	3	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	44	31	6	3	5	0	31	20	11	-	1.99	24.65	1.60	2.67	UUT	1.09	4	-	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		7	45	36	5	2	5	0	27	20	7	-	1.90	19.74	1.59	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	38	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	42	29		ML-CL		8	44	35	4	3	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							12-01-2022	to	12-01-2022	54+496	BH-CL	1.36 m	15.00 m	682726.480 m	3145657.348 m	(+)217.393 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	9	16		ML-CL		6	47	39	5	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	13	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	17	20		ML-CL		7	46	34	8	3	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	20	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	51	28	5	1	4	0	31	20	11	-	1.98	23.85	1.60	2.67	UUT	1.09	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		10	47	31	4	3	5	0	30	20	10	-	1.99	23.66	1.61	2.68	UUT	1.26	4	-	-	-	-	-	-	-	-	-
SPT-7	9.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		CL		12	48	24	7	2	7	0	33	22	11	-	2.00	22.80	1.63	2.68	UUT	1.42	4	-	-	-	-	-	-	-	-	-
SPT-9	12.00	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.25	-	-		CL		11	49	26	5	2	7	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-08-2021	to	24-08-2021	55+910	BH-A1	16.00 m	40.00 m	682418.856 m	3147009.213 m	(+)218.101 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, loose to medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	18	72	6	4	0	0	-	Nil	NP	-	1.68	11.36	1.51	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.50	9	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	17	67	12	3	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Very stiff to Hard, Silty clay of low plasticity	CL		11	62	19	5	1	2	0	31	20	11	-	1.81	14.26	1.58	2.68	UUT	0.85	4	-	-	-	-	-	-	-	-
SPT-3	8.50	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	62	16	3	4	3	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL		9	54	23	7	2	5	0	29	22	7	-	1.83	15.28	1.59	2.66	DST	0.20	25	-	-	-	-	-	-	-	-
SPT-5	14.50	39	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	56	29	3	1	4	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	46	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		8	54	28	2	1	7	0	28	21	7	-	1.85	17.14	1.58	2.66	DST	0.18	26	-	-	-	-	-	-	-	-
SPT-7	20.50	51	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	53	28	4	2	6	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	54	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	57	27	2	1	5	2	26	20	6	-	1.87	17.91	1.59	2.67	DST	0.20	26	-	-	-	-	-	-	-	-
SPT-9	26.50	65	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-08-2021	to	24-08-2021	55+910	BH-A1	16.00 m	40.00 m	682418.856 m	3147009.213 m	(+)218.101 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	53	30	3	4	4	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	69	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		7	50	26	5	2	9	1	27	20	7	-	1.89	18.06	1.60	2.67	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-11	32.50	85	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-12	34.00	-	-		ML-CL		8	57	22	3	4	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	35.50	102 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	37.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	38.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	40.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-08-2021	to	21-08-2021	55+910	BH-A2	15.60 m	40.00 m	682407.318 m	3147059.917 m	(+)217.474 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense to dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	15	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	18	75	3	4	0	0	-	Nil	NP	-	1.75	10.69	1.58	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	26	67	5	1	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	26	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	34	60	4	2	0	0	-	Nil	NP	-	1.77	12.04	1.58	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-4	10.00	32	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM		0	32	64	1	2	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	39	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		SM		0	27	69	3	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	35	35	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		11	61	22	2	1	3	0	30	20	10	-	1.99	23.14	1.62	2.68	UUT	1.34	4	-	-	-	-	-	-	-	-	-
SPT-7	19.00	43	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	45	33	2	1	11	0	27	20	7	-	1.86	17.64	1.58	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-8	22.00	53	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		6	48	34	2	1	7	2	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	58	24				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		7	61	28	2	1	1	0	26	19	7	-	1.95	18.06	1.65	2.67	DST	0.16	28	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-08-2021	to	21-08-2021	55+910	BH-A2	15.60 m	40.00 m	682407.318 m	3147059.917 m	(+)217.474 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	73	28	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	100 (19cm)	-		ML-CL		8	44	26	3	2	9	8	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (21cm)	-		ML-CL		6	46	34	3	2	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							25-09-2021	to	25-09-2021	56+403 km		BH-C/L		Not encountered		10.00 m		682303.349 m			3147516.813 m			(+)215.389		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	7	11		SM	-	0	41	56	2	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM	-	0	40	58	1	1	0	0	-	Nil	NP	-	1.65	10.64	1.49	2.62	DST	0.00	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25	Brown, Medium dense to dense, Sandy silt of low plasticity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL	-	6	54	33	4	1	2	0	27	20	7	-	1.78	12.88	1.58	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	25	24		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL	-	7	54	31	4	1	3	0	28	21	7	-	1.83	13.46	1.61	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-4	10.00	42	34		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							10-01-2022	to	10-01-2022	56+701 Minor Bridge	BH-CL	1.40 m	15.00 m	682237.228 m	3147807.384 m	(+)215.273	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	8	14		ML-CL		7	50	37	4	2	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		6	45	39	5	3	2	0	26	20	6	-	1.80	20.16	1.50	2.65	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-3	3.00	14	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	19	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Medium dense to dense, Silty sand	SP-SM		0	12	74	8	3	3	0	-	Nil	NP	-	1.85	17.40	1.58	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-5	6.00	29	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	33	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		SP-SM		0	12	70	11	4	3	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	35	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	29	23		SM		0	15	72	6	2	5	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	11.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	12.00	36	36	Brown, Hard, Silty clay of low plasticity	CL		11	44	31	6	3	5	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	46	46		CL		12	50	26	5	2	5	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							10-01-2022	to	10-01-2022	56+978	BH-CL	1.36 m	10.00 m	682175.767 m	3148077.480 m	(+)212.389 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	11	20		ML-CL		7	46	38	5	2	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		8	44	35	7	4	2	0	28	21	7	-	1.86	19.74	1.55	2.66	DST	0.22	24	-	-	-	-	-	-	-	-	-
SPT-3	3.00	20	20	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	49	28	6	3	3	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		12	52	25	5	2	4	0	32	21	11	-	1.95	23.70	1.58	2.68	UUT	0.85	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.25	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	30	23		SM-SC		6	36	45	3	5	5	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	37	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		27-08-2021	to	27-08-2021	57+400 Major Bridge	BH-A1	10.90 m	30.00 m	682111.171 m	3148361.347 m	(+)217.941 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	12	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		6	25	61	3	1	4	0	26	20	6	-	1.73	12.64	1.54	2.65	DST	0.10	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		5	31	57	3	1	3	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	22	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	62	25	1	0	1	0	33	22	11	-	1.86	16.22	1.60	2.68	UUT	1.06	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		12	64	20	1	1	2	0	34	22	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	52	27	Brown, Very dense, Silty sand	SM		0	16	75	1	2	6	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		SM		0	17	68	3	4	8	0	-	Nil	NP	-	1.86	16.17	1.60	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-6	16.00	62	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		9	64	22	1	1	3	0	31	20	11	-	2.01	22.36	1.64	2.68	UUT	1.66	4	-	-	-	-	-	-	-	-	-
SPT-7	19.00	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		11	67	20	1	1	0	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	60	60		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	75	31	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	85	34		ML-CL		7	56	26	2	1	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	99	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							27-08-2021	to	27-08-2021	57+400 Major Bridge	BH-A1	10.90 m	30.00 m	682111.171 m	3148361.347 m	(+)217.941 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	100 (19cm)	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	53	24	1	3	11	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P2	11.85 m	30.00 m	682104.781 m	3148389.429 m	(+)213.893 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	15	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	51	36	2	3	1	0	27	20	7	-	1.78	12.41	1.58	2.67	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	24	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		9	67	11	4	3	6	0	30	20	10	-	1.83	14.26	1.60	2.69	UUT	1.10	4	-	-	-	-	-	-	-	-	-
SPT-3	7.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		7	52	33	2	3	3	0	26	19	7	-	1.84	15.22	1.60	2.67	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-4	10.00	37	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		8	56	30	1	1	4	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	42	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	50	32	4	2	1	0	31	20	11	-	2.01	21.26	1.66	2.68	UUT	2.22	4	-	-	-	-	-	-	-	-	-
SPT-6	16.00	64	64		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		10	60	26	1	1	2	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	70	70		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	56	33	1	2	2	0	26	20	6	-	1.90	17.86	1.61	2.66	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-8	22.00	84	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		7	56	29	5	1	2	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	96	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		9	62	25	2	0	2	0	27	20	7	-	1.94	18.20	1.64	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P2	11.85 m	30.00 m	682104.781 m	3148389.429 m	(+)213.893 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	100 (21cm)	-	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	29.50	100 (22cm)	-		ML-CL		7	52	27	1	3	10	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	30.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P3	11.50 m	31.00 m	682101.808 m	3148402.495 m	(+)214.414 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		8	53	37	1	1	0	0	27	20	7	-	1.71	12.36	1.52	2.67	DST	0.16	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	12	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	52	40	1	0	1	0	27	20	7	-	1.81	12.89	1.60	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		10	51	31	2	3	3	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	35	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense, Silty sand	SM		0	26	60	5	8	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	37	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		SM		0	27	71	1	1	0	0	-	Nil	NP	-	1.82	15.46	1.58	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-5	14.50	39	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		SM		0	32	65	3	0	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	44	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	44	33	3	3	10	0	27	20	7	-	1.88	18.21	1.59	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	48	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		9	49	30	2	1	9	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	57	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		8	51	27	2	4	6	2	26	19	7	-	1.90	18.62	1.60	2.67	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-9	26.50	61	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P3	11.50 m	31.00 m	682101.808 m	3148402.495 m	(+)214.414 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	52	29	3	2	7	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	79	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		9	51	27	1	2	10	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P4	11.80 m	30.00 m	682098.835 m	3148415.561 m	(+)214.498 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	12	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	16	79	3	0	2	0	-	Nil	NP	-	1.73	11.67	1.55	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	4.00	19	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	39	61	0	0	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	47	44	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	58	25	3	1	5	0	28	21	7	-	1.84	13.44	1.62	2.66	DST	0.25	25	-	-	-	-	-	-	-	-	-
SPT-4	10.00	54	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		9	51	26	2	4	8	0	29	22	7	-	1.90	18.88	1.60	2.67	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-5	13.00	58	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	53	28	3	2	5	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	59	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		7	47	30	4	2	10	0	26	19	7	-	1.93	20.14	1.61	2.67	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	75	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		8	44	33	3	1	9	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	71	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		10	43	26	4	2	15	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	76	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P4	11.80 m	30.00 m	682098.835 m	3148415.561 m	(+)214.498 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	84	32	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P5	12.00 m	30.00 m	682095.861 m	3148428.627 m	(+)214.548 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense to dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	17	80	1	1	1	0	-	Nil	NP	-	1.69	11.21	1.52	2.62	DST	0.00	28	-	-	-	-	-	-	-	-	-
SPT-1	2.50	11	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	17	79	2	1	1	0	-	Nil	NP	-	1.75	11.86	1.56	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	5.50	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	20	73	3	2	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	31	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		8	55	27	2	1	7	0	28	21	7	-	1.85	15.36	1.60	2.66	DST	0.23	25	-	-	-	-	-	-	-	-	-
SPT-4	11.50	45	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		9	60	23	3	1	4	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	53	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	44	37	2	1	9	0	27	20	7	-	1.88	17.22	1.60	2.67	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-6	17.50	61	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		6	48	39	1	1	5	0	26	21	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	68	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	52	30	1	3	7	0	27	20	7	-	1.91	18.56	1.61	2.67	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-8	23.50	79	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	90	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P5	12.00 m	30.00 m	682095.861 m	3148428.627 m	(+)214.548 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-9	28.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		6	48	32	4	2	5	3	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	94	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P6	11.40 m	30.00 m	682092.888 m	3148441.693 m	(+)214.417 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	22	72	3	2	1	0	-	Nil	NP	-	1.71	11.84	1.53	2.63	DST	0.00	28	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	34	63	2	1	0	0	-	Nil	NP	-	1.73	12.04	1.54	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	7.00	20	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Very stiff to hard, Silty clay of low plasticity	CL		12	54	23	6	1	4	0	33	22	11	-	1.84	16.22	1.58	2.67	UUT	0.90	4	-	-	-	-	-	-	-	-	-
SPT-4	10.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		11	63	20	1	2	3	0	32	21	11	-	1.96	22.26	1.60	2.68	UUT	1.03	5	-	-	-	-	-	-	-	-	-
SPT-5	13.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		10	50	31	3	1	5	0	29	22	7	-	1.90	19.94	1.58	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-6	16.00	50	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		9	42	27	7	7	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	53	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		6	50	33	3	1	7	0	26	20	6	-	1.90	20.43	1.58	2.67	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-8	22.00	60	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		8	51	29	5	1	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	63	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		7	48	32	3	1	9	0	26	19	7	-	1.92	20.84	1.59	2.67	DST	0.24	27	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P6	11.40 m	30.00 m	682092.888 m	3148441.693 m	(+)214.417 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	73	29	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P7	11.00 m	30.00 m	682089.915 m	3148454.759 m	(+)214.599 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	21	75	1	1	2	0	-	Nil	NP	-	1.71	11.63	1.53	2.62	DST	0.00	28	-	-	-	-	-	-	-	-	-
SPT-1	2.50	14	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	25	71	2	1	1	0	-	Nil	NP	-	1.74	12.06	1.55	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	5.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	24	68	4	2	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	30	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, hard, Silty clay of low plasticity	CL		12	64	17	2	3	2	0	34	22	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		10	63	21	2	1	3	0	33	22	11	-	1.99	23.63	1.61	2.68	UUT	1.15	4	-	-	-	-	-	-	-	-	-
SPT-5	14.50	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		8	51	34	1	0	6	0	28	21	7	-	1.88	19.26	1.58	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-6	17.50	43	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	45	33	7	1	7	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	59	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	48	30	2	2	11	0	26	19	7	-	1.91	20.04	1.59	2.67	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-8	23.50	63	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	51	32	2	0	9	0	26	20	6	-	1.94	20.42	1.61	2.66	DST	0.23	27	-	-	-	-	-	-	-	-	-
SPT-9	26.50	80	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	28.00	-	-		ML-CL		8	44	35	3	4	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P7	11.00 m	30.00 m	682089.915 m	3148454.759 m	(+)214.599 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	29.50	93	35	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-08-2021	to	22-08-2021	57+400 Major Bridge	BH-P9	12.00 m	35.00 m	682083.968 m	3148480.891 m	(+)214.330 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	13	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		5	49	32	4	3	3	4	26	20	6	-	1.74	12.46	1.55	2.67	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		6	58	35	1	0	0	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	19	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		10	70	20	0	0	0	0	30	20	10	-	1.86	16.24	1.60	2.68	UUT	1.02	4	-	-	-	-	-	-	-	-	-
SPT-4	10.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		12	69	16	2	0	1	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	50	37	1	0	5	0	27	20	7	-	1.88	17.45	1.60	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-6	16.00	66	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	73	14	1	1	0	0	32	21	11	-	1.98	22.36	1.62	2.68	UUT	1.42	4	-	-	-	-	-	-	-	-	-
SPT-7	19.00	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		10	65	18	4	1	2	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	60	26	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	45	35	4	2	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	71	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	77	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	88	33		ML-CL		6	48	33	4	2	5	2	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-08-2021	to	22-08-2021	57+400 Major Bridge	BH-P9	12.00 m	35.00 m	682083.968 m	3148480.891 m	(+)214.330 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	29.50	91	33	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	31.00	97	34		ML-CL		7	48	32	1	3	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	34.00	107 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P10	11.85 m	30.00 m	682080.995 m	3148493.957 m	(+)214.021 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	20	78	1	0	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	2.50	27	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	30	67	1	1	1	0	-	Nil	NP	-	1.78	12.35	1.58	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	5.50	25	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Very stiff, Silty clay of low plasticity	CL		9	57	16	6	4	8	0	30	20	10	-	1.83	15.63	1.58	2.68	UUT	0.92	5	-	-	-	-	-	-	-	-	-
SPT-3	8.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	61	25	4	1	3	0	26	20	6	-	1.84	17.20	1.57	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-4	11.50	31	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	58	26	3	2	4	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	37	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	55	30	1	2	5	0	27	20	7	-	1.88	18.79	1.58	2.67	DST	0.18	26	-	-	-	-	-	-	-	-
SPT-6	17.50	43	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		6	57	29	3	1	4	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	48	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		8	54	26	4	2	6	0	28	21	7	-	1.91	19.26	1.60	2.67	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-8	23.50	55	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	60	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	56	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P10	11.85 m	30.00 m	682080.995 m	3148493.957 m	(+)214.021 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	100	######	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	53	25	5	4	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	30.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P11	11.80 m	30.00 m	682078.022 m	3148507.023 m	(+)213.946 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	55	37	1	1	0	0	26	20	6	-	1.72	13.06	1.52	2.66	DST	0.16	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	54	31	2	3	2	0	28	21	7	-	1.78	14.74	1.55	2.67	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	22	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	57	28	4	2	2	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	27	22	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		9	53	29	3	2	4	0	29	22	7	-	1.83	18.24	1.55	2.67	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-5	13.00	30	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	54	28	5	2	3	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	22	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		8	52	32	4	1	2	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	25	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		7	58	27	2	3	3	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	30	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	45	45	Brown, Hard, Silty clay of low plasticity	CL		12	77	3	2	4	2	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P11	11.80 m	30.00 m	682078.022 m	3148507.023 m	(+)213.946 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	26.50	85	33	Brown, Very dense, Sandy silt of low plastic	ML-CL		0	79	7	2	7	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		26-08-2021	to	27-08-2021	57+400 Major Bridge	BH-P12	12.10 m	30.00 m	682075.049 m	3148520.089 m	(+)214.402 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		6	30	63	1	0	0	0	25	20	5	-	1.77	11.86	1.58	2.65	DST	0.11	28	-	-	-	-	-	-	-	-	-
SPT-1	2.50	25	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM-SC		5	29	65	1	0	0	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL		8	47	44	1	0	0	0	27	20	7	-	1.81	14.63	1.58	2.67	DST	0.22	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	29	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	53	34	3	1	2	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	33	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		8	47	38	4	1	2	0	27	20	7	-	1.83	17.25	1.56	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-5	14.50	37	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	43	46	1	1	1	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	35	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	59	31	2	0	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	32	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	38	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	51	24		ML-CL		6	56	29	2	1	6	0	26	20	6	-	1.87	18.50	1.58	2.67	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-10	25.00	60	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	49	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							26-08-2021	to	27-08-2021	57+400 Major Bridge	BH-P12	12.10 m	30.00 m	682075.049 m	3148520.089 m	(+)214.402 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	58	25	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL		5	46	36	3	2	8	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						27-08-2021	to	28-08-2021	57+400 Major Bridge	BH-P13	12.30 m	30.00 m	682072.075 m	3148533.155 m	(+)214.579 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	37	61	1	1	0	0	-	Nil	NP	-	1.68	11.46	1.51	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	34	39	Brown, Dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	55	31	2	1	4	0	26	19	7	-	1.82	13.22	1.61	2.67	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-3	7.00	38	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		6	49	36	2	1	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	42	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		7	51	35	2	1	3	1	27	20	7	-	1.85	16.54	1.59	2.66	DST	0.23	26	-	-	-	-	-	-	-	-
SPT-5	13.00	46	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		8	47	36	3	2	4	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	38	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	59	21	2	1	6	0	32	21	11	-	2.00	22.14	1.64	2.68	UUT	1.67	4	-	-	-	-	-	-	-	-
SPT-7	19.00	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	46	37	2	1	5	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	73	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	60	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	67	28		ML-CL		6	52	31	2	1	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	60	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	59	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		27-08-2021	to	28-08-2021	57+400 Major Bridge	BH-P13	12.30 m	30.00 m	682072.075 m	3148533.155 m	(+)214.579 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	29.50	62	25	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	54	28	2	1	7	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		25-08-2021	to	26-08-2021	57+400 Major Bridge	BH-P15	11.80 m	30.00 m	682066.129 m	3148559.287 m	(+)213.460 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	15	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	38	56	1	0	0	0	25	20	5	-	1.76	12.16	1.57	2.65	DST	0.09	28	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		6	43	51	0	0	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	25	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	56	46	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.50	-	-		ML-CL		8	50	33	2	1	6	0	27	20	7	-	1.86	16.32	1.60	2.67	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-5	13.00	61	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		ML-CL		10	55	28	1	1	5	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	51	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-		ML-CL		7	54	27	2	3	6	1	27	20	7	-	1.87	17.63	1.59	2.67	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-7	19.00	56	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	64	28		ML-CL		8	51	29	2	2	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	59	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	74	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	79	32		ML-CL		7	49	27	4	2	11	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	86	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		25-08-2021	to	26-08-2021	57+400 Major Bridge	BH-P15	11.80 m	30.00 m	682066.129 m	3148559.287 m	(+)213.460 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	28.00	81	31	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	90	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						27-08-2021	to	28-08-2021	57+400 Major Bridge	BH-P16	11.20 m	30.00 m	682063.156 m	3148572.353 m	(+)212.949 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	59	31	2	1	0	0	26	20	6	-	1.75	12.63	1.55	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	56	33	1	3	1	0	26	19	7	-	1.76	13.41	1.55	2.67	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-2	5.50	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		8	56	32	1	2	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	21	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Medium dense to dense, Silty sand	SM		0	18	78	2	1	1	0	-	Nil	NP	-	1.78	14.78	1.55	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-4	11.50	24	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	13.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	31	19		SM		0	14	80	3	2	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	16.00	-	-		SM		0	19	74	2	2	3	0	-	Nil	NP	-	1.81	16.34	1.56	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-6	17.50	39	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	77	34	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	55	26	3	2	7	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	100 (26cm)	-		ML-CL		8	51	31	5	1	4	0	28	21	7	-	1.94	18.00	1.64	2.66	DST	0.17	28	-	-	-	-	-	-	-	-	-
SPT-11	25.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	26.50	100 (26cm)	-	Brown, Very dense, Silty sand	SM		0	20	76	2	1	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	90	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		26-08-2021	to	27-08-2021	57+400 Major Bridge	BH-P17	10.80 m	30.00 m	682060.182 m	3148585.419 m	(+)213.184 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	5		CL		12	82	5	1	0	0	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		10	78	8	2	2	0	0	30	20	10	-	1.66	14.22	1.45	2.68	UUT	0.20	4	-	-	-	-	-	-	-	-	-
SPT-2	4.00	17	17	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	55	30	5	2	1	0	26	19	7	-	1.75	13.79	1.54	2.66	DST	0.23	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	20	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	53	33	2	3	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	24	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	11.50	27	18		ML-CL		6	58	28	2	4	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	31	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	14.50	34	20		ML-CL		8	52	33	2	2	3	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	16.00	36	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		9	53	24	5	2	7	0	28	21	7	-	1.94	18.12	1.64	2.66	DST	0.18	28	-	-	-	-	-	-	-	-	-
SPT-9	19.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	20.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	22.00	100 (24cm)	-		ML-CL		8	50	26	3	4	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	23.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	25.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	26.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	28.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		26-08-2021	to	27-08-2021	57+400 Major Bridge	BH-P17	10.80 m	30.00 m	682060.182 m	3148585.419 m	(+)213.184 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-16	29.50	100 (18cm)	-	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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						24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P18	10.50 m	30.00 m	682057.209 m	3148598.485 m	(+)213.517 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		8	48	42	1	1	0	0	27	20	7	-	1.74	13.10	1.54	2.67	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	15	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		8	57	28	3	2	2	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	51	33	4	2	2	1	27	20	7	-	1.80	15.26	1.56	2.66	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	26	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Hard, Silty clay of low plasticity	CL		12	61	18	4	2	3	0	34	22	12	-	1.93	20.65	1.60	2.68	UUT	1.07	4	-	-	-	-	-	-	-	-	-
SPT-4	11.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	14.50	34	34		CL		11	65	12	6	2	4	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	16.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	17.50	100 (20cm)	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	52	27	5	2	7	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	19.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	20.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	22.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	23.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	25.00	100 (24cm)	-		ML-CL		6	54	24	2	3	11	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	26.50	103 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-15	28.00	100 (23cm)	-	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	29.50	100 (27cm)	-		ML-CL		8	51	30	2	1	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P19	11.50 m	30.00 m	682054.236 m	3148611.551 m	(+)213.504 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	11	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	46	45	2	0	0	0	26	20	6	-	1.72	12.64	1.53	2.67	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	14	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	49	41	2	0	0	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	19	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		6	52	37	4	0	1	0	26	20	6	-	1.77	14.26	1.55	2.66	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-4	10.00	23	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	11.50	31	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	31	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	14.50	27	18		ML-CL		7	47	44	1	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	16.00	31	31	Brown, Hard, Silty clay of medium plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	17.50	-	-		CL		12	68	16	2	1	1	0	30	20	10	-	1.94	21.34	1.60	2.68	UUT	1.02	5	-	-	-	-	-	-	-	-	-
SPT-9	19.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	20.50	>100	-	Brown, Very dense, Silty sand	SM		0	20	48	20	2	10	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	22.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	23.50	>100	-		SM		0	19	42	32	1	6	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	25.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P19	11.50 m	30.00 m	682054.236 m	3148611.551 m	(+)213.504 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-14	26.50	100 (18cm)	-	Brown, Very dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	28.00	100 (25cm)	-		SM		0	22	77	1	0	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	29.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	30.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						20-08-2021	to	22-08-2021	57+400 Major Bridge	BH-A2	10.90 m	35.00 m	682050.819 m	3148626.567 m	(+)213.090 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	61	31	1	1	0	0	26	20	6	-	1.72	12.36	1.53	2.66	DST	0.16	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	14	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Very stiff, Silty clay of low plasticity	CL		9	69	19	1	1	1	0	30	20	10	-	1.80	14.22	1.58	2.68	UUT	0.88	4	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		10	74	11	2	1	2	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		6	47	39	1	1	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	30	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	53	30	5	2	3	0	26	19	7	-	1.82	17.49	1.55	2.67	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-5	14.50	34	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	45	33	4	4	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	33	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		9	51	28	5	3	4	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	36	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	>100	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	48	27	4	4	11	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	54	25		ML-CL		8	43	29	2	1	9	8	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	100 (28cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-08-2021	to	22-08-2021	57+400 Major Bridge	BH-A2	10.90 m	35.00 m	682050.819 m	3148626.567 m	(+)213.090 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	99	38	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	31.00	110 (20cm)	-		ML-CL		6	48	36	2	1	7	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	32.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	34.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.00	110 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-09-2021	to	24-09-2021	58+191	BH-CL	Not Encountered	10.00 m	681895.083 m	3149257.396 m	(+)212.823 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	6	10		ML-CL		7	50	37	4	2	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	48	35	6	3	2	0	26	20	6	-	1.69	12.60	1.50	2.65	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	49	28	5	2	5	0	31	20	11	-	1.84	15.24	1.60	2.67	UUT	1.05	5	-	-	-	-	-	-	-	-	-
SPT-3	7.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		10	53	24	4	3	6	0	30	20	10	-	1.90	16.49	1.63	2.68	UUT	1.51	4	-	-	-	-	-	-	-	-	-
SPT-4	10.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CGG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-08-2021	to	16-08-2021	58+497	BH-A1	11.30 m	40.00 m	681858.380 m	3149467.024 m	(+)213.216 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense TO DENSE, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	17	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	51	36	4	2	0	0	26	20	6	-	1.76	11.56	1.58	2.67	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	24	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	56	32	3	1	0	0	27	20	7	-	1.80	12.31	1.60	2.67	DST	0.22	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	32	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	56	25	2	1	5	0	31	20	11	-	2.68	2.68	2.68	2.68	UUT	1.52	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	11.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		CL		13	58	20	3	2	3	1	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-		CL		12	56	26	2	1	3	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	58	27	2	1	4	0	28	21	7	-	1.86	15.06	1.62	2.66	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-8	22.00	75	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		7	49	30	3	4	6	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	69	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	26.50	-	-		ML-CL		8	53	27	5	2	5	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							14-08-2021	to	16-08-2021	58+497	BH-A1	11.30 m	40.00 m	681858.380 m	3149467.024 m	(+)213.216 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	75	27	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	29.50	-	-		ML-CL		6	46	36	2	2	8	0	27	20	7	-	2.66	2.66	2.66	2.66	DST	0.17	28	-	-	-	-	-	-	-	-	-
SPT-11	31.00	80	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	32.50	-	-		ML-CL		6	49	37	3	1	4	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	37.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	67	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	40.00	-	-		ML-CL		7	47	32	3	2	9	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-08-2021	to	18-08-2021	58+497	BH-P1	11.60 m	40.00 m	681844.488 m	3149495.176 m	(+)214.371 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	67	25	1	0	0	0	27	20	7	-	1.75	12.36	1.56	2.66	DST	0.23	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	17	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		8	64	24	3	1	0	0	28	21	7	-	1.81	12.86	1.60	2.67	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Hard, Silty clay of low plasticity	CL		13	63	18	3	2	1	0	32	21	11	-	1.86	15.10	1.62	2.68	UUT	1.34	5	-	-	-	0.655	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.05 5.79 5.17 4.25	1.84 1.36 0.91 0.59	0.1230
SPT-3	8.50	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	63	15	3	4	3	0	33	22	11	-	1.91	17.22	1.63	2.69	UUT	1.48	4	-	-	-	-	-	-	-	-	-
SPT-4	11.50	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		14	53	19	8	4	2	0	34	23	11	-	1.97	20.34	1.64	2.68	UUT	1.65	5	-	-	-	-	-	-	-	-	-
SPT-5	14.50	49	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		14	71	12	1	2	0	0	33	22	11	-	2.02	22.29	1.65	2.69	UUT	1.80	4	-	-	-	-	-	-	-	-	-
SPT-6	17.50	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	55	30	3	2	4	0	26	20	6	-	1.88	17.25	1.60	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	61	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		8	52	28	5	2	5	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	68	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	81	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	69	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							16-08-2021	to	18-08-2021	58+497		BH-P1		11.60 m		40.00 m		681844.488 m			3149495.176 m			(+)214.371 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
UDS-9	28.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	51	34	4	1	3	0	27	20	7	-	1.91	18.34	1.61	2.67	DST	0.16	28	-	-	-	-	-	-	-	-
SPT-11	29.50	77	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	31.00	86	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	32.50	100 (17cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	35.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	37.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	38.50	73	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	40.00	-	-		ML-CL		8	51	30	1	1	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-08-2021	to	20-08-2021	58+497	BH-P2	11.40 m	40.00 m	681840.419 m	3149522.156 m	(+)213.108 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	19	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		6	33	55	2	3	1	0	25	19	6	-	1.74	11.34	1.56	2.65	DST	0.09	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	26	26	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		11	74	10	1	2	2	0	30	20	10	-	1.81	14.67	1.58	2.68	UUT	0.93	4	-	-	-	-	-	-	-	-	-
SPT-3	7.00	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		12	58	14	4	2	10	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	52	34	4	2	1	0	26	19	7	-	1.83	16.80	1.57	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-5	13.00	38	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		6	50	38	4	1	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	45	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	63	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		7	51	33	3	2	4	0	27	20	7	-	1.88	17.76	1.60	2.67	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-8	22.00	58	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		8	49	28	1	3	11	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	64	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	26.50	-	-		ML-CL		6	51	25	3	2	13	0	26	20	6	-	2.66	2.66	2.66	2.66	DST	0.17	28	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-08-2021	to	20-08-2021	58+497	BH-P2	11.40 m	40.00 m	681840.419 m	3149522.156 m	(+)213.108 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	>100	-	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	29.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	31.00	>100	-		ML-CL		7	47	32	2	2	10	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	34.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	35.50	>100	-		ML-CL		8	53	28	2	0	9	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	37.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	58+497	BH-P3	11.00 m	40.00 m	681840.000 m	3149565.000 m	(+)214.145 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	22	77	1	0	0	0	-	Nil	NP	-	1.69	10.63	1.53	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-1	2.50	14	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	22	72	3	2	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		5	59	30	3	2	1	0	25	20	5	-	1.80	14.22	1.58	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	33	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		6	56	34	1	1	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	38	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	56	29	3	2	3	0	27	20	7	-	1.85	16.87	1.58	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-5	14.50	40	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	45	33	4	4	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	53	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		6	57	21	1	2	8	5	26	20	6	-	1.89	17.64	1.61	2.67	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-7	20.50	80	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		9	51	19	1	1	9	10	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	84	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	46	40	1	1	6	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	100	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	58+497	BH-P3	11.00 m	40.00 m	681840.000 m	3149565.000 m	(+)214.145 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	51	35	1	1	5	0	26	19	7	-	1.94	18.10	1.64	2.66	DST	0.18	28	-	-	-	-	-	-	-	-	-
SPT-10	29.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	105	36		ML-CL		8	55	25	3	1	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	107 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-08-2021	to	19-08-2021	58+497	BH-P4	11.90 m	40.00 m	681837.920 m	3149594.593 m	(+)214.312 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	19	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		5	63	30	2	0	0	0	26	20	6	-	1.77	11.23	1.59	2.66	DST	0.18	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	24	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		6	60	29	3	1	1	0	26	19	7	-	1.80	11.84	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	35	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	53	32	4	1	3	0	27	20	7	-	2.67	2.67	2.67	2.67	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-4	10.00	43	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	11.50	48	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	54	26	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		ML-CL		7	51	35	2	3	2	0	27	21	6	-	2.66	2.66	2.66	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-7	16.00	58	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-		ML-CL		8	51	29	6	2	4	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	53	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		7	55	26	4	3	5	0	27	20	7	-	1.87	16.75	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	66	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	23.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	78	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	26.50	-	-		ML-CL		9	59	23	3	4	2	0	29	22	7	-	2.66	2.66	2.66	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-08-2021	to	19-08-2021	58+497	BH-P4	11.90 m	40.00 m	681837.920 m	3149594.593 m	(+)214.312 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	78	26	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	29.50	-	-		ML-CL		7	61	27	3	2	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	31.00	82	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	32.50	-	-		ML-CL		8	65	24	2	1	0	0	28	21	7	-	2.66	2.66	2.66	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	89	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-08-2021	to	20-08-2021	58+497	BH-P5	12.00 m	40.00 m	681834.868 m	3149620.114 m	(+)213.726 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	8	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	33	66	0	0	1	0	-	Nil	NP	-	1.66	10.81	1.50	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	25	28	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	23	75	1	0	1	0	-	Nil	NP	-	1.76	11.26	1.58	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-3	7.00	31	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		13	66	8	2	2	9	0	33	21	12	-	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		10	69	12	2	4	3	0	30	20	10	-	1.92	19.22	1.61	2.68	UUT	1.26	4	-	-	-	-	-	-	-	-
SPT-5	13.00	37	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		11	56	19	6	2	5	1	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	56	28	3	2	4	0	27	21	6	2.66	2.66	2.66	2.66	2.66	DST	0.20	26	-	-	-	-	-	-	-	-
SPT-7	19.00	51	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		6	51	30	2	3	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	56	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		7	56	27	3	2	5	0	27	20	7	-	2.67	2.67	2.67	2.67	DST	0.22	27	-	-	-	-	-	-	-	-
SPT-9	25.00	67	27				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		8	58	22	5	1	6	0	28	21	7	-	0.00	-	-	-	-	-	-	-	-	-	-	-	-	#######	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						19-08-2021	to	20-08-2021	58+497	BH-P5	12.00 m	40.00 m	681834.868 m	3149620.114 m	(+)213.726 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	89	35	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	29.50	-	-		ML-CL		9	56	26	3	1	5	0	29	22	7	-	2.66	2.66	2.66	2.66	DST	0.17	28	-	-	-	-	-	-	-	-	-
SPT-11	31.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100	34		ML-CL		7	56	24	4	1	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (24cm)	-		ML-CL		9	65	25	1	0	0	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						17-08-2021	to	18-08-2021	58+497	BH-P6	11.00 m	40.00 m	681836.405 m	3149645.522 m	-	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	58	27	4	3	1	0	27	20	7	-	1.74	12.19	1.55	2.66	DST	0.24	23	-	-	-	-	-	-	-	-
SPT-1	2.50	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		9	58	24	5	2	2	0	28	21	7	-	1.79	13.26	1.58	2.67	DST	0.19	24	-	-	-	-	-	-	-	-
SPT-2	5.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Hard, Silty clay of low plasticity	CL		13	71	11	3	1	1	0	33	22	11	-	1.87	16.34	1.61	2.68	UUT	1.22	5	-	-	-	-	-	-	-	-
SPT-3	8.50	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	66	15	3	2	2	0	32	21	11	-	1.90	17.48	1.62	2.68	UUT	1.36	5	-	-	-	0.655	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.61 6.38 5.24 4.03	1.71 1.23 0.81 0.52	0.1100
SPT-4	11.50	43	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		12	61	18	4	1	4	0	31	20	11	-	1.99	21.63	1.64	2.67	UUT	1.65	4	-	-	-	-	-	-	-	-
SPT-5	14.50	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		13	57	16	5	3	5	1	33	22	11	-	2.02	22.20	1.65	2.68	UUT	1.79	4	-	-	-	-	-	-	-	-
SPT-6	17.50	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	58	28	2	1	3	0	28	21	7	-	1.87	17.10	1.60	2.66	DST	0.18	26	-	-	-	-	-	-	-	-
SPT-7	20.50	67	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		6	52	32	3	1	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	72	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		7	62	21	4	1	5	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	80	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							17-08-2021	to	18-08-2021	58+497	BH-P6	11.00 m	40.00 m	681836.405 m	3149645.522 m	-	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	63	22	1	0	6	0	28	21	7	-	1.95	18.19	1.65	2.67	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-10	29.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	>100	-		ML-CL		7	59	26	7	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							17-08-2021	to	18-08-2021	58+497	BH-A2	12.00 m	40.00 m	681833.809 m	3149673.452 m	(+)214.044 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	13	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	54	34	4	1	0	0	27	20	7	-	1.74	12.36	1.55	2.67	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	26	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		9	51	33	6	1	0	0	29	22	7	-	1.80	13.21	1.59	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	31	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	50	35	3	3	1	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	31	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL		7	57	31	2	0	3	0	26	19	7	-	1.81	16.63	1.55	2.67	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-5	13.00	32	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		6	55	33	3	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	28	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		9	59	24	2	2	4	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	41	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	52	29	3	4	5	0	27	20	7	-	1.87	18.10	1.58	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-8	22.00	50	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		8	56	25	6	1	3	1	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	55	24				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		6	55	30	3	4	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							17-08-2021	to	18-08-2021	58+497	BH-A2	12.00 m	40.00 m	681833.809 m	3149673.452 m	(+)214.044 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	58	25	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	29.50	-	-		ML-CL		7	67	26	0	0	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	65	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	32.50	-	-		ML-CL		5	51	36	4	1	3	0	26	19	7	-	2.66	2.66	2.66	2.66	DST	0.17	27	-	-	-	-	-	-	-	-	-	-
SPT-12	34.00	99	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	37.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							24-09-2021	to	24-09-2021	58+837 Minor Bridge	BH-CL	Not Encountered	10.00 m	681823.952 m	3149897.982 m	(+)213.610 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	6	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	38	55	6	1	0	0	-	Nil	NP	-	1.66	12.31	1.48	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	53	30	6	1	3	0	26	20	6	-	1.82	15.13	1.58	2.66	DST	0.18	25	-	-	-	-	-	-	-	-
SPT-3	7.00	32	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	52	28	6	2	4	0	28	21	7	-	1.88	15.94	1.62	2.66	DST	0.19	26	-	-	-	-	-	-	-	-
SPT-4	10.00	47	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							24-09-2021	to	24-09-2021	59+071 Minor Bridge	BH-CL	Not Encountered	10.00 m	681817.835 m	3150131.892 m	(+)213.832 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	51	33	5	1	3	0	27	20	7	-	1.79	14.60	1.56	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	18	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	54	30	4	2	4	0	26	20	6	-	1.85	15.41	1.60	2.66	DST	0.22	25	-	-	-	-	-	-	-	-	-
SPT-2	5.50	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		8	51	28	6	1	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	32	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-09-2021	to	24-09-2021	59+206 Minor Bridge	BH-CL	12.65 m	15.00 m	681807.000 m	3150266.000 m	(+)213.360 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	49	40	4	1	0	0	27	20	7	-	1.79	13.56	1.58	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	20	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		7	53	33	3	2	2	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		8	57	28	5	1	1	0	28	21	7	-	1.80	14.80	1.57	2.66	DST	0.22	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	24	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		6	57	27	4	3	3	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	33	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	13.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.50	30	18		ML-CL		7	51	31	6	1	4	0	27	20	7	-	1.88	21.00	1.55	2.65	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-6	15.00	49	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-09-2021	to	23-09-2021	59+270 Minor Bridge	BH-CL	Not Encountered	10.00 m	681801.000 m	3150330.000 m	(+)212.598 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	20	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	55	31	5	1	2	0	26	20	6	-	1.83	14.23	1.60	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-2	4.00	26	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	53	28	6	1	4	0	28	21	7	-	1.85	15.10	1.61	2.65	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-3	7.00	39	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	52	29	5	1	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	42	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CSIR TEST HOUSE

RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

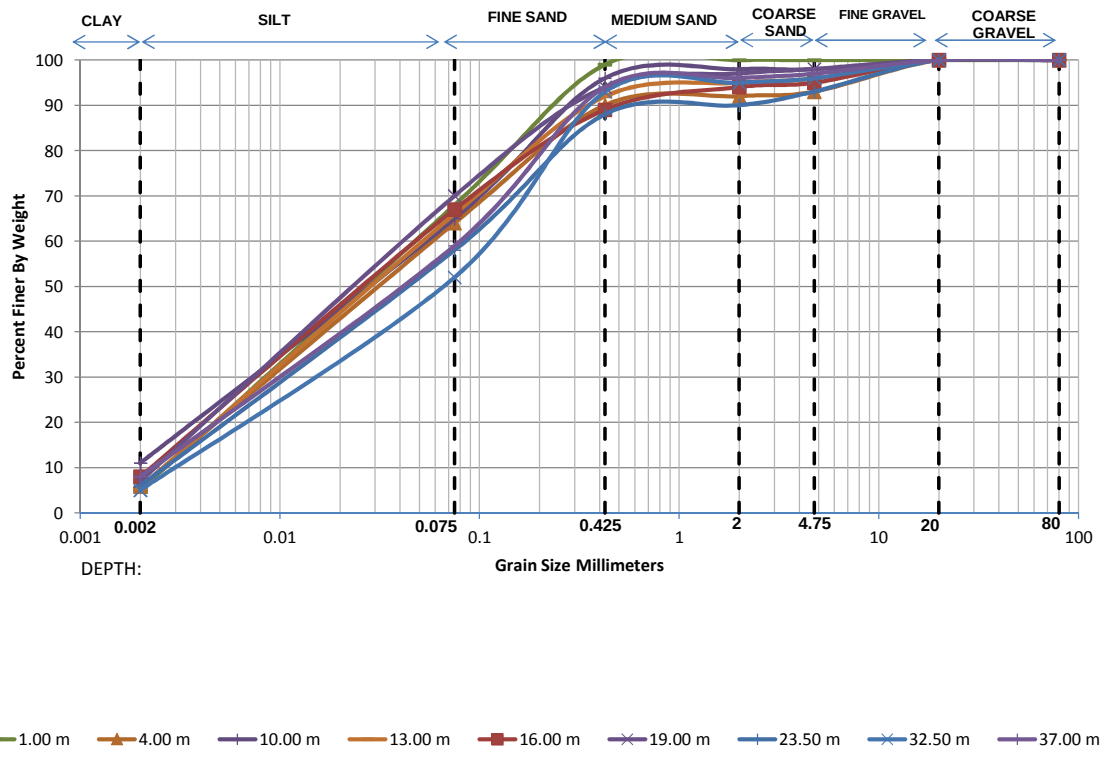
Sr. No	Chainage Old	Chainage New	BH No.	Depth of collected sample (m)	pH	Chlorides (Cl^-)		Sulphate (SO_3^{2-})	
						(mg/kg)	(%)	(mg/kg)	(%)
1.	52+518	55+719	BH-A1	1.0	8.79	76.23	0.0076	18.14	0.0018
			BH-A2	16.0	7.88	85.68	0.0086	29.30	0.0029
2.	55+910	59+107	BH-A1	13.0	7.14	56.12	0.0056	19.35	0.0019
			BH-A2	2.5	9.34	65.67	0.0066	24.26	0.0024
3.	57+400	60+603	BH-P3	13.0	8.74	74.54	0.0074	23.10	0.0023
			BH-P19	5.5	9.70	61.71	0.0062	29.20	0.0029
4.	58+497	61+676	BH-A1	2.5	8.90	80.43	0.0080	17.04	0.0017
			BH-A2	11.5	8.75	79.71	0.0080	22.40	0.0022

RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLE

Sr. No	Chainage Old	Chainage New	BH No.	pH	Chlorides (Cl^-) (mg/l)	Sulphate (SO_3^{2-}) (mg/l)
1.	52+518	55+719	BH-A1	9.23	55.34	20.64
2.	55+910	59+107	BH-A1	9.06	70.33	24.19
3.	57+400	60+603	BH-A1	10.12	57.73	25.43
4.	58+497	61+676	BH-A1	9.43	57.65	23.28

GRAIN SIZE DISTRIBUTION CURVES

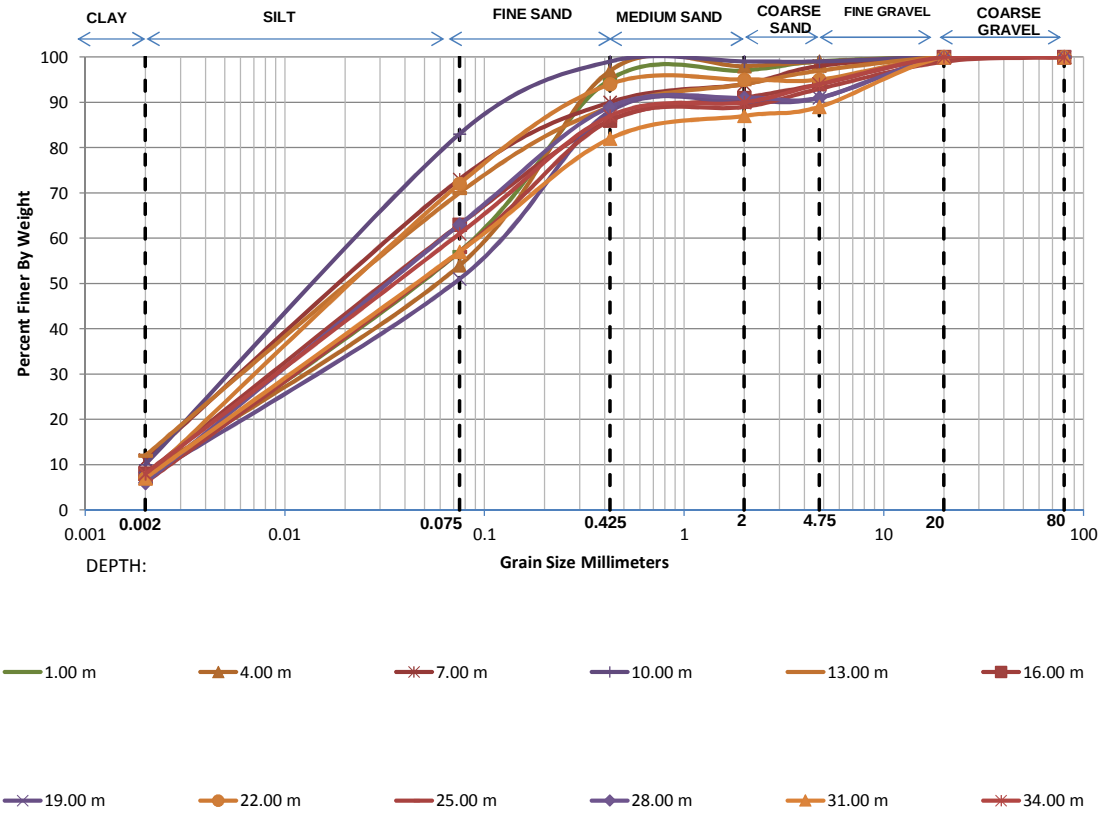
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	52+518 (Old Ch) & 55+719 (New Ch) Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	5.00	63.00	31.00	1.00	0.00	0.00	0.00	0.0051	0.0202	0.0595	11.76	1.36
4.00 m	5.80	58.20	26.00	2.00	1.00	7.00	0.00	0.0044	0.0203	0.0662	15.06	1.42
10.00 m	11.00	54.00	31.00	2.00	0.00	2.00	0.00	-	0.0148	0.0634	-	-
13.00 m	5.60	60.40	26.00	3.00	1.00	4.00	0.00	0.0045	0.0199	0.0625	13.79	1.39
16.00 m	8.00	59.00	22.00	5.00	1.00	5.00	0.00	0.0029	0.0167	0.0600	20.88	1.61
19.00 m	7.00	63.00	24.00	3.00	1.00	2.00	0.00	0.0034	0.0169	0.0555	16.15	1.50
23.50 m	6.00	52.00	30.00	2.00	3.00	7.00	0.00	0.0044	0.0231	0.0810	18.60	1.51
32.50 m	5.00	47.00	41.00	2.00	1.00	4.00	0.00	0.0056	0.0291	0.1022	18.27	1.48
37.00 m	8.00	51.00	35.00	2.00	1.00	3.00	0.00	0.0029	0.0205	0.0777	26.55	1.86

GRAIN SIZE DISTRIBUTION CURVES

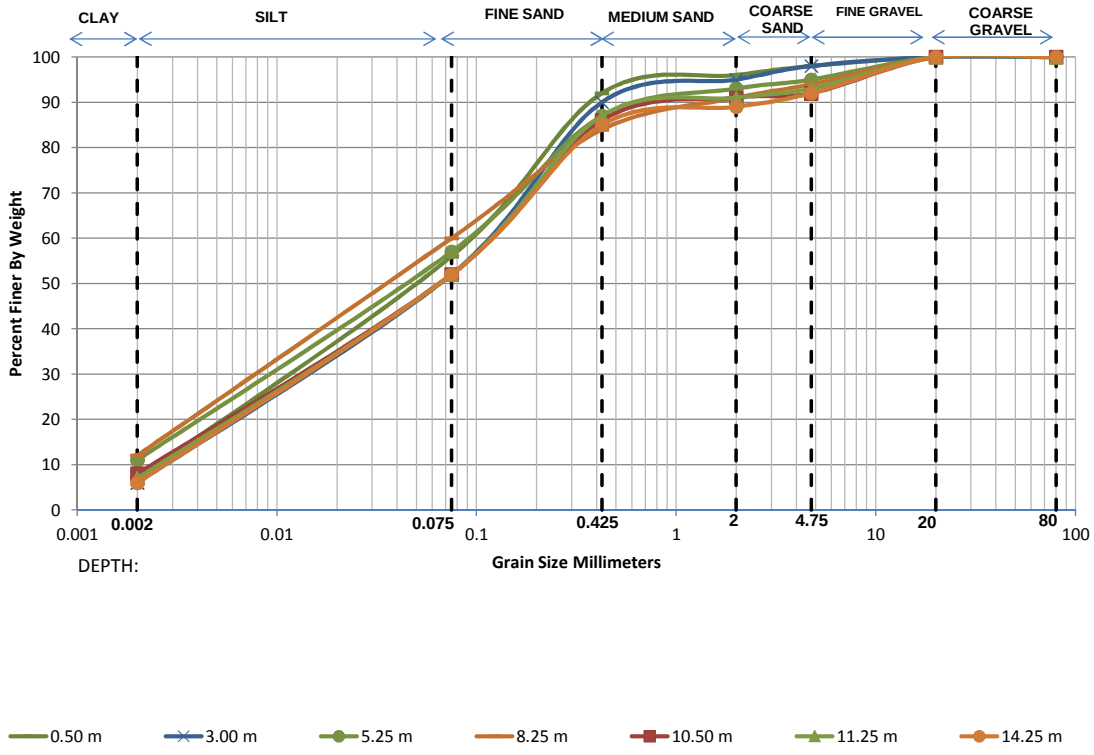
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	52+518 (Old Ch) & 55+719 (New Ch) Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	50.00	38.00	2.00	2.00	1.00	0.00	0.0036	0.0229	0.0836	23.25	1.75
4.00 m	8.00	46.00	43.00	1.00	1.00	1.00	0.00	0.0030	0.0241	0.0937	31.52	2.09
7.00 m	11.00	62.00	17.00	4.00	4.00	2.00	0.00	-	0.0122	0.0493	-	-
10.00 m	10.00	73.00	16.00	0.00	0.00	1.00	0.00	0.0020	0.0113	0.0388	19.42	1.66
13.00 m	12.00	58.00	19.00	5.00	3.00	3.00	0.00	-	0.0122	0.0535	-	-
16.00 m	8.00	55.00	23.00	5.00	3.00	6.00	0.00	0.0029	0.0181	0.0679	23.47	1.67
19.00 m	7.00	44.00	37.00	2.00	1.00	9.00	0.00	0.0037	0.0273	0.1106	29.87	1.82
22.00 m	7.00	65.00	22.00	1.00	0.00	5.00	0.00	0.0034	0.0163	0.0525	15.37	1.48
25.00 m	6.00	51.00	29.00	3.00	4.00	6.00	1.00	0.0044	0.0236	0.0851	19.45	1.50
28.00 m	6.00	57.00	26.00	2.00	0.00	9.00	0.00	0.0042	0.0205	0.0682	16.06	1.45
31.00 m	7.00	50.00	25.00	5.00	2.00	11.00	0.00	0.0036	0.0222	0.0866	24.20	1.60
34.00 m	8.00	53.00	26.00	3.00	4.00	6.00	0.00	0.0029	0.0191	0.0725	24.96	1.74

GRAIN SIZE DISTRIBUTION CURVES

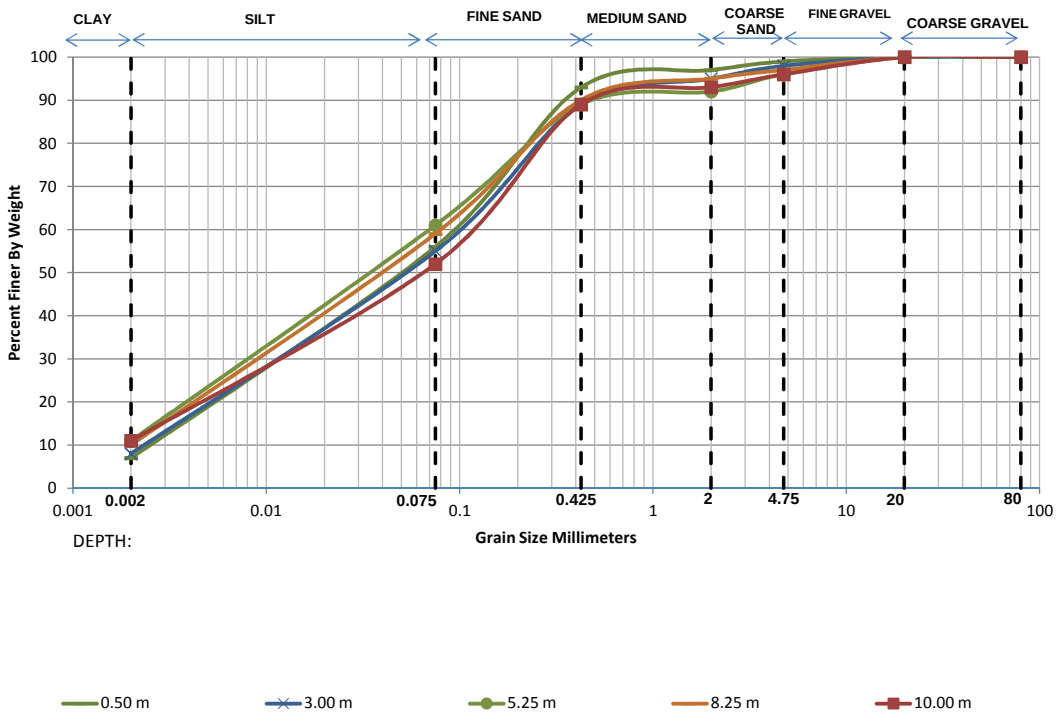
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	53+107
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	49.00	36.00	4.00	2.00	2.00	0.00	0.0036	0.0235	0.0877	24.29	1.74
3.00 m	6.00	46.00	38.00	5.00	3.00	2.00	0.00	0.0045	0.0277	0.1047	23.08	1.61
5.25 m	11.00	46.00	30.00	6.00	2.00	5.00	0.00	-	0.0183	0.0856	-	-
8.25 m	12.00	48.00	24.00	7.00	3.00	6.00	0.00	-	0.0156	0.0750	-	-
10.50 m	8.00	44.00	34.00	5.00	1.00	8.00	0.00	0.0030	0.0252	0.1087	36.44	1.95
11.25 m	7.00	45.00	35.00	4.00	2.00	7.00	0.00	0.0037	0.0263	0.1073	29.16	1.76
14.25 m	6.00	46.00	33.00	4.00	3.00	8.00	0.00	0.0045	0.0274	0.1091	24.13	1.52

GRAIN SIZE DISTRIBUTION CURVES

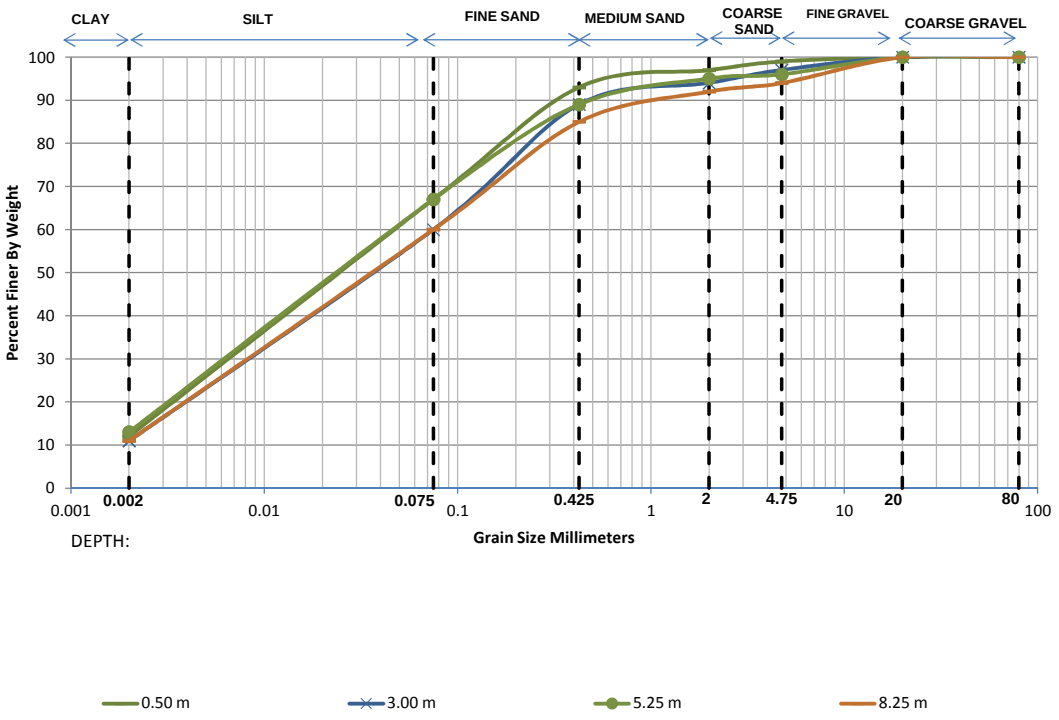
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	53+282
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	49.00	37.00	4.00	2.00	1.00	0.00	0.0036	0.0235	0.0875	24.22	1.75
3.00 m	8.00	47.00	34.00	6.00	3.00	2.00	0.00	0.0030	0.0229	0.0929	31.43	1.91
5.25 m	11.00	50.00	28.00	3.00	4.00	4.00	0.00	-	0.0163	0.0724	-	-
8.25 m	10.00	49.00	31.00	5.00	2.00	3.00	0.00	0.0020	0.0183	0.0779	38.93	2.15
10.00 m	11.00	41.00	37.00	4.00	3.00	4.00	0.00	-	0.0221	0.1067	-	-

GRAIN SIZE DISTRIBUTION CURVES

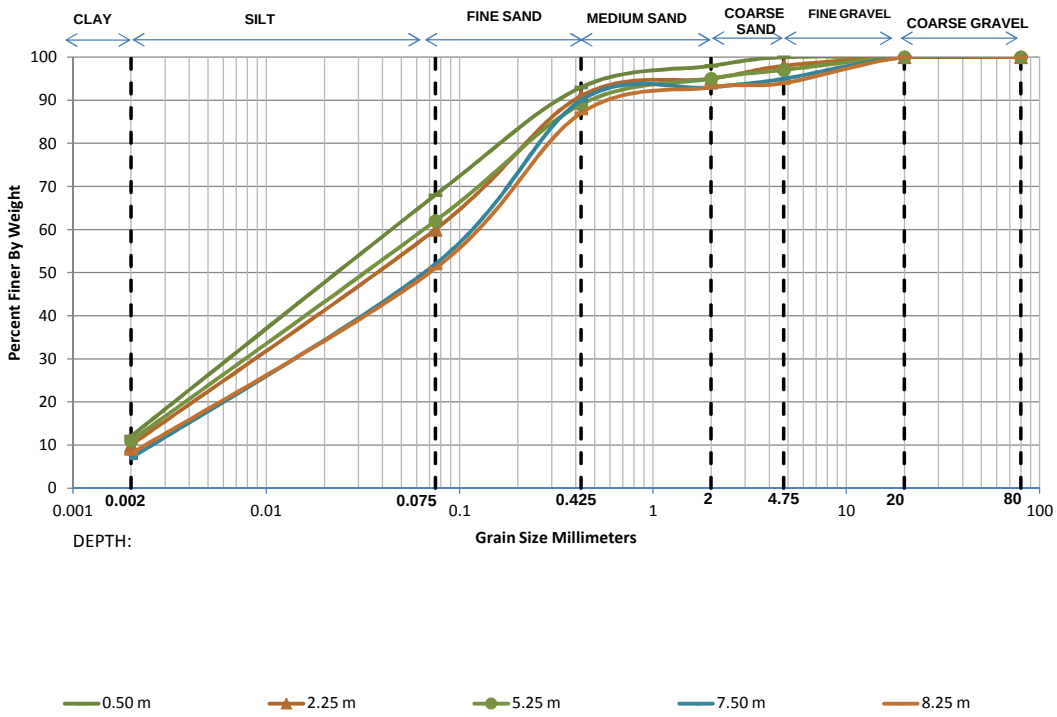
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	53+572
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	12.00	55.00	26.00	4.00	2.00	1.00	0.00	-	0.0132	0.0591	-	-
3.00 m	11.00	49.00	29.00	5.00	3.00	3.00	0.00	-	0.0168	0.0750	-	-
5.25 m	13.00	54.00	22.00	6.00	1.00	4.00	0.00	-	0.0122	0.0586	-	-
8.25 m	11.00	49.00	25.00	7.00	2.00	6.00	0.00	-	0.0166	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

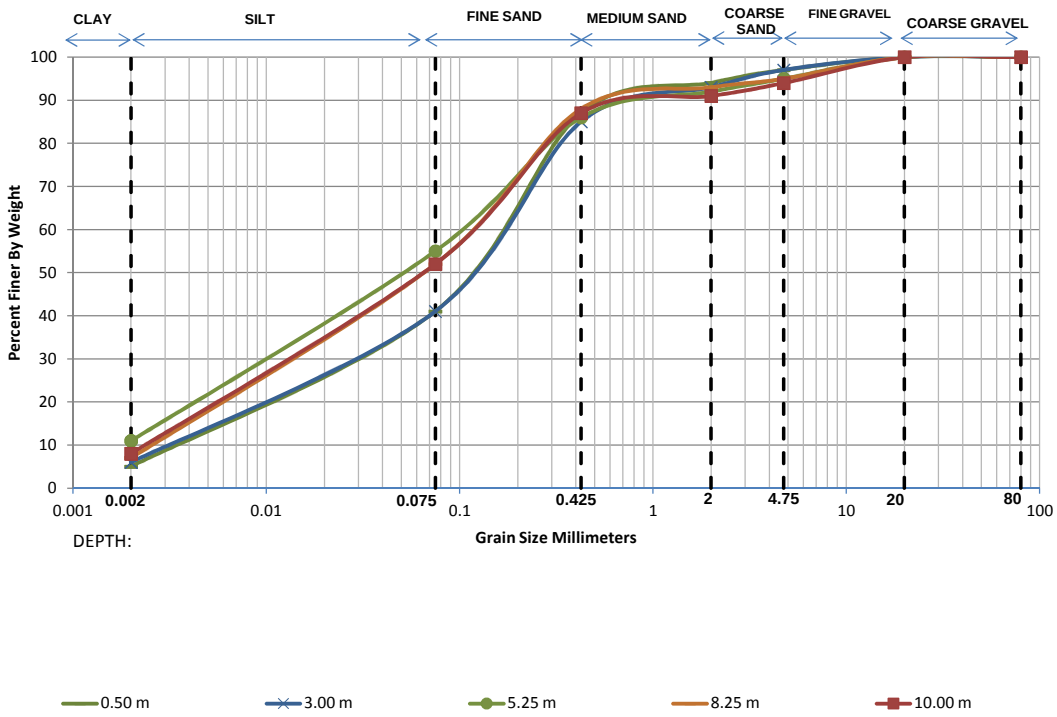
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	53+982
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	12.00	56.00	25.00	5.00	2.00	0.00	0.00	-	0.0129	0.0572	-	-
2.25 m	10.00	50.00	31.00	4.00	3.00	2.00	0.00	0.0020	0.0178	0.0750	37.50	2.12
5.25 m	11.00	51.00	27.00	6.00	2.00	3.00	0.00	-	0.0158	0.0699	-	-
7.50 m	7.00	45.00	38.00	3.00	2.00	5.00	0.00	0.0037	0.0265	0.1047	28.41	1.82
8.25 m	8.00	43.00	36.00	6.00	1.00	6.00	0.00	0.0030	0.0262	0.1127	37.62	2.03

GRAIN SIZE DISTRIBUTION CURVES

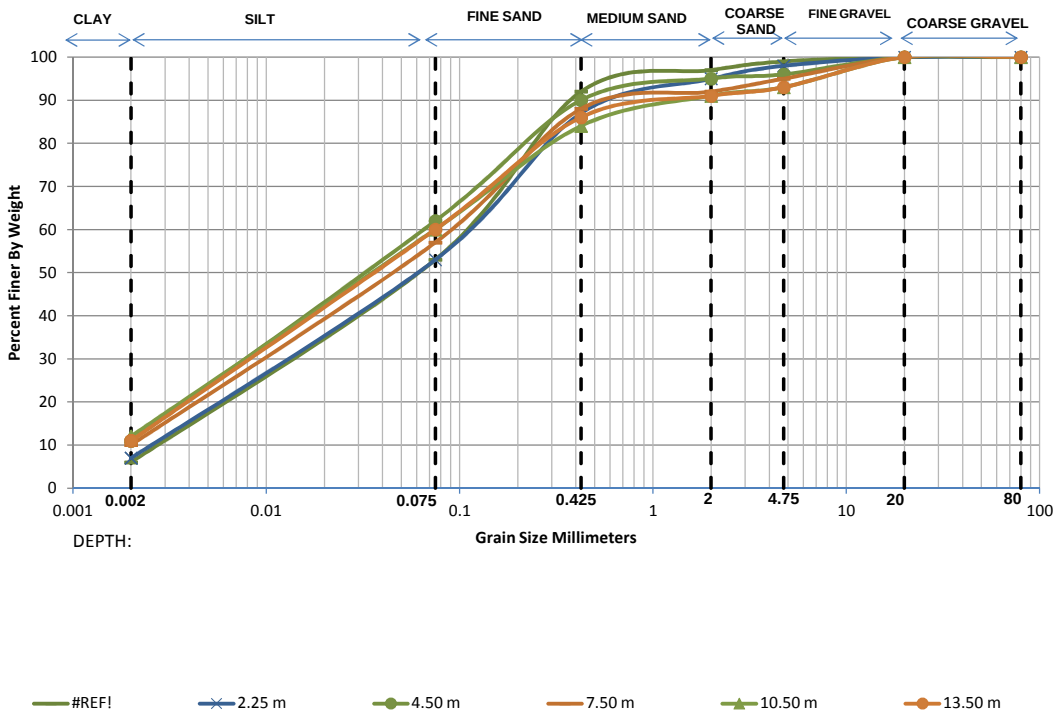
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	54+363
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	5.00	36.00	46.00	7.00	3.00	3.00	0.00	0.0064	0.0433	0.1580	24.70	1.85
3.00 m	6.00	35.00	44.00	8.00	4.00	3.00	0.00	0.0051	0.0422	0.1634	31.99	2.13
5.25 m	11.00	44.00	31.00	6.00	3.00	5.00	0.00	-	0.0196	0.0949	-	-
8.25 m	7.00	45.00	36.00	5.00	2.00	5.00	0.00	0.0037	0.0264	0.1065	28.95	1.78
10.00 m	8.00	44.00	35.00	4.00	3.00	6.00	0.00	0.0030	0.0252	0.1075	36.04	1.99

GRAIN SIZE DISTRIBUTION CURVES

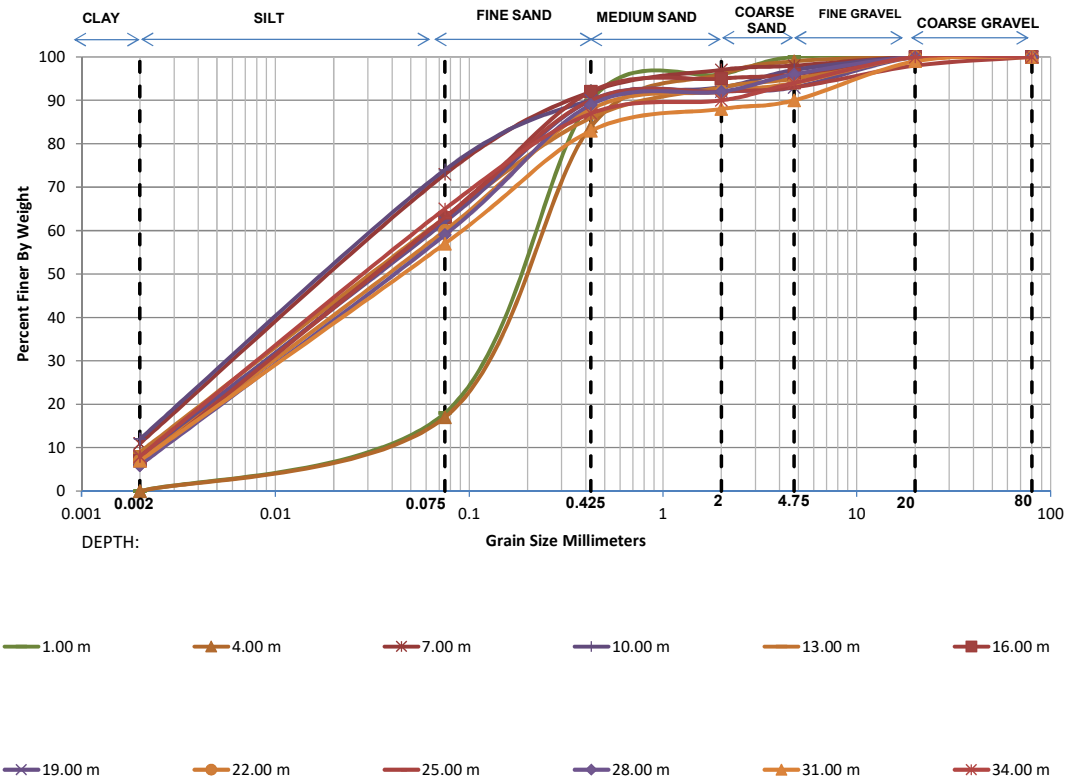
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	54+496
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
#REF!	6.00	47.00	39.00	5.00	2.00	1.00	0.00	0.0045	0.0269	0.0993	22.01	1.62
2.25 m	7.00	46.00	34.00	8.00	3.00	2.00	0.00	0.0037	0.0255	0.1031	28.20	1.72
4.50 m	11.00	51.00	28.00	5.00	1.00	4.00	0.00	-	0.0159	0.0700	-	-
7.50 m	10.00	47.00	31.00	4.00	3.00	5.00	0.00	0.0020	0.0194	0.0851	42.56	2.21
10.50 m	12.00	48.00	24.00	7.00	2.00	7.00	0.00	-	0.0156	0.0750	-	-
13.50 m	11.00	49.00	26.00	5.00	2.00	7.00	0.00	-	0.0166	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

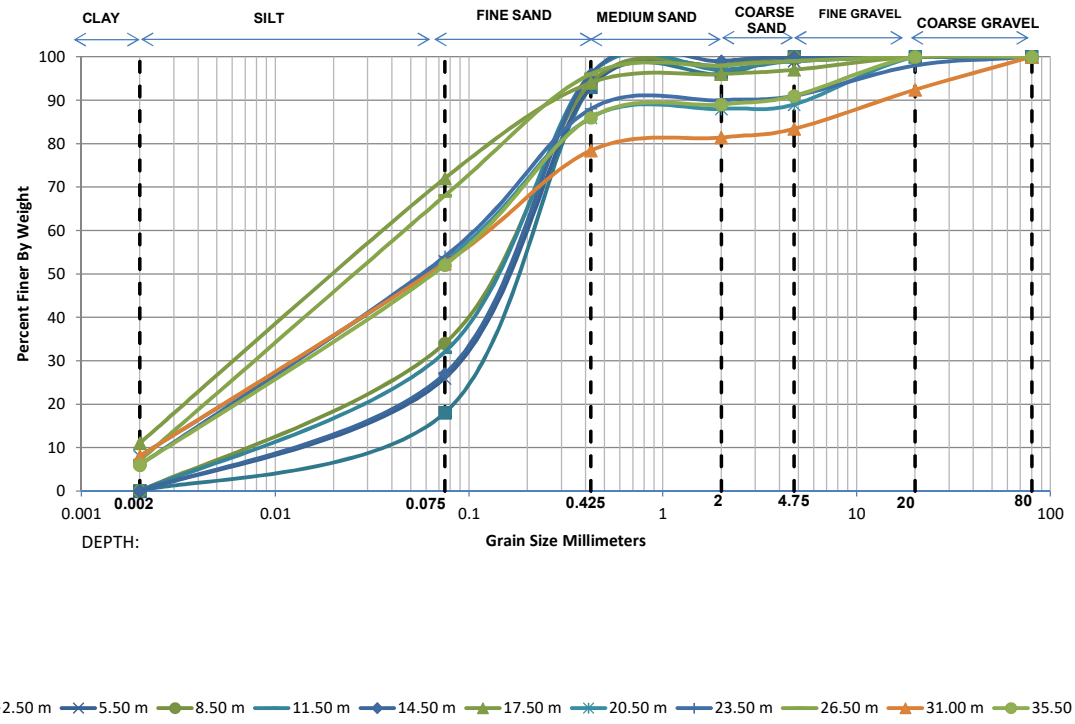
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	55+910 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	18.00	72.00	6.00	4.00	0.00	0.00	0.0336	0.1219	0.2281	6.78	1.94
4.00 m	0.00	17.00	67.00	12.00	3.00	1.00	0.00	0.0366	0.1288	0.2491	6.80	1.82
7.00 m	11.00	62.00	19.00	5.00	1.00	2.00	0.00	-	0.0123	0.0494	-	-
10.00 m	12.00	62.00	16.00	3.00	4.00	3.00	0.00	-	0.0112	0.0475	-	-
13.00 m	9.00	54.00	23.00	7.00	2.00	5.00	0.00	0.0024	0.0171	0.0678	28.27	1.81
16.00 m	7.00	56.00	29.00	3.00	1.00	4.00	0.00	0.0035	0.0195	0.0681	19.43	1.59
19.00 m	8.00	54.00	28.00	2.00	1.00	7.00	0.00	0.0029	0.0188	0.0702	24.20	1.73
22.00 m	7.00	53.00	28.00	4.00	2.00	6.00	0.00	0.0035	0.0208	0.0750	21.18	1.63
25.00 m	6.00	57.00	27.00	2.00	1.00	5.00	2.00	0.0042	0.0205	0.0682	16.05	1.46
28.00 m	6.00	53.00	30.00	3.00	4.00	4.00	0.00	0.0043	0.0226	0.0777	17.94	1.51
31.00 m	7.00	50.00	26.00	5.00	2.00	9.00	1.00	0.0036	0.0223	0.0862	24.09	1.61
34.00 m	8.00	57.00	22.00	3.00	4.00	6.00	0.00	0.0029	0.0173	0.0637	22.11	1.64

GRAIN SIZE DISTRIBUTION CURVES

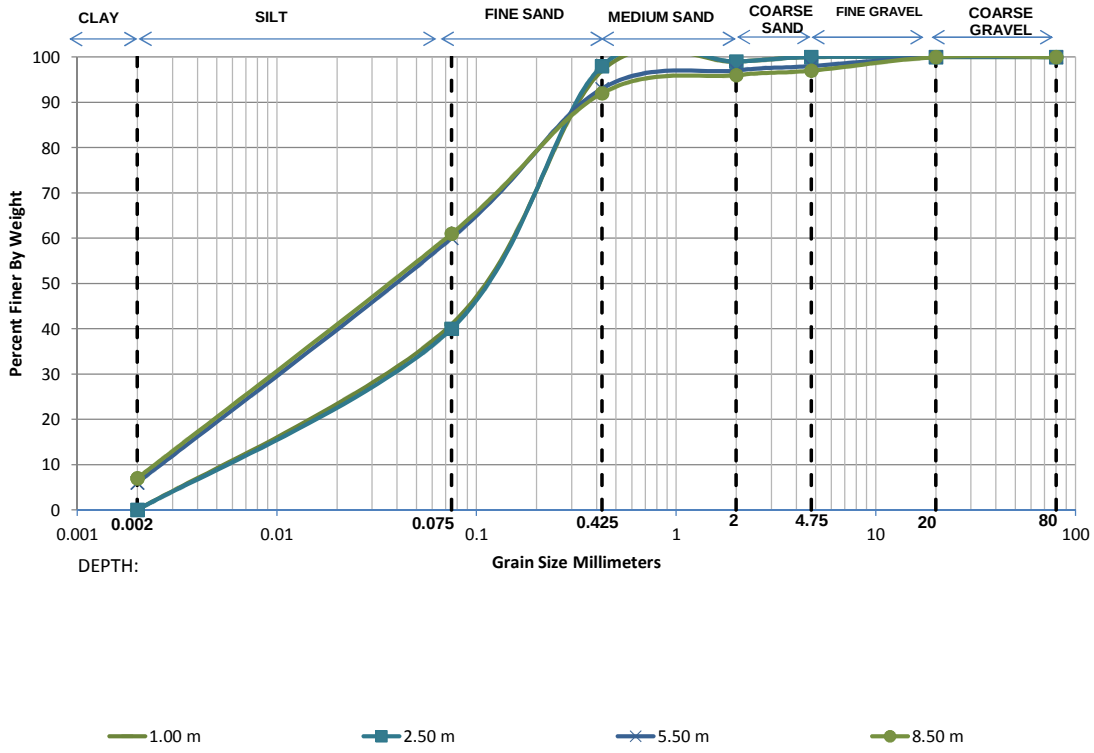
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	55+910 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	18.00	75.00	3.00	4.00	0.00	0.00	0.0338	0.1208	0.2209	6.53	1.95
5.50 m	0.00	26.00	67.00	5.00	1.00	1.00	0.00	0.0174	0.0892	0.1967	11.28	2.32
8.50 m	0.00	34.00	60.00	4.00	2.00	0.00	0.00	0.0107	0.0624	0.1680	15.68	2.17
11.50 m	0.00	32.00	64.00	1.00	2.00	1.00	0.00	0.0120	0.0685	0.1708	14.21	2.29
14.50 m	0.00	27.00	69.00	3.00	1.00	0.00	0.00	0.0164	0.0854	0.1875	11.44	2.37
17.50 m	11.00	61.00	22.00	2.00	1.00	3.00	0.00	-	0.0126	0.0510	-	-
20.50 m	8.00	45.00	33.00	2.00	1.00	11.00	0.00	0.0030	0.0243	0.1033	34.76	1.92
23.50 m	6.00	48.00	34.00	2.00	1.00	7.00	2.00	0.0045	0.0259	0.0969	21.71	1.55
26.50 m	7.00	61.00	28.00	2.00	1.00	1.00	0.00	0.0035	0.0176	0.0588	17.01	1.53
31.00 m	8.00	44.40	26.00	3.00	2.00	9.00	7.60	0.0030	0.0243	0.1171	39.43	1.70
35.50 m	6.00	46.00	34.00	3.00	2.00	9.00	0.00	0.0045	0.0274	0.1078	23.83	1.54

GRAIN SIZE DISTRIBUTION CURVES

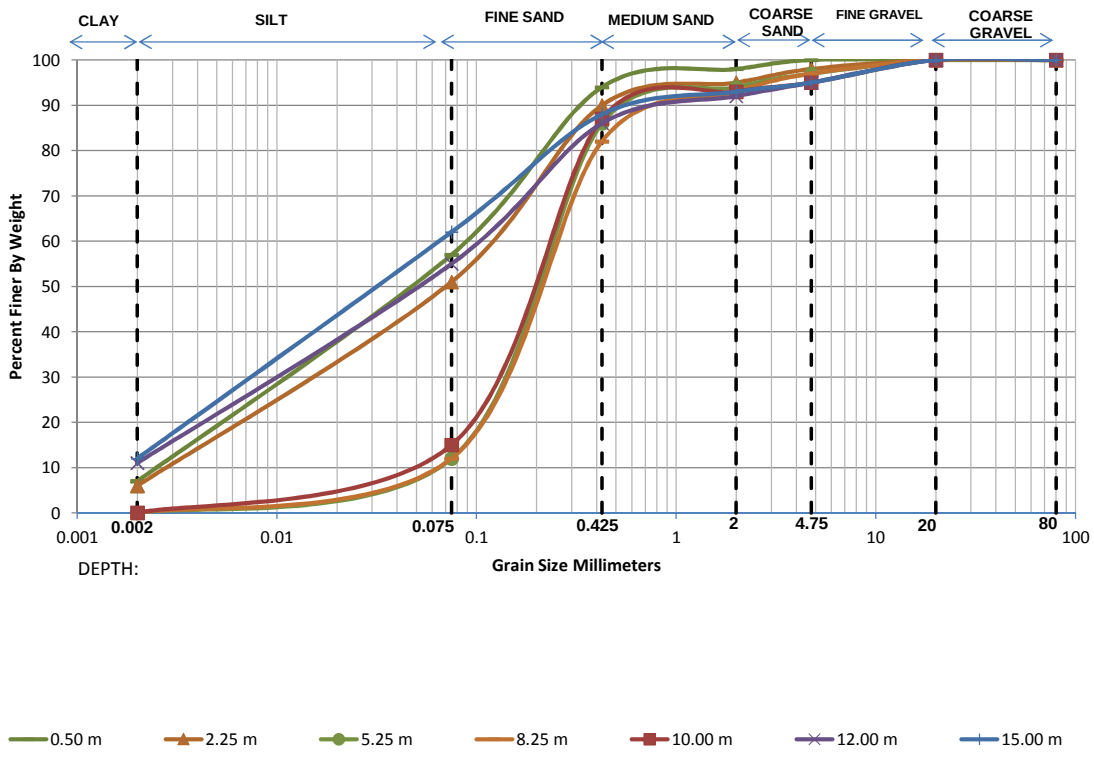
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	56+403 km
B.H. No.	BH-C/L



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	41.00	56.00	2.00	1.00	0.00	0.00	0.0078	0.0457	0.1387	17.78	1.93
2.50 m	0.00	40.00	58.00	1.00	1.00	0.00	0.00	0.0082	0.0478	0.1409	17.28	1.99
5.50 m	6.00	54.00	33.00	4.00	1.00	2.00	0.00	0.0043	0.0222	0.0750	17.37	1.52
8.50 m	7.00	54.00	31.00	4.00	1.00	3.00	0.00	0.0035	0.0204	0.0726	20.55	1.63

GRAIN SIZE DISTRIBUTION CURVES

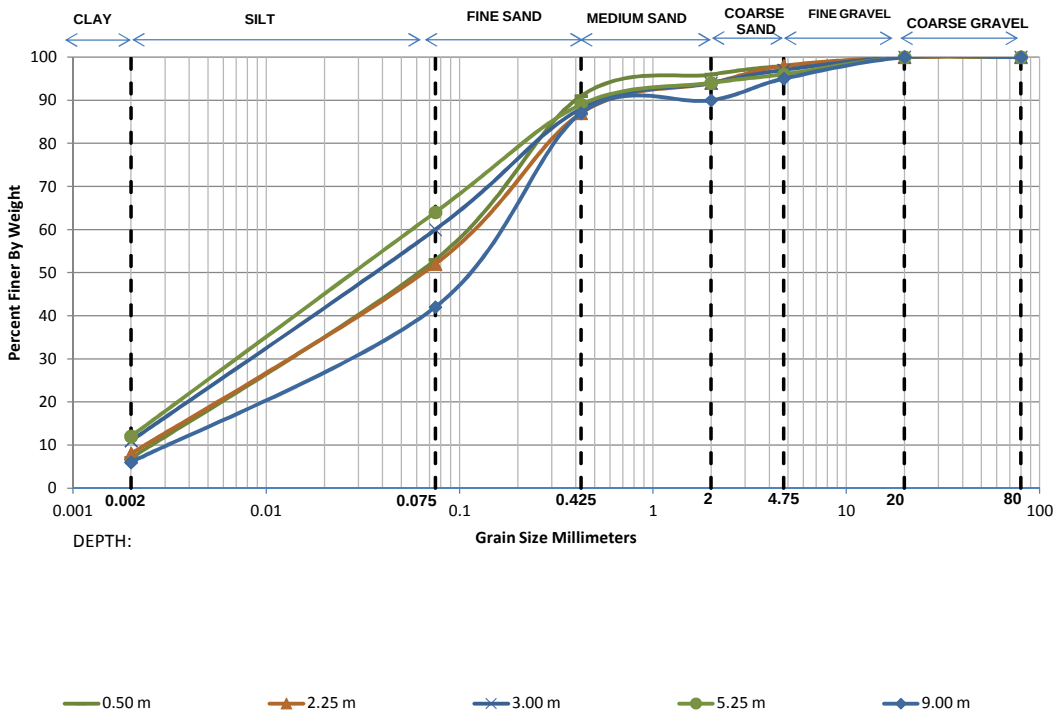
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	56+701 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	50.00	37.00	4.00	2.00	0.00	0.00	0.0036	0.0229	0.0838	23.31	1.74
2.25 m	6.00	45.00	39.00	5.00	3.00	2.00	0.00	0.0046	0.0286	0.1091	23.84	1.64
5.25 m	0.00	12.00	74.00	8.00	3.00	3.00	0.00	0.0622	0.1513	0.2562	4.12	1.44
8.25 m	0.00	12.00	70.00	11.00	4.00	3.00	0.00	0.0620	0.1538	0.2691	4.34	1.42
10.00 m	0.00	15.00	72.00	6.00	2.00	5.00	0.00	0.0453	0.1364	0.2444	5.40	1.68
12.00 m	11.00	44.00	31.00	6.00	3.00	5.00	0.00	-	0.0196	0.0949	-	-
15.00 m	12.00	50.00	26.00	5.00	2.00	5.00	0.00	-	0.0149	0.0698	-	-

GRAIN SIZE DISTRIBUTION CURVES

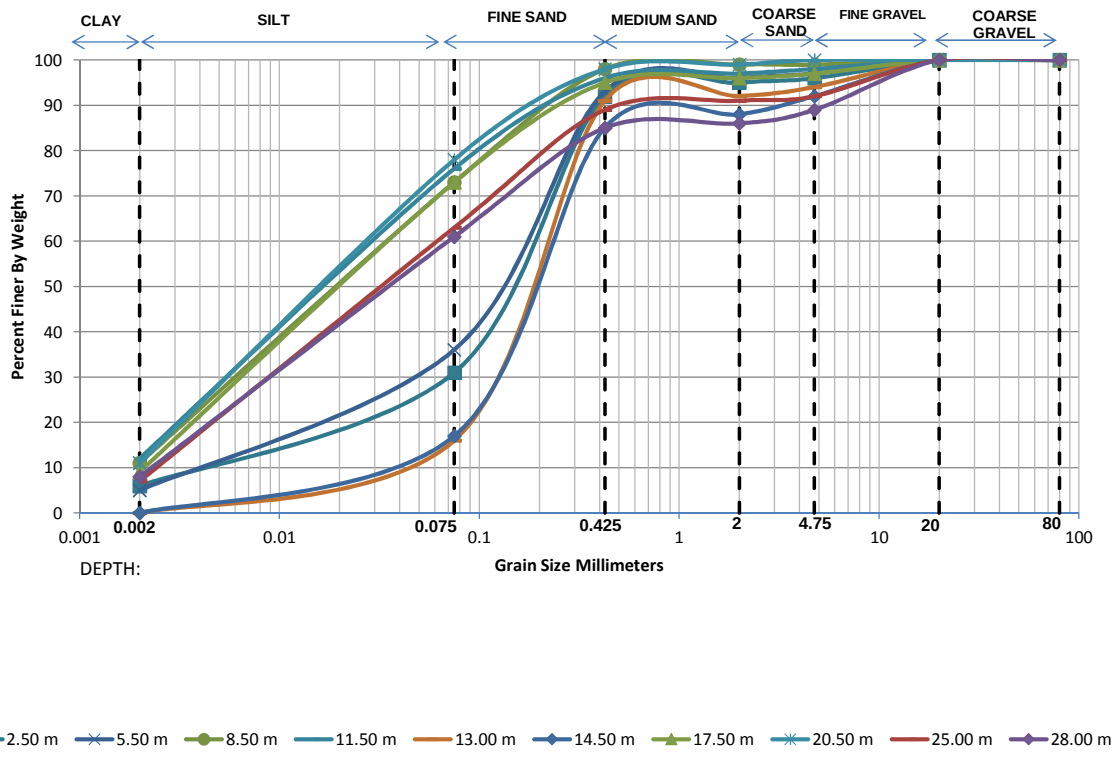
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	56+978
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	46.00	38.00	5.00	2.00	2.00	0.00	0.0037	0.0257	0.1000	27.29	1.80
2.25 m	8.00	44.00	35.00	7.00	4.00	2.00	0.00	0.0030	0.0252	0.1080	36.21	1.98
3.00 m	11.00	49.00	28.00	6.00	3.00	3.00	0.00	-	0.0167	0.0750	-	-
5.25 m	12.00	52.00	25.00	5.00	2.00	4.00	0.00	-	0.0141	0.0652	-	-
9.00 m	6.00	36.00	45.00	3.00	5.00	5.00	0.00	0.0050	0.0404	0.1528	30.31	2.12

GRAIN SIZE DISTRIBUTION CURVES

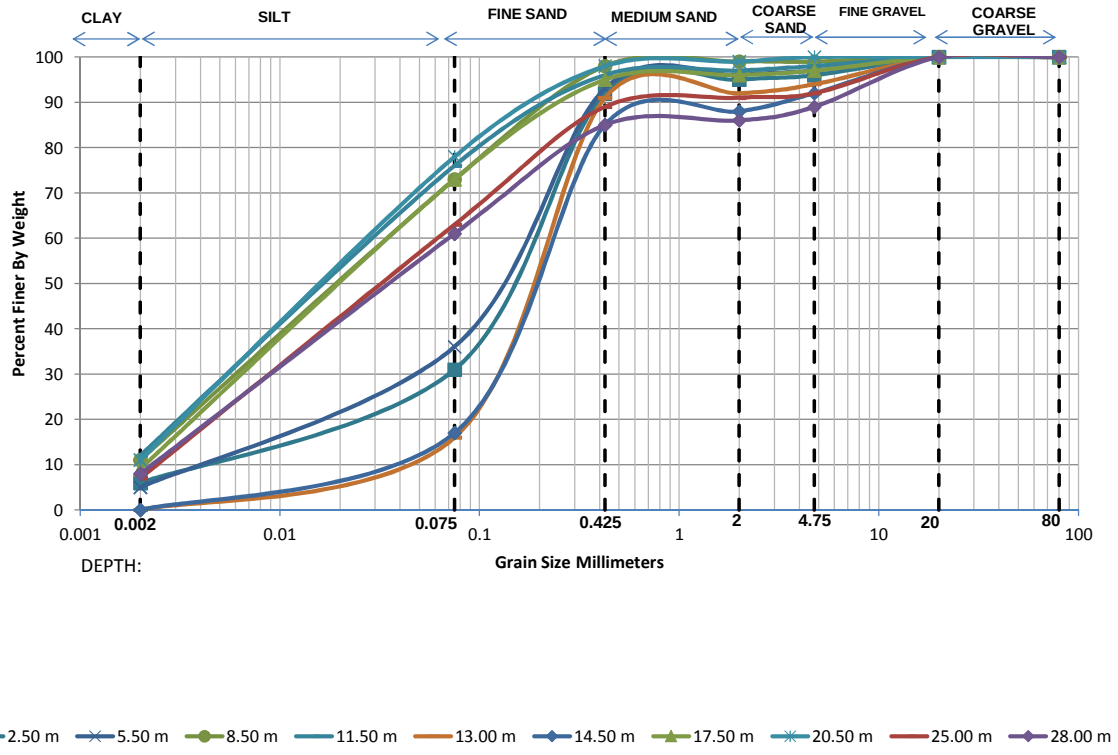
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	25.00	61.00	3.00	1.00	4.00	0.00	0.0066	0.0711	0.1859	28.09	4.11
5.50 m	5.00	31.00	57.00	3.00	1.00	3.00	0.00	0.0072	0.0552	0.1653	22.99	2.57
8.50 m	11.00	62.00	25.00	1.00	0.00	1.00	0.00	-	0.0125	0.0498	-	-
11.50 m	12.00	64.00	20.00	1.00	1.00	2.00	0.00	-	0.0110	0.0452	-	-
13.00 m	0.00	16.00	75.00	1.00	2.00	6.00	0.00	0.0411	0.1300	0.2304	5.61	1.78
14.50 m	0.00	17.00	68.00	3.00	4.00	8.00	0.00	0.0367	0.1278	0.2432	6.62	1.83
17.50 m	9.00	64.00	22.00	1.00	1.00	3.00	0.00	0.0024	0.0141	0.0504	21.17	1.66
20.50 m	11.00	67.00	20.00	1.00	1.00	0.00	0.00	-	0.0114	0.0434	-	-
25.00 m	7.00	56.00	26.00	2.00	1.00	8.00	0.00	0.0035	0.0193	0.0681	19.43	1.57
28.00 m	8.00	53.00	24.00	1.00	3.00	11.00	0.00	0.0029	0.0190	0.0725	24.96	1.72

GRAIN SIZE DISTRIBUTION CURVES

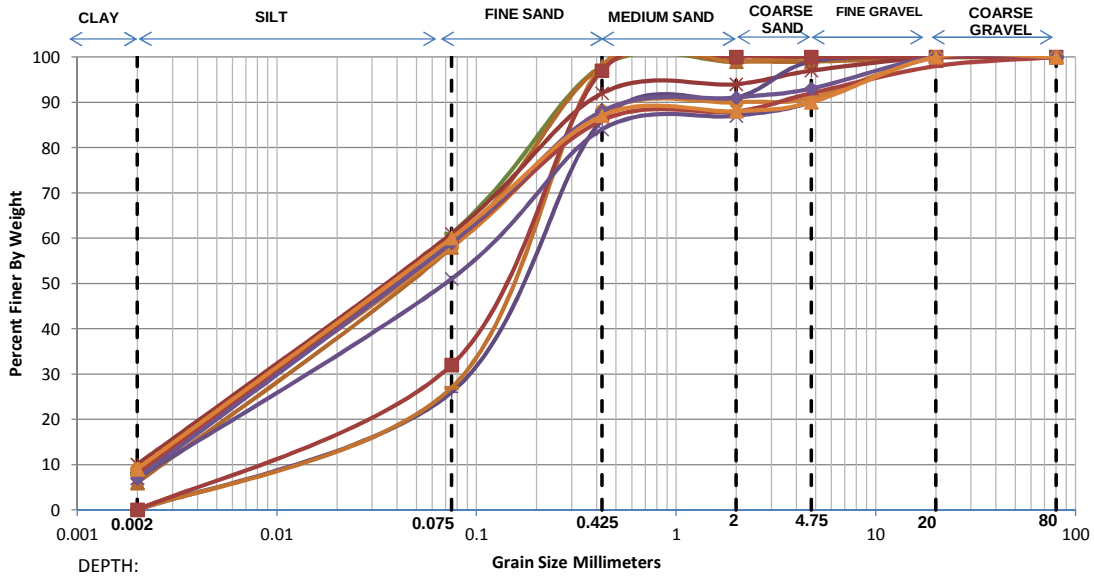
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	51.00	36.00	2.00	3.00	1.00	0.00	0.0036	0.0222	0.0806	22.51	1.72
5.50 m	9.00	67.00	11.00	4.00	3.00	6.00	0.00	0.0024	0.0132	0.0460	19.38	1.58
8.50 m	7.00	52.00	33.00	2.00	3.00	3.00	0.00	0.0036	0.0215	0.0777	21.81	1.68
11.50 m	8.00	56.00	30.00	1.00	1.00	4.00	0.00	0.0029	0.0180	0.0660	22.81	1.71
14.50 m	11.00	50.00	32.00	4.00	2.00	1.00	0.00	-	0.0164	0.0724	-	-
17.50 m	10.00	60.00	26.00	1.00	1.00	2.00	0.00	0.0020	0.0141	0.0546	27.29	1.81
20.50 m	6.00	56.00	33.00	1.00	2.00	2.00	0.00	0.0043	0.0212	0.0704	16.46	1.50
23.50 m	7.00	56.00	29.00	5.00	1.00	2.00	0.00	0.0035	0.0195	0.0681	19.43	1.59
26.50 m	9.00	62.00	25.00	2.00	0.00	2.00	0.00	0.0024	0.0147	0.0534	22.38	1.69
29.50 m	7.00	52.00	27.00	1.00	3.00	10.00	0.00	0.0036	0.0212	0.0778	21.91	1.63

GRAIN SIZE DISTRIBUTION CURVES

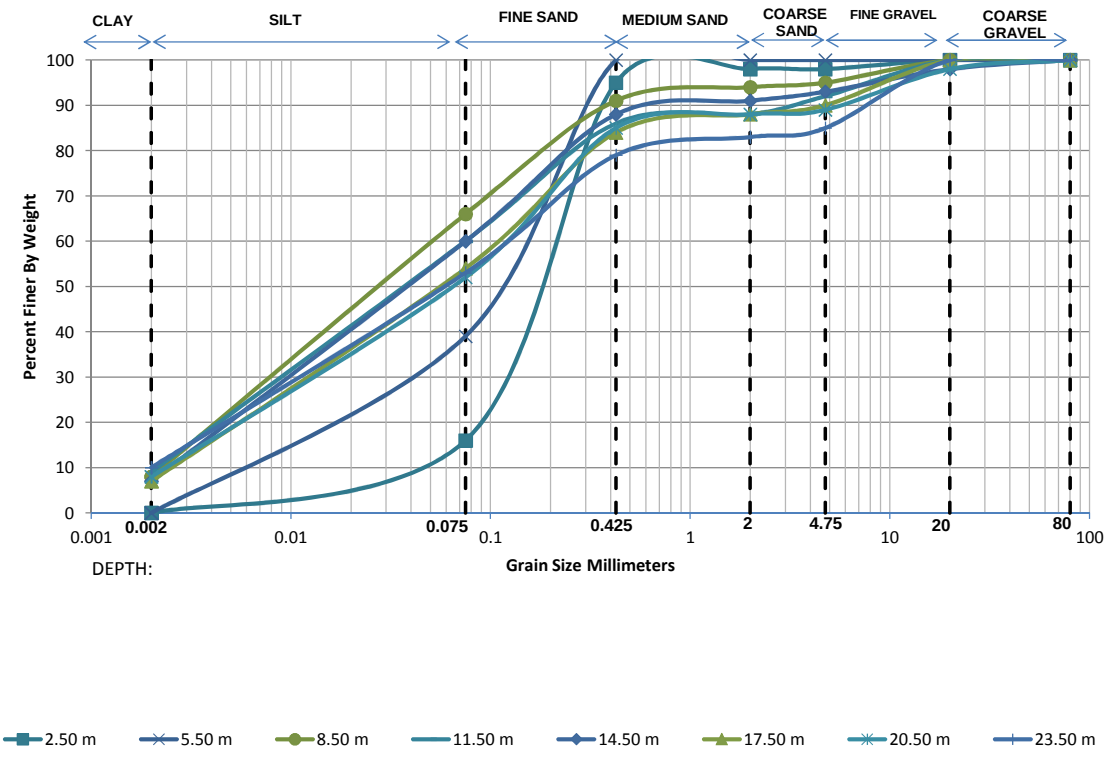
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P3



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	8.00	53.00	37.00	1.00	1.00	0.00	0.00	0.0029	0.0196	0.0726	24.93	1.82
4.00 m	6.00	52.00	40.00	1.00	0.00	1.00	0.00	0.0044	0.0236	0.0803	18.33	1.59
7.00 m	10.00	51.00	31.00	2.00	3.00	3.00	0.00	0.0020	0.0174	0.0725	36.24	2.08
10.00 m	0.00	26.00	60.00	5.00	8.00	1.00	0.00	0.0171	0.0898	0.2134	12.46	2.21
13.00 m	0.00	27.00	71.00	1.00	1.00	0.00	0.00	0.0165	0.0852	0.1839	11.16	2.40
16.00 m	0.00	32.00	65.00	3.00	0.00	0.00	0.00	0.0120	0.0685	0.1698	14.09	2.30
19.00 m	7.00	44.00	33.00	3.00	3.00	10.00	0.00	0.0037	0.0271	0.1154	31.25	1.72
22.00 m	9.00	49.00	30.00	2.00	1.00	9.00	0.00	0.0024	0.0198	0.0812	33.72	2.00
25.00 m	8.00	51.00	27.00	2.00	4.00	6.00	2.00	0.0029	0.0201	0.0779	26.68	1.79
28.00 m	7.00	52.00	29.00	3.00	2.00	7.00	0.00	0.0036	0.0213	0.0778	21.88	1.65
31.00 m	9.00	51.00	27.00	1.00	2.00	10.00	0.00	0.0024	0.0186	0.0750	31.21	1.92

GRAIN SIZE DISTRIBUTION CURVES

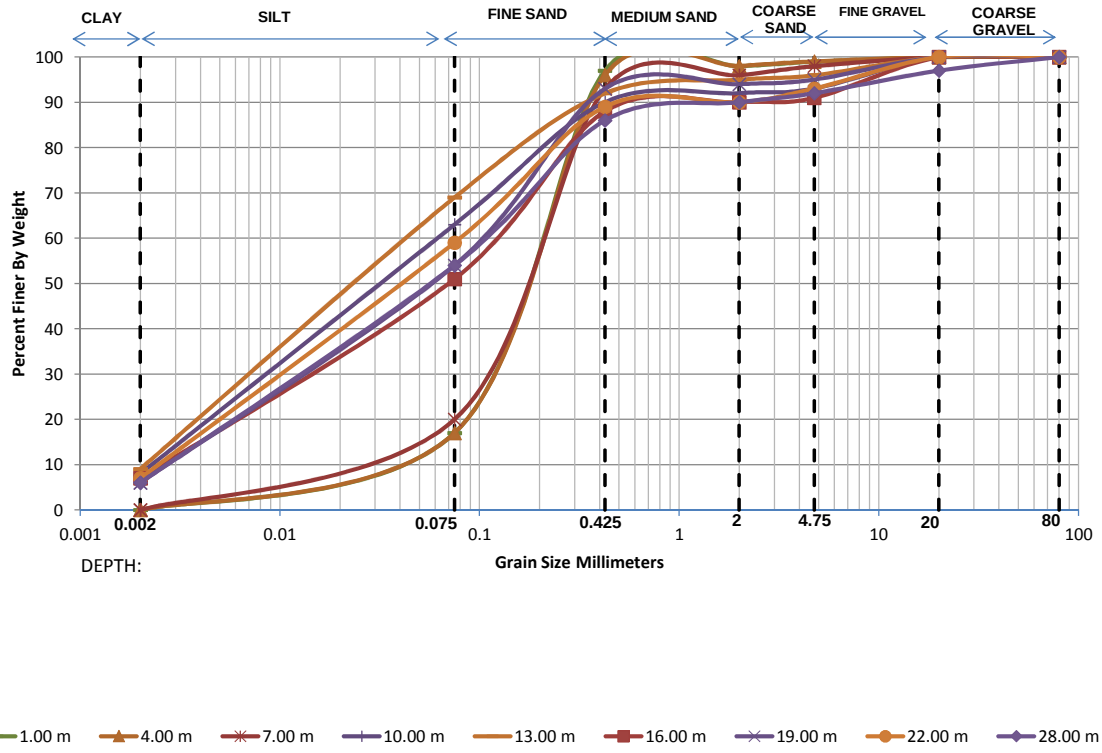
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P4



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	16.00	79.00	3.00	0.00	2.00	0.00	0.0414	0.1287	0.2232	5.40	1.80
5.50 m	0.00	39.00	61.00	0.00	0.00	0.00	0.00	0.0086	0.0501	0.1964	22.95	1.49
8.50 m	8.00	58.00	25.00	3.00	1.00	5.00	0.00	0.0029	0.0171	0.0619	21.51	1.64
11.50 m	9.00	51.00	26.00	2.00	4.00	8.00	0.00	0.0024	0.0186	0.0750	31.21	1.91
14.50 m	7.00	53.00	28.00	3.00	2.00	5.00	2.00	0.0035	0.0208	0.0750	21.18	1.63
17.50 m	7.00	47.00	30.00	4.00	2.00	10.00	0.00	0.0036	0.0245	0.1002	27.58	1.65
20.50 m	8.00	44.00	33.00	3.00	1.00	9.00	2.00	0.0030	0.0251	0.1094	36.68	1.93
23.50 m	10.00	43.00	26.00	4.00	2.00	15.00	0.00	0.0020	0.0217	0.1129	56.43	2.09

GRAIN SIZE DISTRIBUTION CURVES

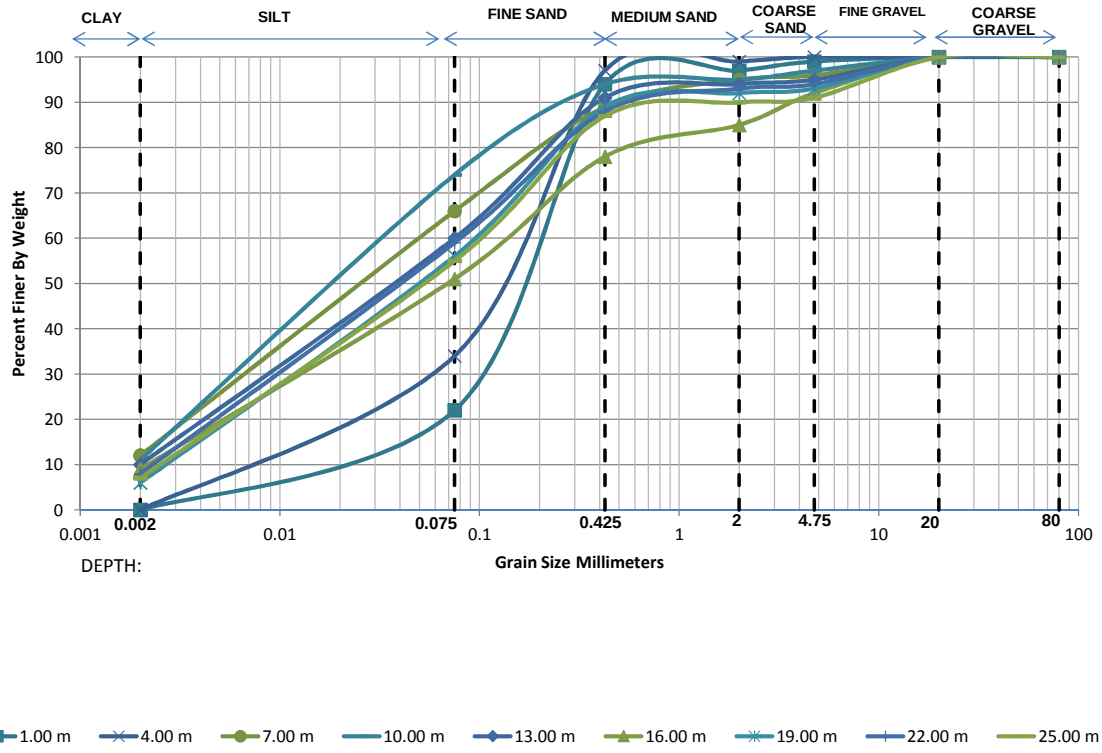
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P5



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	17.00	80.00	1.00	1.00	1.00	0.00	0.0376	0.1238	0.2162	5.76	1.89
4.00 m	0.00	17.00	79.00	2.00	1.00	1.00	0.00	0.0375	0.1241	0.2182	5.82	1.88
7.00 m	0.00	20.00	73.00	3.00	2.00	2.00	0.00	0.0281	0.1125	0.2148	7.63	2.10
10.00 m	8.00	55.00	27.00	2.00	1.00	7.00	0.00	0.0029	0.0183	0.0680	23.48	1.70
13.00 m	9.00	60.00	23.00	3.00	1.00	4.00	0.00	0.0024	0.0151	0.0563	23.61	1.70
16.00 m	7.00	44.00	37.00	2.00	1.00	9.00	0.00	0.0037	0.0273	0.1106	29.87	1.82
19.00 m	6.00	48.00	39.00	1.00	1.00	5.00	0.00	0.0045	0.0262	0.0945	21.10	1.62
22.00 m	7.00	52.00	30.00	1.00	3.00	7.00	0.00	0.0036	0.0214	0.0777	21.85	1.65
28.00 m	6.00	48.00	32.00	4.00	2.00	5.00	3.00	0.0045	0.0258	0.0984	22.08	1.51

GRAIN SIZE DISTRIBUTION CURVES

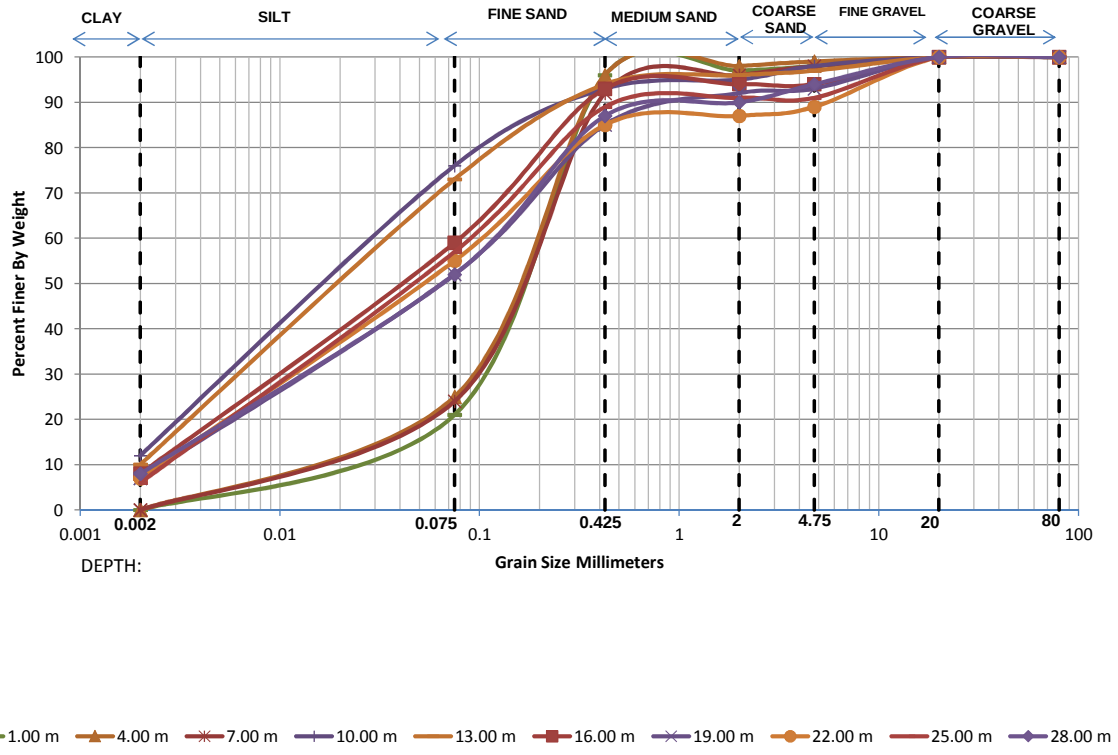
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P6



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	22.00	72.00	3.00	2.00	1.00	0.00	0.0238	0.1043	0.2068	8.70	2.22
4.00 m	0.00	34.00	63.00	2.00	1.00	0.00	0.00	0.0108	0.0626	0.1629	15.08	2.23
7.00 m	12.00	54.00	23.00	6.00	1.00	4.00	0.00	-	0.0134	0.0609	-	-
10.00 m	11.00	63.00	20.00	1.00	2.00	3.00	0.00	-	0.0121	0.0481	-	-
13.00 m	10.00	50.00	31.00	3.00	1.00	5.00	0.00	0.0020	0.0178	0.0750	37.50	2.12
16.00 m	9.00	42.00	27.00	7.00	7.00	8.00	0.00	0.0024	0.0245	0.1290	53.15	1.91
19.00 m	6.00	50.00	33.00	3.00	1.00	7.00	0.00	0.0044	0.0245	0.0882	20.02	1.54
22.00 m	8.00	51.00	29.00	5.00	1.00	6.00	0.00	0.0029	0.0202	0.0778	26.65	1.80
25.00 m	7.00	48.00	32.00	3.00	1.00	9.00	0.00	0.0036	0.0239	0.0933	25.79	1.69

GRAIN SIZE DISTRIBUTION CURVES

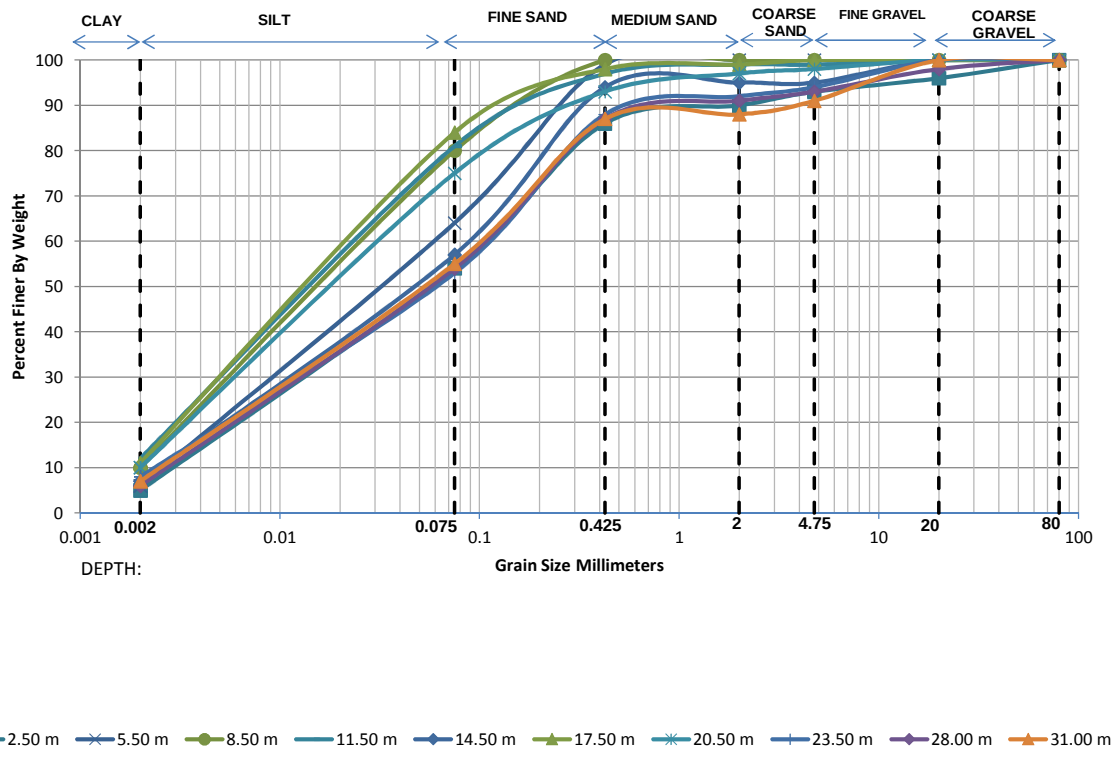
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P7



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	21.00	75.00	1.00	1.00	2.00	0.00	0.0260	0.1078	0.2057	7.93	2.18
4.00 m	0.00	25.00	71.00	2.00	1.00	1.00	0.00	0.0189	0.0926	0.1936	10.25	2.34
7.00 m	0.00	24.00	68.00	4.00	2.00	2.00	0.00	0.0202	0.0969	0.2048	10.15	2.27
10.00 m	12.00	64.00	17.00	2.00	3.00	2.00	0.00	-	0.0109	0.0450	-	-
13.00 m	10.00	63.00	21.00	2.00	1.00	3.00	0.00	0.0020	0.0132	0.0499	24.97	1.74
16.00 m	8.00	51.00	34.00	1.00	0.00	6.00	0.00	0.0029	0.0205	0.0777	26.56	1.85
19.00 m	7.00	45.00	33.00	7.00	1.00	7.00	0.00	0.0037	0.0262	0.1099	29.91	1.70
22.00 m	7.00	48.00	30.00	2.00	2.00	11.00	0.00	0.0036	0.0238	0.0943	26.08	1.66
25.00 m	6.00	51.00	32.00	2.00	0.00	9.00	0.00	0.0044	0.0238	0.0844	19.26	1.53
28.00 m	8.00	44.00	35.00	3.00	4.00	6.00	0.00	0.0030	0.0252	0.1074	35.98	1.99

GRAIN SIZE DISTRIBUTION CURVES

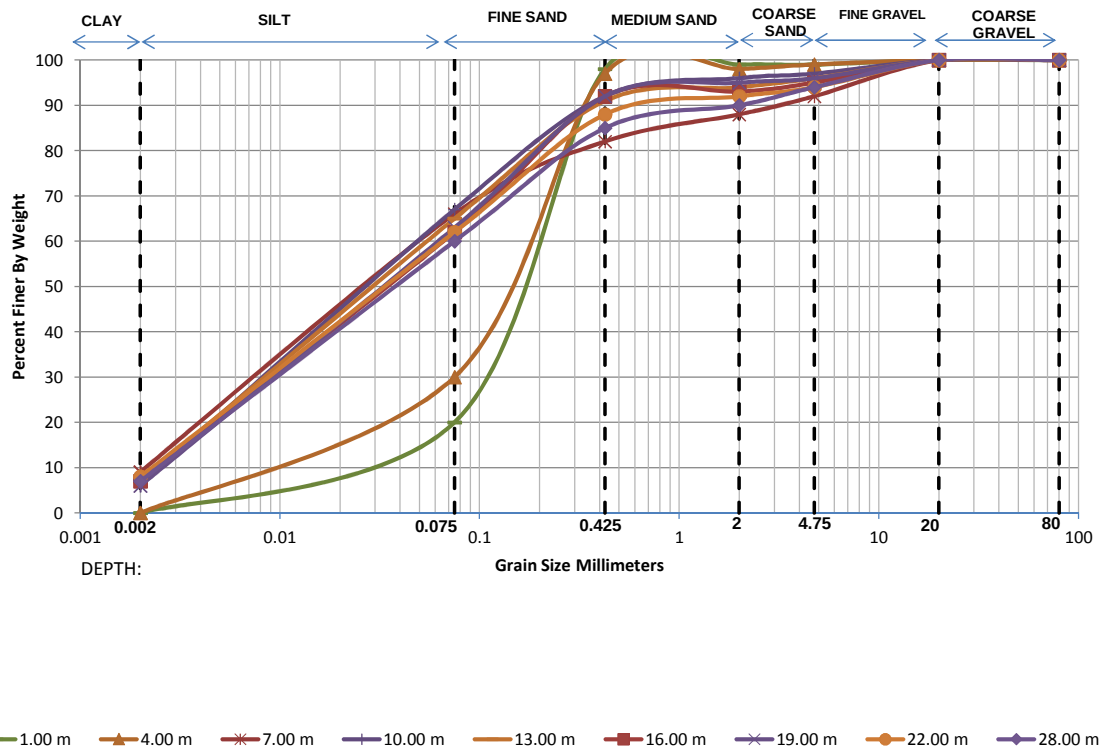
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P9



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	49.00	32.00	4.00	3.00	3.00	4.00	0.0055	0.0270	0.0982	17.97	1.36
5.50 m	6.00	58.00	35.00	1.00	0.00	0.00	0.00	0.0042	0.0205	0.0664	15.63	1.49
8.50 m	10.00	70.00	20.00	0.00	0.00	0.00	0.00	0.0020	0.0119	0.0418	20.91	1.68
11.50 m	12.00	69.00	16.00	2.00	0.00	1.00	0.00	-	0.0101	0.0396	-	-
14.50 m	7.00	50.00	37.00	1.00	0.00	5.00	0.00	0.0036	0.0229	0.0837	23.29	1.74
17.50 m	11.00	73.00	14.00	1.00	1.00	0.00	0.00	-	0.0104	0.0374	-	-
20.50 m	10.00	65.00	18.00	4.00	1.00	2.00	0.00	0.0020	0.0127	0.0472	23.59	1.71
23.50 m	8.00	45.00	35.00	4.00	2.00	6.00	0.00	0.0030	0.0244	0.1021	34.32	1.97
28.00 m	6.00	48.00	33.00	4.00	2.00	5.00	2.00	0.0045	0.0258	0.0978	21.91	1.53
31.00 m	7.00	48.00	32.00	1.00	3.00	9.00	0.00	0.0036	0.0239	0.0931	25.74	1.69

GRAIN SIZE DISTRIBUTION CURVES

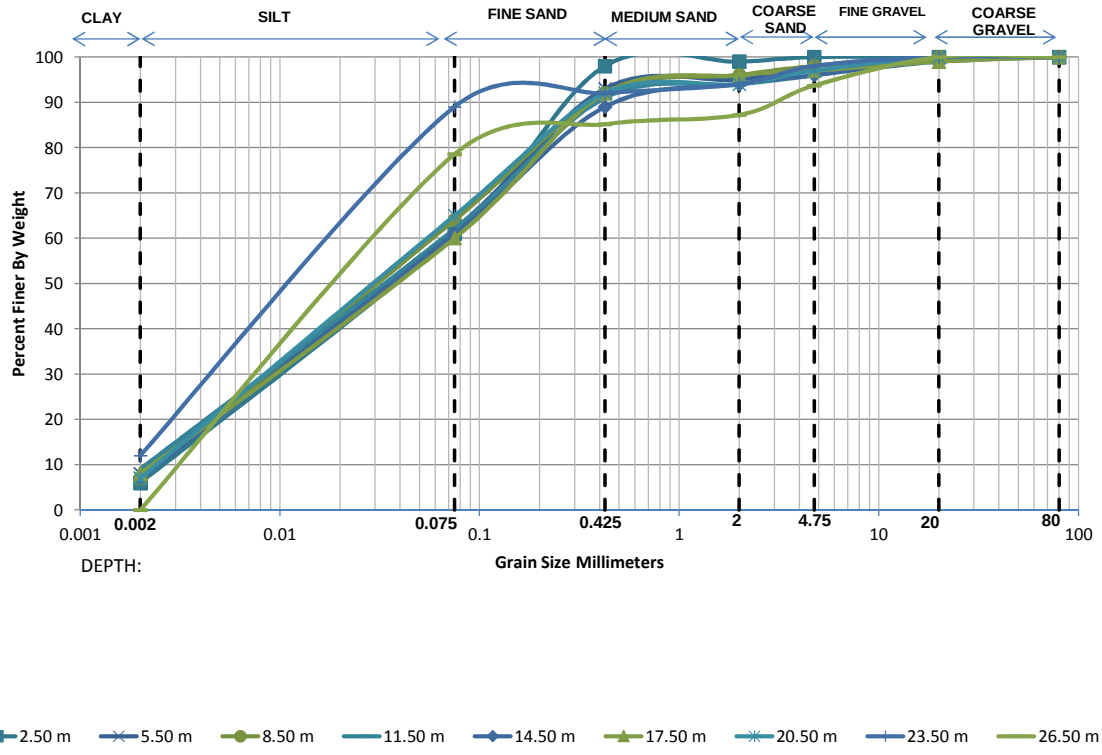
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P10



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	20.00	78.00	1.00	0.00	1.00	0.00	0.0284	0.1114	0.2055	7.23	2.12
4.00 m	0.00	30.00	67.00	1.00	1.00	1.00	0.00	0.0135	0.0750	0.1758	12.98	2.36
7.00 m	9.00	57.00	16.00	6.00	4.00	8.00	0.00	0.0024	0.0158	0.0613	25.66	1.70
10.00 m	6.00	61.00	25.00	4.00	1.00	3.00	0.00	0.0042	0.0190	0.0606	14.50	1.42
13.00 m	7.00	58.00	26.00	3.00	2.00	4.00	0.00	0.0035	0.0186	0.0640	18.38	1.55
16.00 m	7.00	55.00	30.00	1.00	2.00	5.00	0.00	0.0035	0.0199	0.0703	19.98	1.61
19.00 m	6.00	57.00	29.00	3.00	1.00	4.00	0.00	0.0043	0.0206	0.0683	16.05	1.47
22.00 m	8.00	54.00	26.00	4.00	2.00	6.00	0.00	0.0029	0.0187	0.0702	24.20	1.72
28.00 m	7.00	53.00	25.00	5.00	4.00	6.00	0.00	0.0035	0.0206	0.0750	21.20	1.60

GRAIN SIZE DISTRIBUTION CURVES

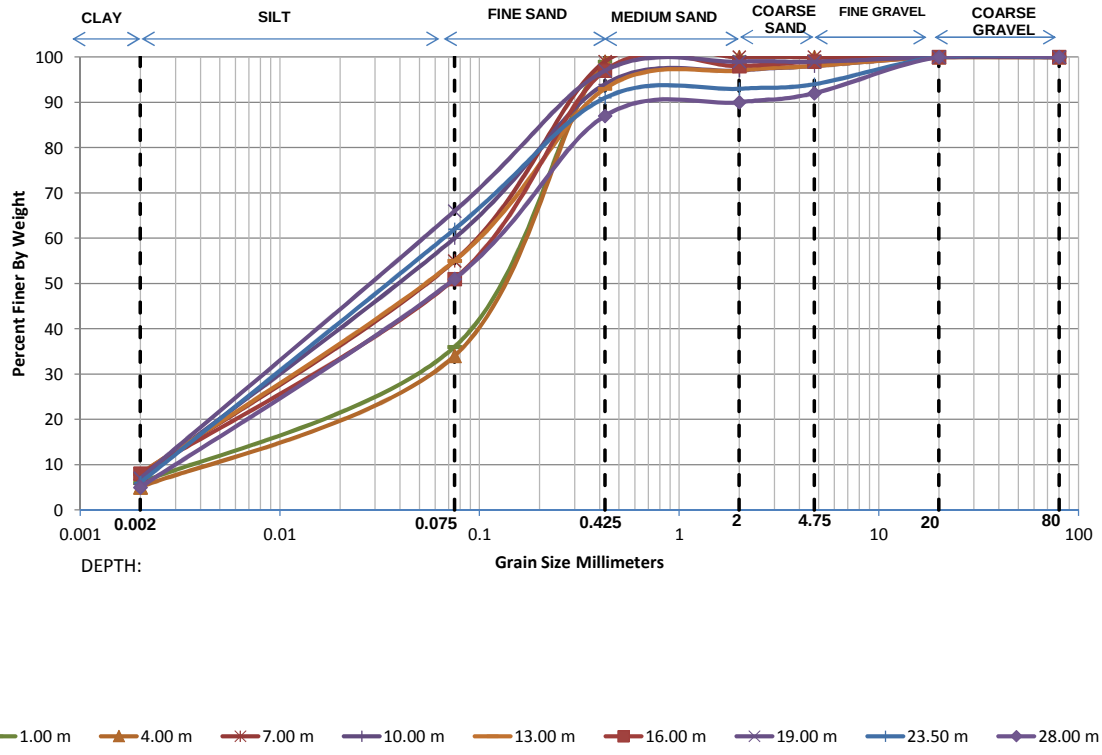
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P11



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	55.00	37.00	1.00	1.00	0.00	0.00	0.0043	0.0219	0.0727	16.88	1.53
5.50 m	8.00	54.00	31.00	2.00	3.00	2.00	0.00	0.0029	0.0189	0.0703	24.20	1.75
8.50 m	7.00	57.00	28.00	4.00	2.00	2.00	0.00	0.0035	0.0190	0.0661	18.90	1.57
11.50 m	9.00	53.00	29.00	3.00	2.00	4.00	0.00	0.0024	0.0178	0.0701	29.23	1.88
14.50 m	7.00	54.00	28.00	5.00	2.00	3.00	1.00	0.0035	0.0203	0.0726	20.57	1.61
17.50 m	8.00	52.00	32.00	4.00	1.00	2.00	1.00	0.0029	0.0199	0.0750	25.72	1.81
20.50 m	7.00	58.00	27.00	2.00	3.00	3.00	0.00	0.0035	0.0186	0.0641	18.39	1.55
23.50 m	12.00	77.00	3.00	2.00	4.00	2.00	0.00	-	0.0090	0.0325	-	-
26.50 m	0.00	78.55	6.60	2.05	6.50	6.30	0.00	0.0032	0.0129	0.0449	13.96	1.15

GRAIN SIZE DISTRIBUTION CURVES

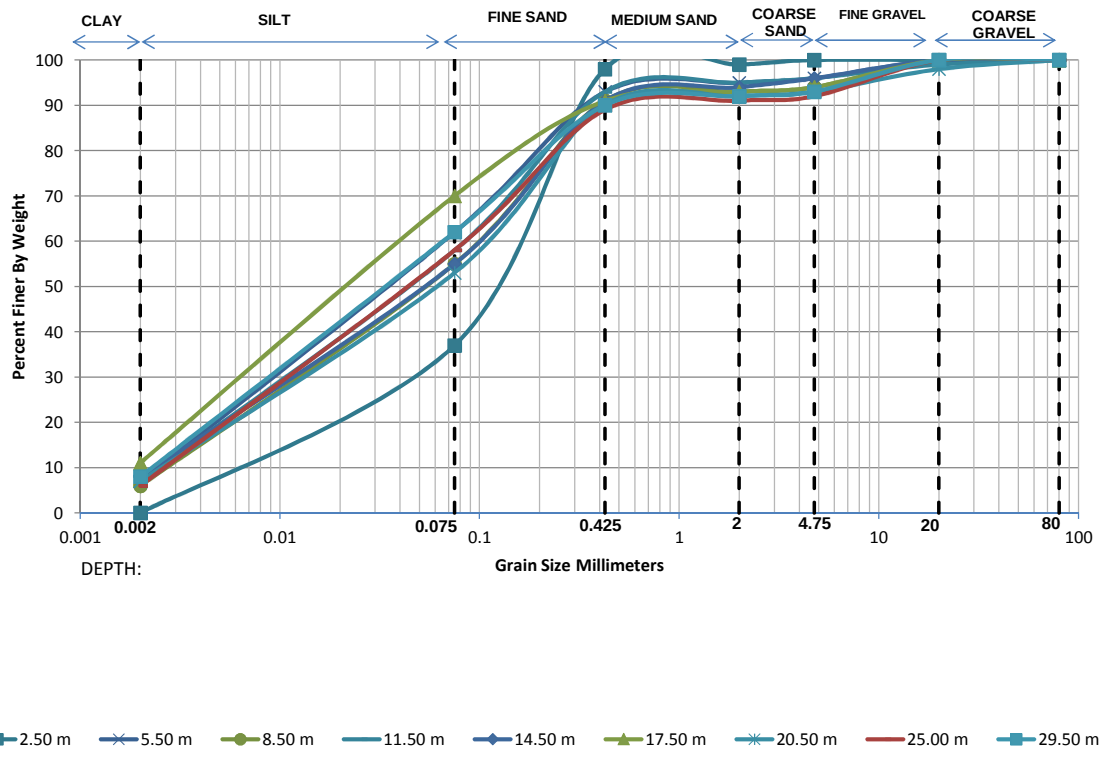
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P12



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	30.00	63.00	1.00	0.00	0.00	0.00	0.0057	0.0550	0.1571	27.35	3.35
4.00 m	5.00	29.00	65.00	1.00	0.00	0.00	0.00	0.0077	0.0613	0.1633	21.27	3.00
7.00 m	8.00	47.00	44.00	1.00	0.00	0.00	0.00	0.0030	0.0235	0.0898	30.30	2.07
10.00 m	7.00	53.00	34.00	3.00	1.00	2.00	0.00	0.0035	0.0211	0.0750	21.13	1.67
13.00 m	8.00	47.00	38.00	4.00	1.00	2.00	0.00	0.0030	0.0231	0.0913	30.87	1.98
16.00 m	8.00	43.00	46.00	1.00	1.00	1.00	0.00	0.0030	0.0268	0.1047	34.83	2.28
19.00 m	7.00	59.00	31.00	2.00	0.00	1.00	0.00	0.0035	0.0184	0.0623	17.92	1.56
23.50 m	6.00	56.00	29.00	2.00	1.00	6.00	0.00	0.0043	0.0211	0.0704	16.48	1.48
28.00 m	5.00	46.00	36.00	3.00	2.00	8.00	0.00	0.0056	0.0297	0.1113	19.81	1.41

GRAIN SIZE DISTRIBUTION CURVES

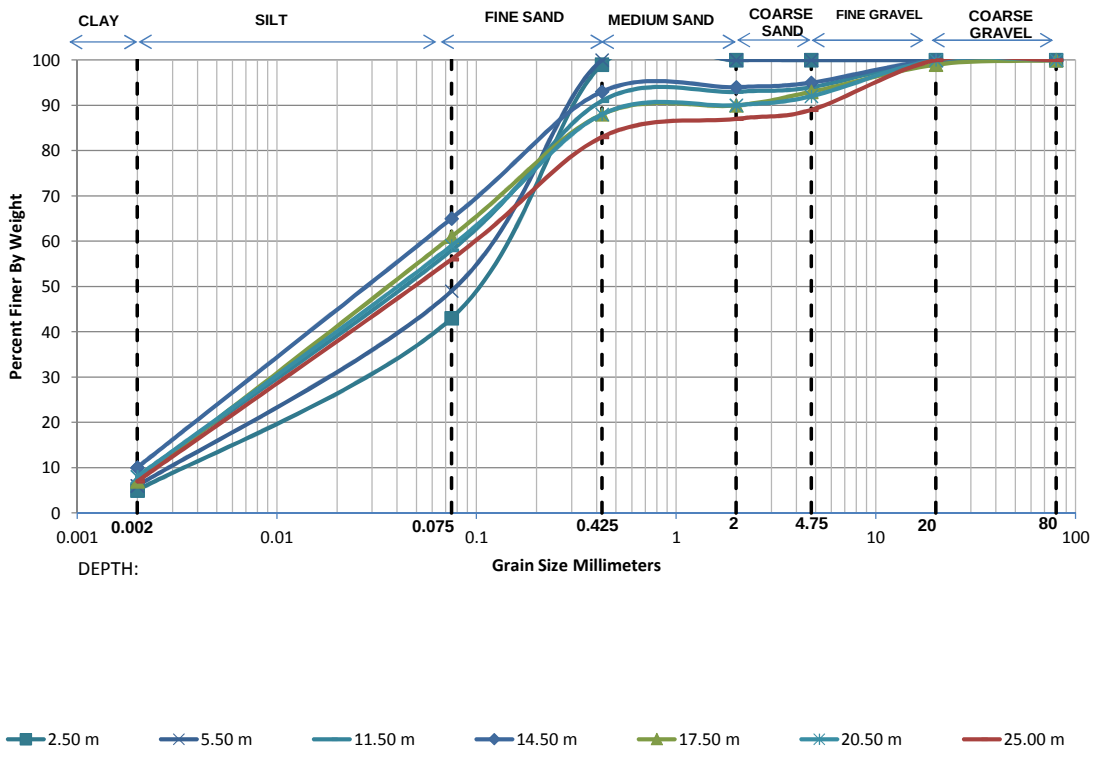
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P13



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	37.00	61.00	1.00	1.00	0.00	0.00	0.0093	0.0546	0.1512	16.22	2.12
5.50 m	7.00	55.00	31.00	2.00	1.00	4.00	0.00	0.0035	0.0200	0.0703	19.98	1.61
8.50 m	6.00	49.00	36.00	2.00	1.00	6.00	0.00	0.0044	0.0253	0.0915	20.59	1.57
11.50 m	7.00	51.00	35.00	2.00	1.00	3.00	1.00	0.0036	0.0222	0.0806	22.53	1.71
14.50 m	8.00	47.00	36.00	3.00	2.00	4.00	0.00	0.0030	0.0230	0.0919	31.08	1.95
17.50 m	11.00	59.00	21.00	2.00	1.00	6.00	0.00	-	0.0130	0.0540	-	-
20.50 m	7.00	46.00	37.00	2.00	1.00	5.00	2.00	0.0037	0.0257	0.1003	27.37	1.79
25.00 m	6.00	52.00	31.00	2.00	1.00	8.00	0.00	0.0044	0.0232	0.0809	18.56	1.52
29.50 m	8.00	54.00	28.00	2.00	1.00	7.00	0.00	0.0029	0.0188	0.0702	24.20	1.73

GRAIN SIZE DISTRIBUTION CURVES

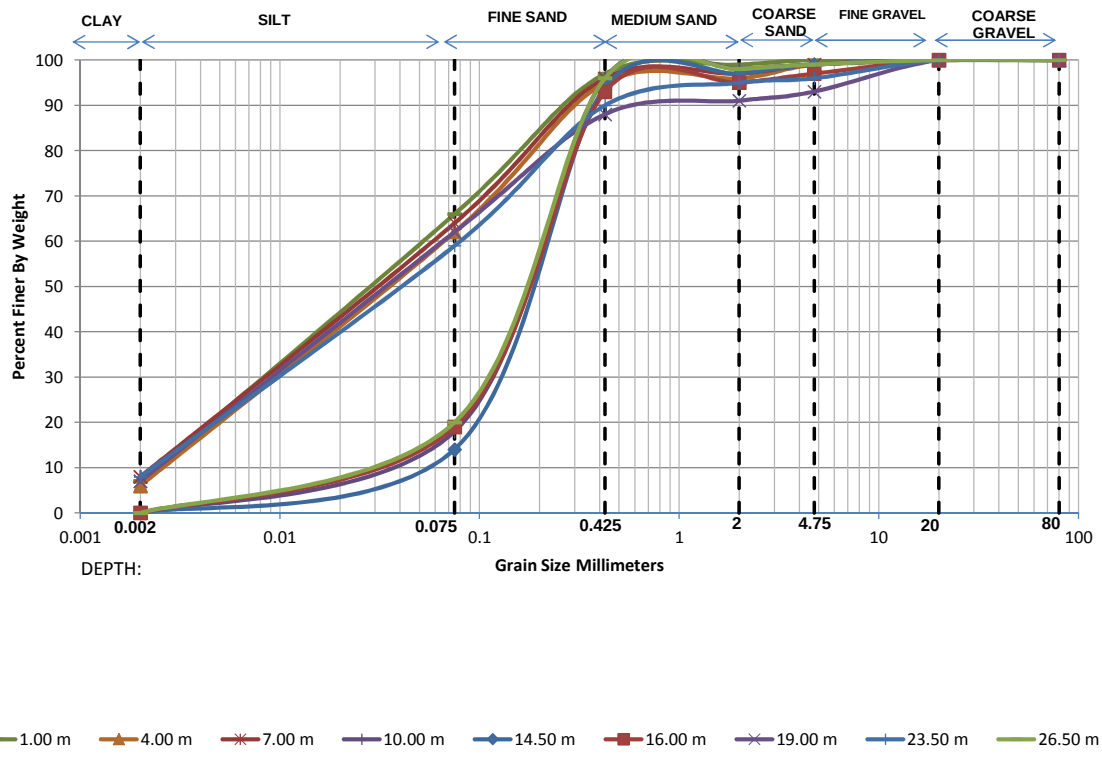
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P15



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	38.00	56.00	1.00	0.00	0.00	0.00	0.0063	0.0406	0.1317	20.98	2.00
5.50 m	6.00	43.00	51.00	0.00	0.00	0.00	0.00	0.0047	0.0313	0.1352	28.82	1.55
11.50 m	8.00	50.00	33.00	2.00	1.00	6.00	0.00	0.0029	0.0210	0.0808	27.59	1.86
14.50 m	10.00	55.00	28.00	1.00	1.00	5.00	0.00	0.0020	0.0156	0.0635	31.76	1.93
17.50 m	7.00	54.00	27.00	2.00	3.00	6.00	1.00	0.0035	0.0203	0.0726	20.57	1.60
20.50 m	8.00	51.00	29.00	2.00	2.00	8.00	0.00	0.0029	0.0202	0.0778	26.64	1.80
25.00 m	7.00	49.00	27.00	4.00	2.00	11.00	0.00	0.0036	0.0229	0.0909	25.28	1.61

GRAIN SIZE DISTRIBUTION CURVES

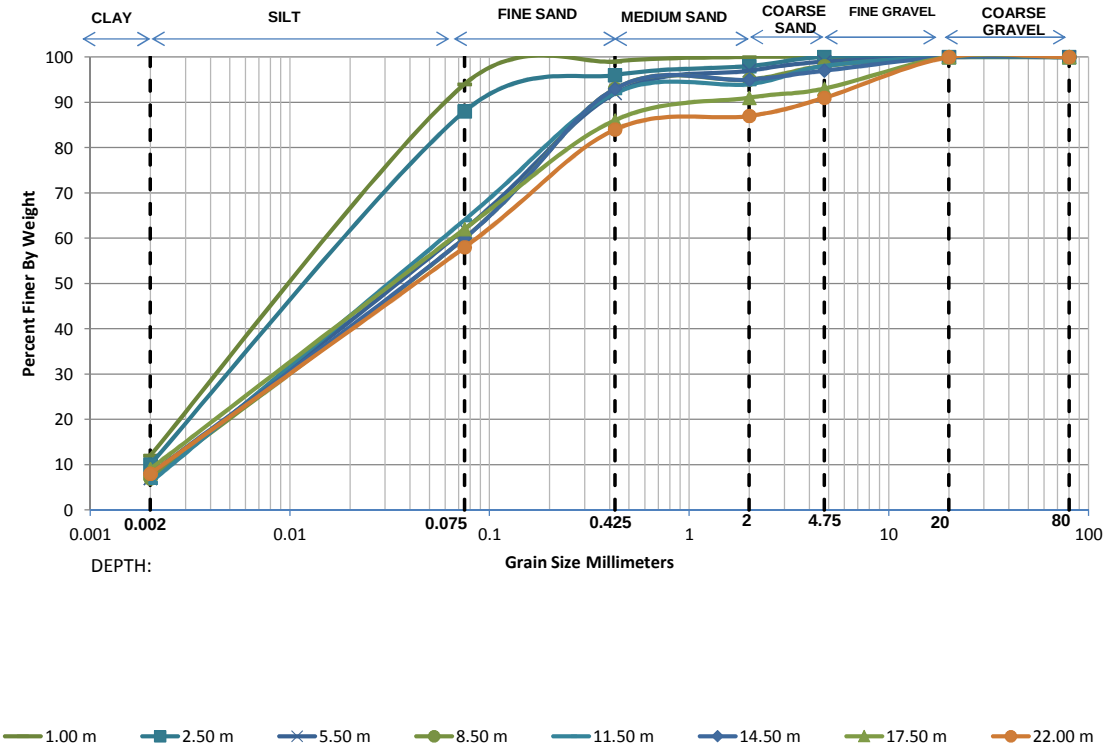
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P16



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	59.00	31.00	2.00	1.00	0.00	0.00	0.0035	0.0184	0.0623	17.92	1.56
4.00 m	6.00	56.00	33.00	1.00	3.00	1.00	0.00	0.0043	0.0212	0.0704	16.46	1.50
7.00 m	8.00	56.00	32.00	1.00	2.00	1.00	0.00	0.0029	0.0181	0.0660	22.82	1.72
10.00 m	0.00	18.00	78.00	2.00	1.00	1.00	0.00	0.0340	0.1200	0.2151	6.32	1.97
14.50 m	0.00	14.00	80.00	3.00	2.00	1.00	0.00	0.0508	0.1379	0.2311	4.55	1.62
16.00 m	0.00	19.00	74.00	2.00	2.00	3.00	0.00	0.0308	0.1166	0.2176	7.06	2.03
19.00 m	7.00	55.00	26.00	3.00	2.00	7.00	0.00	0.0035	0.0198	0.0703	19.99	1.58
23.50 m	8.00	51.00	31.00	5.00	1.00	4.00	0.00	0.0029	0.0204	0.0778	26.61	1.82
26.50 m	0.00	20.00	76.00	2.00	1.00	1.00	0.00	0.0283	0.1118	0.2090	7.38	2.11

GRAIN SIZE DISTRIBUTION CURVES

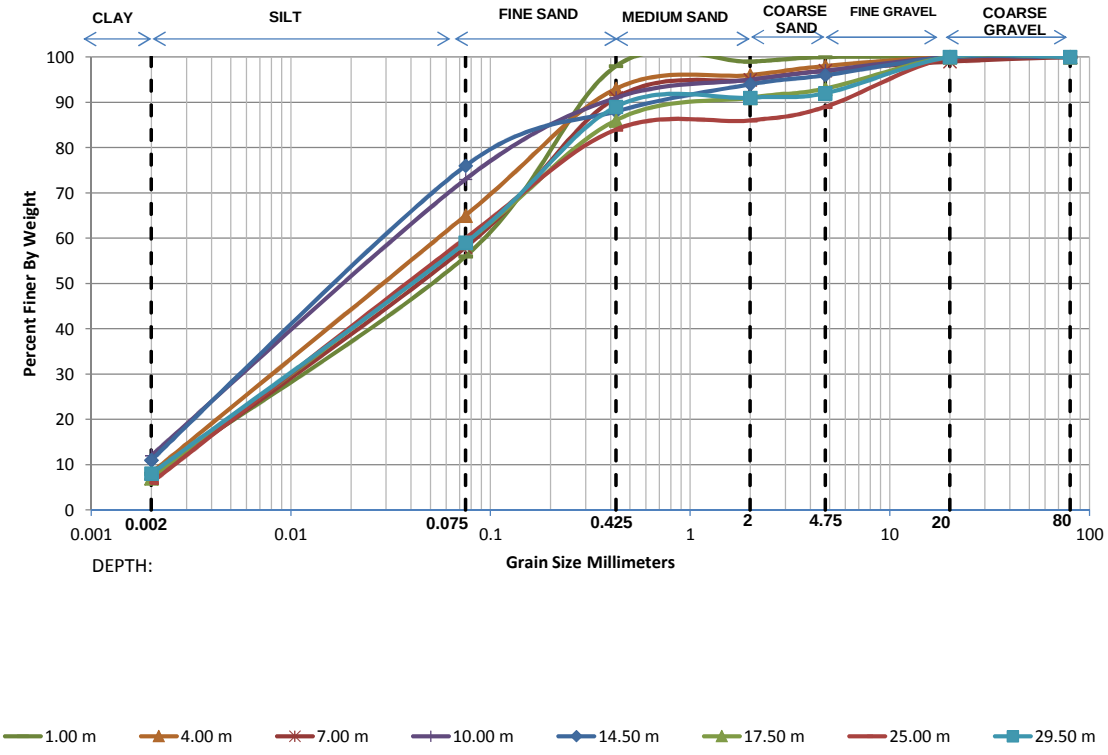
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P17



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	12.00	82.00	5.00	1.00	0.00	0.00	0.00	-	0.0087	0.0296	-	-
2.50 m	10.00	78.00	8.00	2.00	2.00	0.00	0.00	0.0020	0.0106	0.0346	17.29	1.62
5.50 m	7.00	55.00	30.00	5.00	2.00	1.00	0.00	0.0035	0.0199	0.0703	19.98	1.61
8.50 m	7.00	53.00	33.00	2.00	3.00	2.00	0.00	0.0035	0.0210	0.0750	21.14	1.66
11.50 m	6.00	58.00	28.00	2.00	4.00	2.00	0.00	0.0042	0.0202	0.0662	15.64	1.45
14.50 m	8.00	52.00	33.00	2.00	2.00	3.00	0.00	0.0029	0.0199	0.0750	25.71	1.82
17.50 m	9.00	53.00	24.00	5.00	2.00	7.00	0.00	0.0024	0.0176	0.0701	29.21	1.84
22.00 m	8.00	50.00	26.00	3.00	4.00	9.00	0.00	0.0029	0.0206	0.0817	27.91	1.78

GRAIN SIZE DISTRIBUTION CURVES

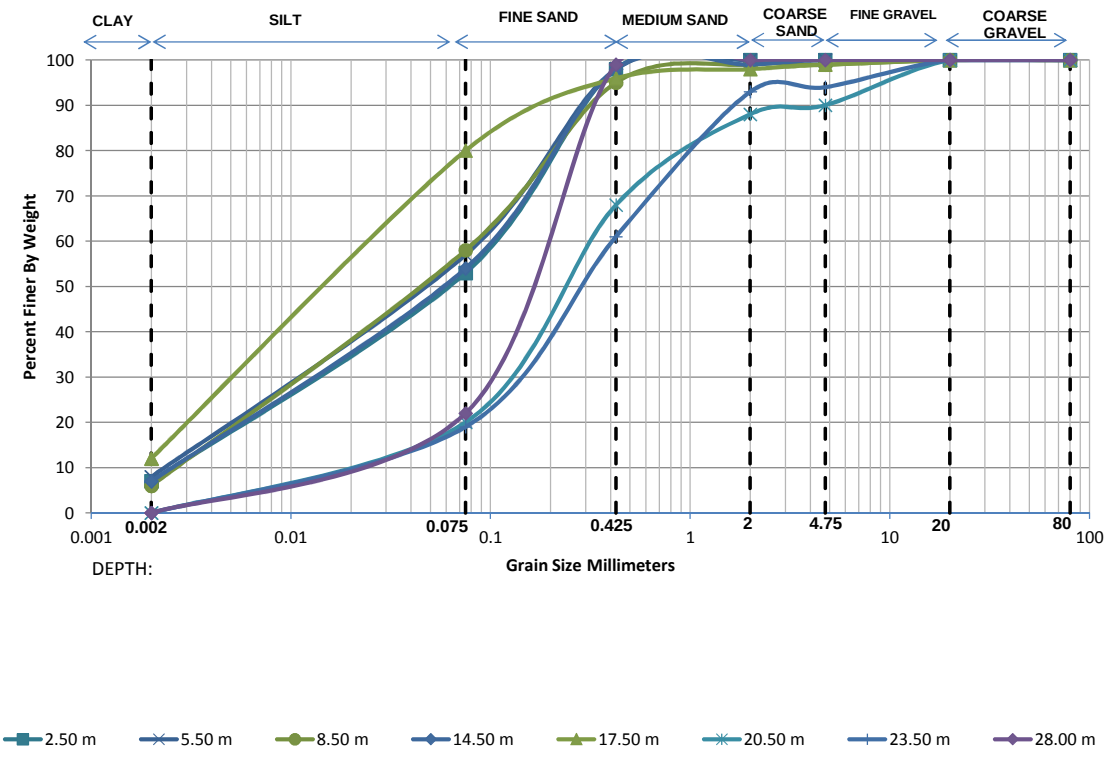
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P18



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	8.00	48.00	42.00	1.00	1.00	0.00	0.00	0.0030	0.0227	0.0866	29.34	2.01
4.00 m	8.20	56.80	28.00	3.00	2.00	2.00	0.00	0.0028	0.0174	0.0639	22.99	1.70
7.00 m	7.00	51.00	33.00	4.00	2.00	2.00	1.00	0.0036	0.0221	0.0808	22.60	1.69
10.00 m	12.00	61.00	18.00	4.00	2.00	3.00	0.00	-	0.0115	0.0490	-	-
14.50 m	11.00	65.00	12.00	6.00	2.00	4.00	0.00	-	0.0115	0.0452	-	-
17.50 m	7.00	52.00	27.00	5.00	2.00	7.00	0.00	0.0036	0.0212	0.0779	21.92	1.63
25.00 m	6.00	54.00	24.00	2.00	3.00	11.00	0.00	0.0043	0.0217	0.0750	17.45	1.47
29.50 m	8.00	51.00	30.00	2.00	1.00	8.00	0.00	0.0029	0.0203	0.0778	26.62	1.81

GRAIN SIZE DISTRIBUTION CURVES

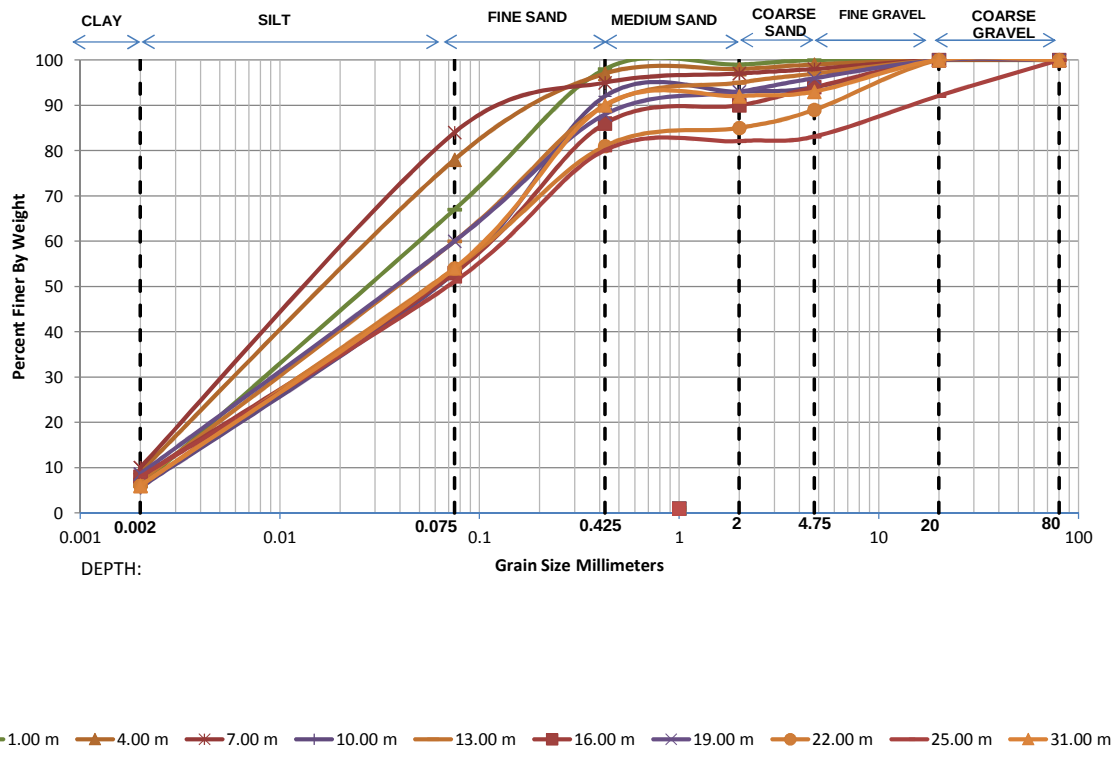
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P19



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	46.00	45.00	2.00	0.00	0.00	0.00	0.0037	0.0261	0.0968	26.31	1.92
5.50 m	8.00	49.00	41.00	2.00	0.00	0.00	0.00	0.0029	0.0220	0.0834	28.34	1.97
8.50 m	6.00	52.00	37.00	4.00	0.00	1.00	0.00	0.0044	0.0235	0.0804	18.40	1.57
14.50 m	7.00	47.00	44.00	1.00	1.00	0.00	0.00	0.0037	0.0253	0.0932	25.48	1.88
17.50 m	12.00	68.00	16.00	2.00	1.00	1.00	0.00	-	0.0103	0.0406	-	-
20.50 m	0.00	20.00	48.00	20.00	2.00	10.00	0.00	0.0263	0.1227	0.3303	12.54	1.73
23.50 m	0.00	19.00	42.00	32.00	1.00	6.00	0.00	0.0283	0.1357	0.4110	14.54	1.58
28.00 m	0.00	22.00	77.00	1.00	0.00	0.00	0.00	0.0240	0.1034	0.1979	8.24	2.25

GRAIN SIZE DISTRIBUTION CURVES

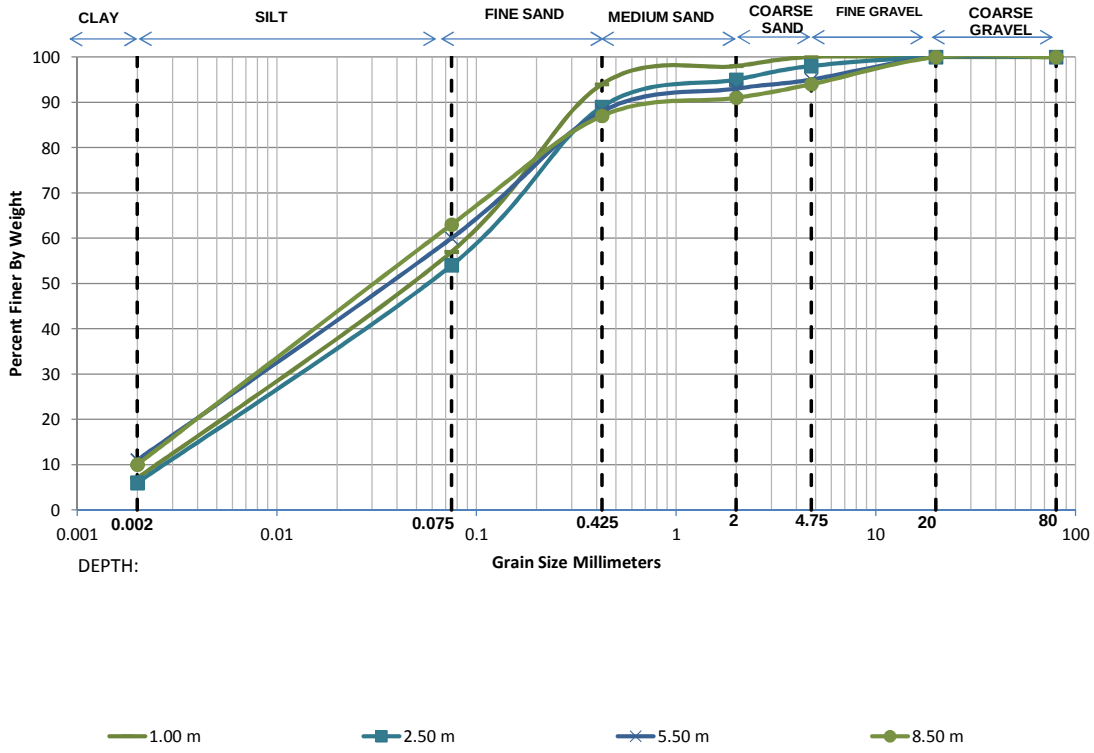
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	61.00	31.00	1.00	1.00	0.00	0.00	0.0042	0.0192	0.0608	14.52	1.45
4.00 m	9.00	69.00	19.00	1.00	1.00	1.00	0.00	0.0024	0.0130	0.0443	18.66	1.61
7.00 m	10.00	74.00	11.00	2.00	1.00	2.00	0.00	0.0020	0.0111	0.0377	18.86	1.64
10.00 m	5.60	47.40	39.00	1.00	1.00	6.00	0.00	0.0049	0.0274	0.0988	20.17	1.56
13.00 m	7.00	53.00	30.00	5.00	2.00	3.00	0.00	0.0035	0.0209	0.0750	21.16	1.64
16.00 m	8.00	45.00	33.00	4.00	4.00	6.00	0.00	0.0030	0.0243	0.1036	34.87	1.92
19.00 m	8.60	51.40	28.00	5.00	3.00	4.00	0.00	0.0026	0.0191	0.0750	28.91	1.87
22.00 m	6.00	48.00	27.00	4.00	4.00	11.00	0.00	0.0044	0.0254	0.1030	23.19	1.41
25.00 m	8.00	43.10	29.00	2.00	1.00	9.00	7.90	0.0030	0.0256	0.1214	40.64	1.81
31.00 m	6.00	48.00	36.00	2.00	1.00	7.00	0.00	0.0045	0.0260	0.0959	21.45	1.58

GRAIN SIZE DISTRIBUTION CURVES

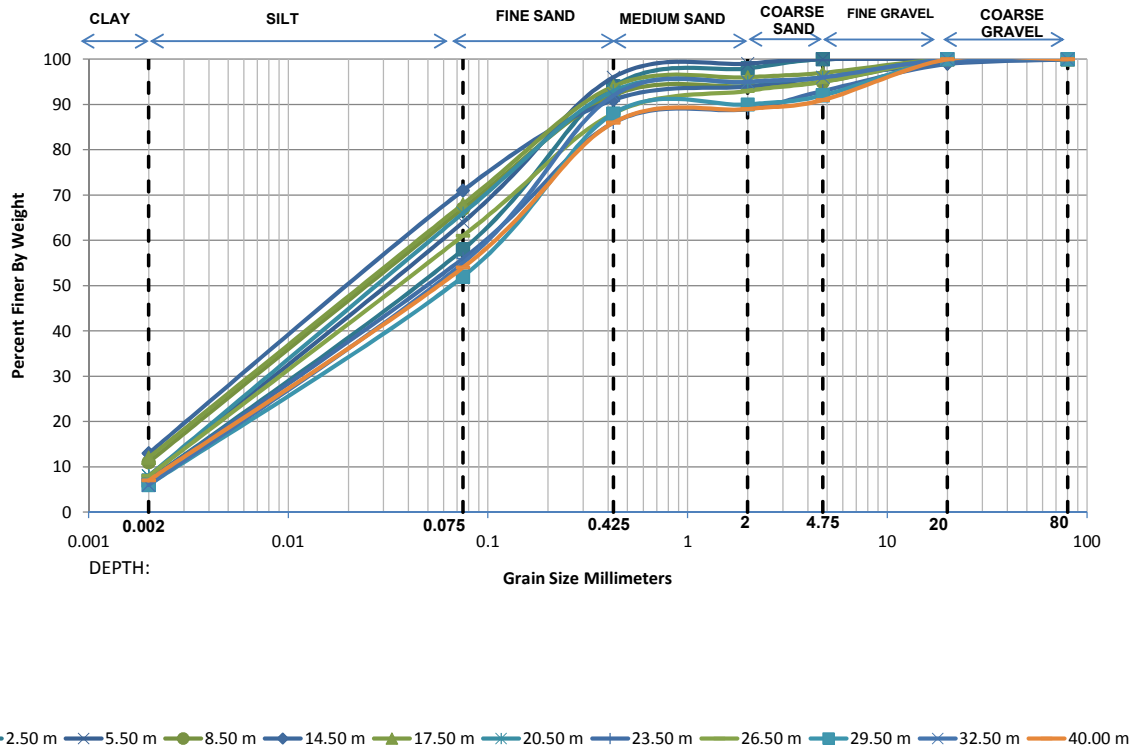
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+191
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	50.00	37.00	4.00	2.00	0.00	0.00	0.0036	0.0229	0.0838	23.31	1.74
2.50 m	6.00	48.00	35.00	6.00	3.00	2.00	0.00	0.0045	0.0259	0.0968	21.66	1.56
5.50 m	11.00	49.00	28.00	5.00	2.00	5.00	0.00	-	0.0167	0.0750	-	-
8.50 m	10.00	53.00	24.00	4.00	3.00	6.00	0.00	0.0020	0.0162	0.0677	33.83	1.94

GRAIN SIZE DISTRIBUTION CURVES

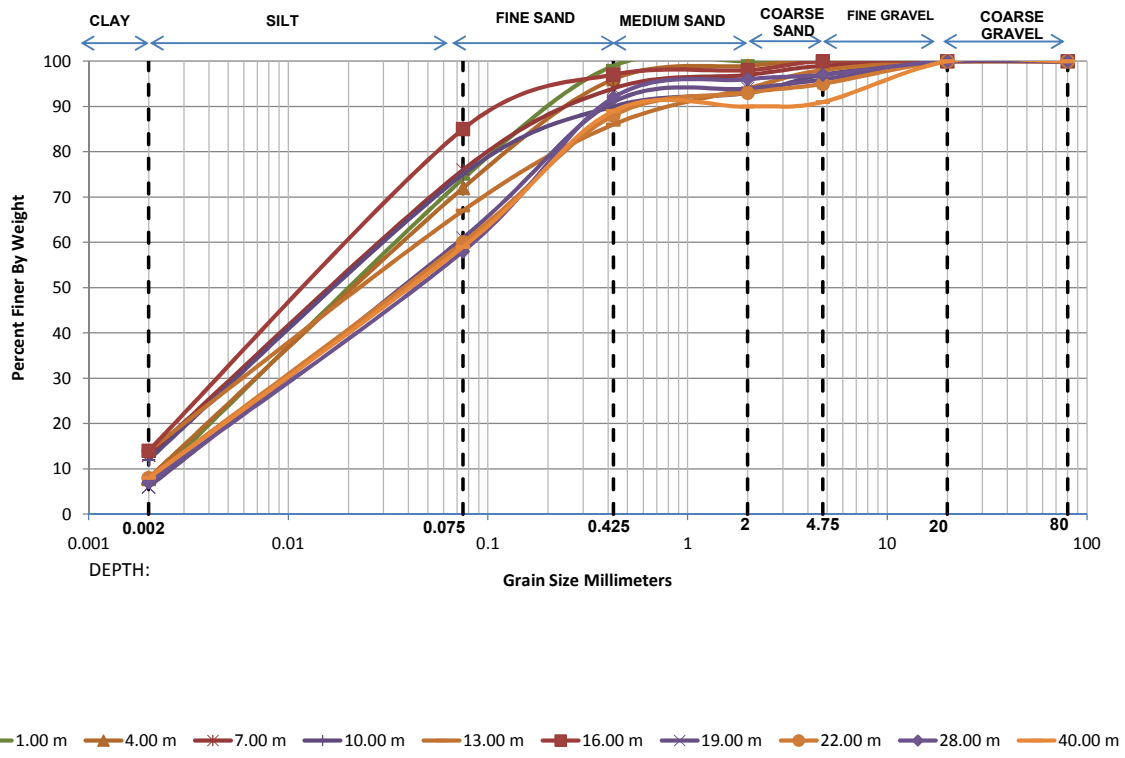
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	51.00	36.00	4.00	2.00	0.00	0.00	0.0036	0.0222	0.0806	22.51	1.72
5.50 m	8.00	56.00	32.00	3.00	1.00	0.00	0.00	0.0029	0.0181	0.0660	22.82	1.72
8.50 m	11.00	56.00	25.00	2.00	1.00	5.00	0.00	-	0.0140	0.0593	-	-
14.50 m	13.00	58.00	20.00	3.00	2.00	3.00	1.00	-	0.0112	0.0516	-	-
17.50 m	12.00	56.00	26.00	2.00	1.00	3.00	0.00	-	0.0129	0.0573	-	-
20.50 m	8.00	58.00	27.00	2.00	1.00	4.00	0.00	0.0029	0.0172	0.0620	21.53	1.66
23.50 m	7.00	49.00	30.00	3.00	4.00	6.00	1.00	0.0036	0.0231	0.0894	24.84	1.66
26.50 m	8.00	53.00	27.00	5.00	2.00	5.00	0.00	0.0029	0.0192	0.0725	24.95	1.74
29.50 m	6.00	46.00	36.00	2.00	2.00	8.00	0.00	0.0045	0.0276	0.1058	23.36	1.58
32.50 m	6.00	49.00	37.00	3.00	1.00	4.00	0.00	0.0044	0.0253	0.0912	20.52	1.58
40.00 m	7.00	47.00	32.00	3.00	2.00	9.00	0.00	0.0036	0.0246	0.0985	27.09	1.69

GRAIN SIZE DISTRIBUTION CURVES

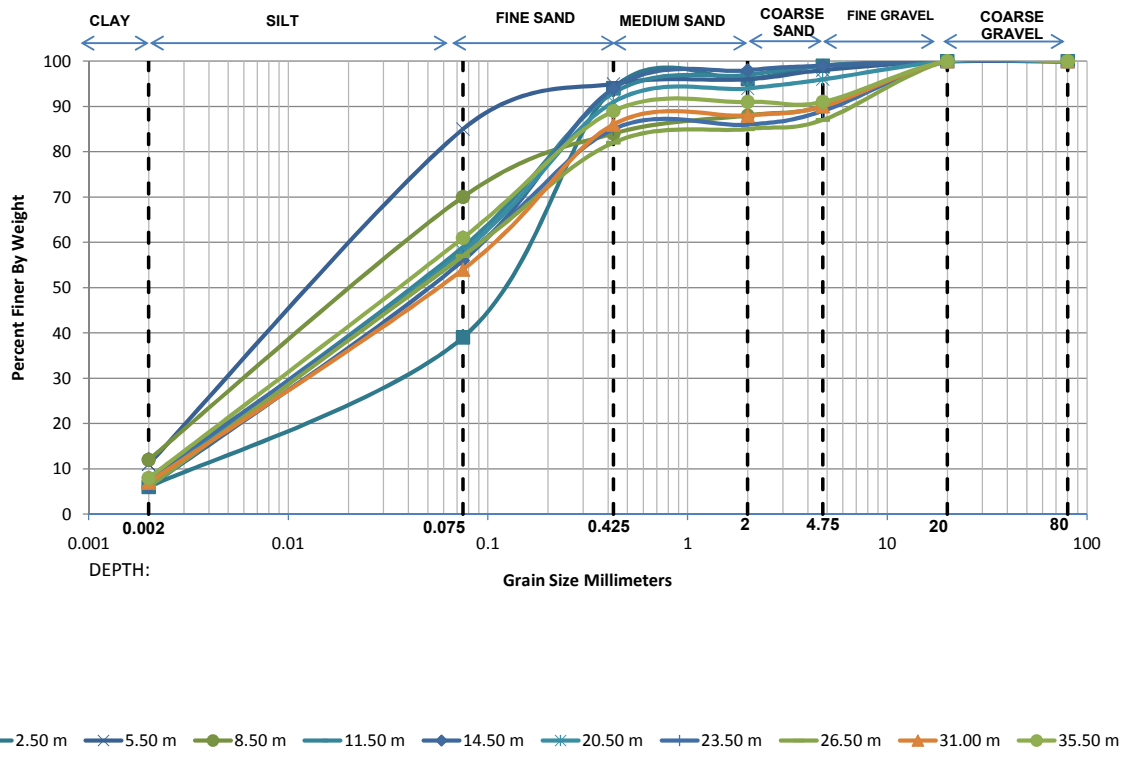
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.60	67.40	25.00	1.00	0.00	0.00	0.00	0.0037	0.0163	0.0503	13.73	1.45
4.00 m	8.00	64.00	24.00	3.00	1.00	0.00	0.00	0.0029	0.0153	0.0523	18.33	1.58
7.00 m	13.00	63.00	18.00	3.00	2.00	1.00	0.00	-	0.0102	0.0446	-	-
10.00 m	12.00	63.00	15.00	3.00	4.00	3.00	0.00	-	0.0110	0.0461	-	-
13.00 m	14.00	53.00	19.00	8.00	4.00	2.00	0.00	-	0.0113	0.0582	-	-
16.00 m	14.00	71.00	12.00	1.00	2.00	0.00	0.00	-	0.0083	0.0348	-	-
19.00 m	6.00	55.00	30.00	3.00	2.00	4.00	0.00	0.0043	0.0216	0.0726	16.93	1.49
22.00 m	8.00	52.00	28.00	5.00	2.00	5.00	0.00	0.0029	0.0197	0.0750	25.74	1.78
28.00 m	7.00	51.00	34.00	4.00	1.00	3.00	0.00	0.0036	0.0221	0.0807	22.57	1.70
40.00 m	8.00	51.00	30.00	1.00	1.00	9.00	0.00	0.0029	0.0203	0.0778	26.62	1.81

GRAIN SIZE DISTRIBUTION CURVES

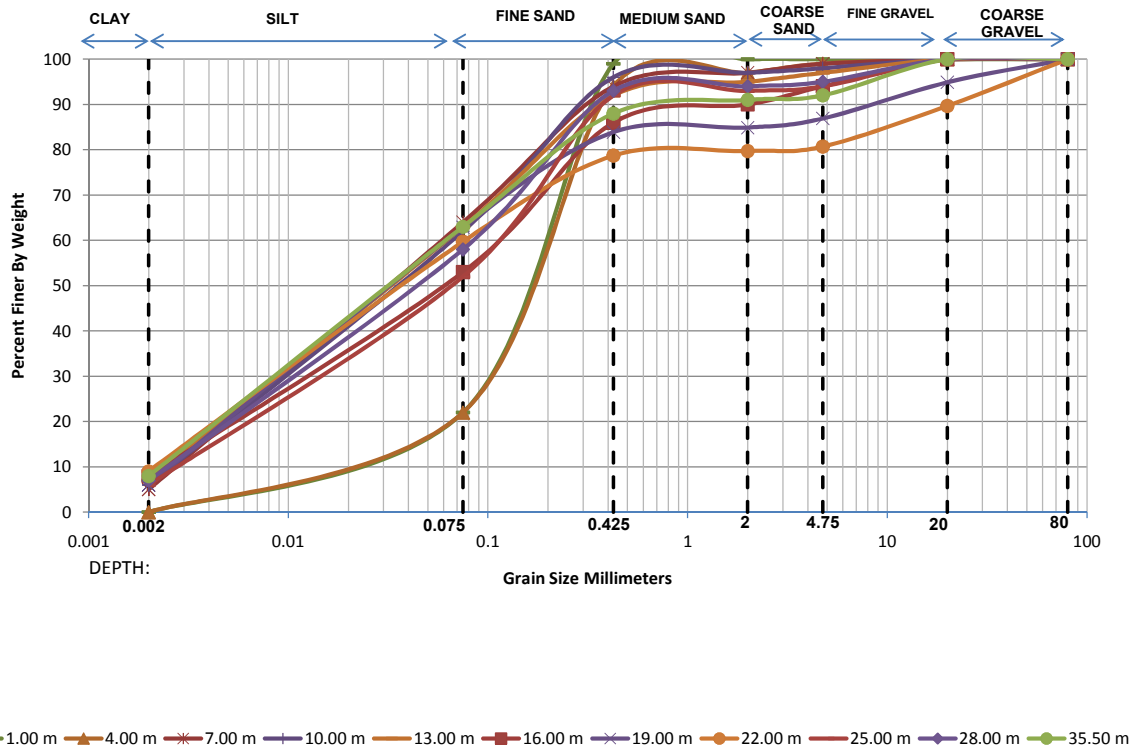
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	33.00	55.00	2.00	3.00	1.00	0.00	0.0053	0.0471	0.1529	28.58	2.71
5.50 m	11.00	74.00	10.00	1.00	2.00	2.00	0.00	-	0.0102	0.0363	-	-
8.50 m	12.00	58.00	14.00	4.00	2.00	10.00	0.00	-	0.0120	0.0532	-	-
11.50 m	7.00	52.00	34.00	4.00	2.00	1.00	0.00	0.0036	0.0216	0.0776	21.79	1.68
14.50 m	6.00	50.00	38.00	4.00	1.00	1.00	0.00	0.0044	0.0247	0.0871	19.70	1.59
20.50 m	7.00	51.00	33.00	3.00	2.00	4.00	0.00	0.0036	0.0221	0.0808	22.60	1.69
23.50 m	8.00	49.00	28.00	1.00	3.00	11.00	0.00	0.0029	0.0213	0.0854	29.12	1.81
26.50 m	6.00	51.00	25.00	3.00	2.00	13.00	0.00	0.0044	0.0234	0.0863	19.78	1.45
31.00 m	7.00	47.00	32.00	2.00	2.00	10.00	0.00	0.0036	0.0246	0.0984	27.05	1.69
35.50 m	8.00	53.00	28.00	2.00	0.00	9.00	0.00	0.0029	0.0192	0.0725	24.95	1.75

GRAIN SIZE DISTRIBUTION CURVES

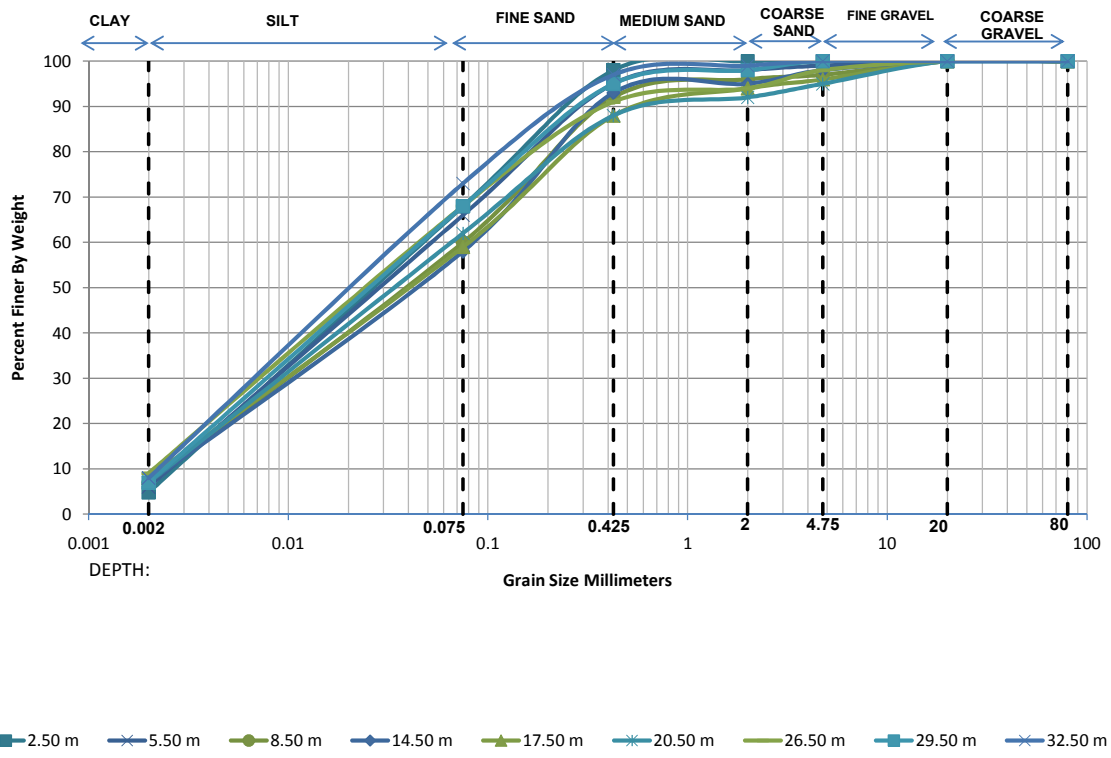
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P3



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	22.00	77.00	1.00	0.00	0.00	0.00	0.0240	0.1034	0.1979	8.24	2.25
4.00 m	0.00	22.00	72.00	3.00	2.00	1.00	0.00	0.0238	0.1043	0.2068	8.70	2.22
7.00 m	5.00	59.00	30.00	3.00	2.00	1.00	0.00	0.0051	0.0216	0.0664	12.90	1.36
10.00 m	6.00	56.00	34.00	1.00	1.00	2.00	0.00	0.0043	0.0213	0.0705	16.46	1.50
13.00 m	7.00	56.00	29.00	3.00	2.00	3.00	0.00	0.0035	0.0195	0.0681	19.43	1.59
16.00 m	8.00	45.00	33.00	4.00	4.00	6.00	0.00	0.0030	0.0243	0.1036	34.87	1.92
19.00 m	6.00	56.90	21.00	1.00	2.00	8.00	5.10	0.0042	0.0203	0.0683	16.12	1.42
22.00 m	9.00	50.70	19.00	1.00	1.00	9.00	10.30	0.0024	0.0184	0.0759	31.58	1.85
25.00 m	6.00	46.00	40.00	1.00	1.00	6.00	0.00	0.0045	0.0278	0.1029	22.64	1.65
28.00 m	7.00	51.00	35.00	1.00	1.00	5.00	0.00	0.0036	0.0222	0.0806	22.53	1.71
35.50 m	8.00	55.00	25.00	3.00	1.00	8.00	0.00	0.0029	0.0182	0.0679	23.47	1.69

GRAIN SIZE DISTRIBUTION CURVES

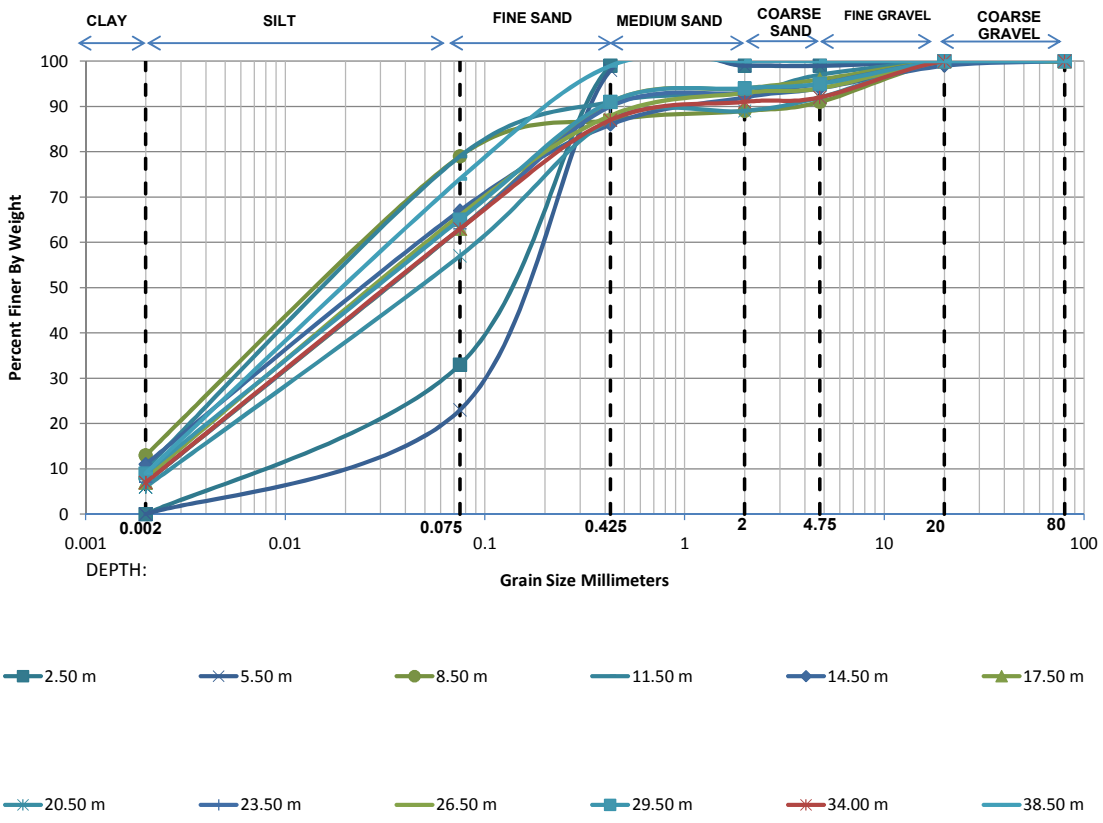
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P4



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	4.80	63.20	30.00	2.00	0.00	0.00	0.00	0.0053	0.0204	0.0595	11.32	1.34
5.50 m	6.00	60.00	29.00	3.00	1.00	1.00	0.00	0.0042	0.0195	0.0625	14.87	1.45
8.50 m	7.00	53.00	32.00	4.00	1.00	3.00	0.00	0.0035	0.0210	0.0750	21.15	1.65
14.50 m	7.00	51.00	35.00	2.00	3.00	2.00	0.00	0.0036	0.0222	0.0806	22.53	1.71
17.50 m	8.00	51.00	29.00	6.00	2.00	4.00	0.00	0.0029	0.0202	0.0778	26.65	1.80
20.50 m	7.00	55.00	26.00	4.00	3.00	5.00	0.00	0.0035	0.0198	0.0703	19.99	1.58
26.50 m	9.00	59.00	23.00	3.00	4.00	2.00	0.00	0.0024	0.0154	0.0580	24.29	1.72
29.50 m	7.00	61.00	27.00	3.00	2.00	0.00	0.00	0.0035	0.0176	0.0588	17.00	1.52
32.50 m	8.00	65.00	24.00	2.00	1.00	0.00	0.00	0.0028	0.0151	0.0509	17.88	1.57

GRAIN SIZE DISTRIBUTION CURVES

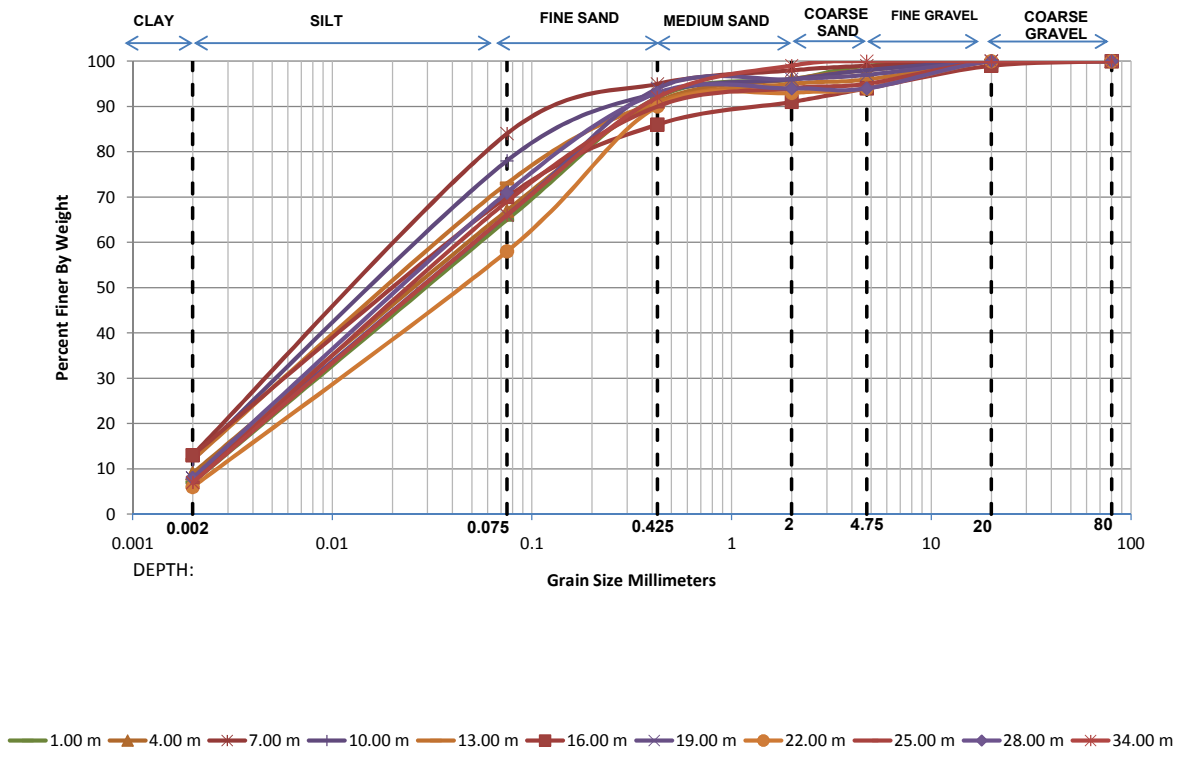
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P5



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	33.00	66.00	0.00	0.00	1.00	0.00	0.0115	0.0656	0.2322	20.28	1.62
5.50 m	0.00	23.00	75.00	1.00	0.00	1.00	0.00	0.0221	0.0998	0.1963	8.88	2.29
8.50 m	13.00	66.00	8.00	2.00	2.00	9.00	0.00	-	0.0096	0.0406	-	-
11.50 m	10.00	69.00	12.00	2.00	4.00	3.00	0.00	0.0020	0.0118	0.0423	21.17	1.65
14.50 m	11.00	56.00	19.00	6.00	2.00	5.00	1.00	-	0.0138	0.0591	-	-
17.50 m	7.00	56.00	28.00	3.00	2.00	4.00	0.00	0.0035	0.0194	0.0681	19.43	1.58
20.50 m	6.00	51.00	30.00	2.00	3.00	8.00	0.00	0.0044	0.0237	0.0848	19.37	1.51
23.50 m	7.00	56.00	27.00	3.00	2.00	5.00	0.00	0.0035	0.0194	0.0681	19.43	1.57
26.50 m	8.00	58.00	22.00	5.00	1.00	6.00	0.00	0.0029	0.0170	0.0618	21.48	1.62
29.50 m	9.00	56.00	26.00	3.00	1.00	5.00	0.00	0.0024	0.0165	0.0637	26.59	1.79
34.00 m	7.00	56.00	24.00	4.00	1.00	8.00	0.00	0.0035	0.0192	0.0680	19.43	1.56
38.50 m	9.00	65.00	25.00	1.00	0.00	0.00	0.00	0.0024	0.0140	0.0493	20.70	1.66

GRAIN SIZE DISTRIBUTION CURVES

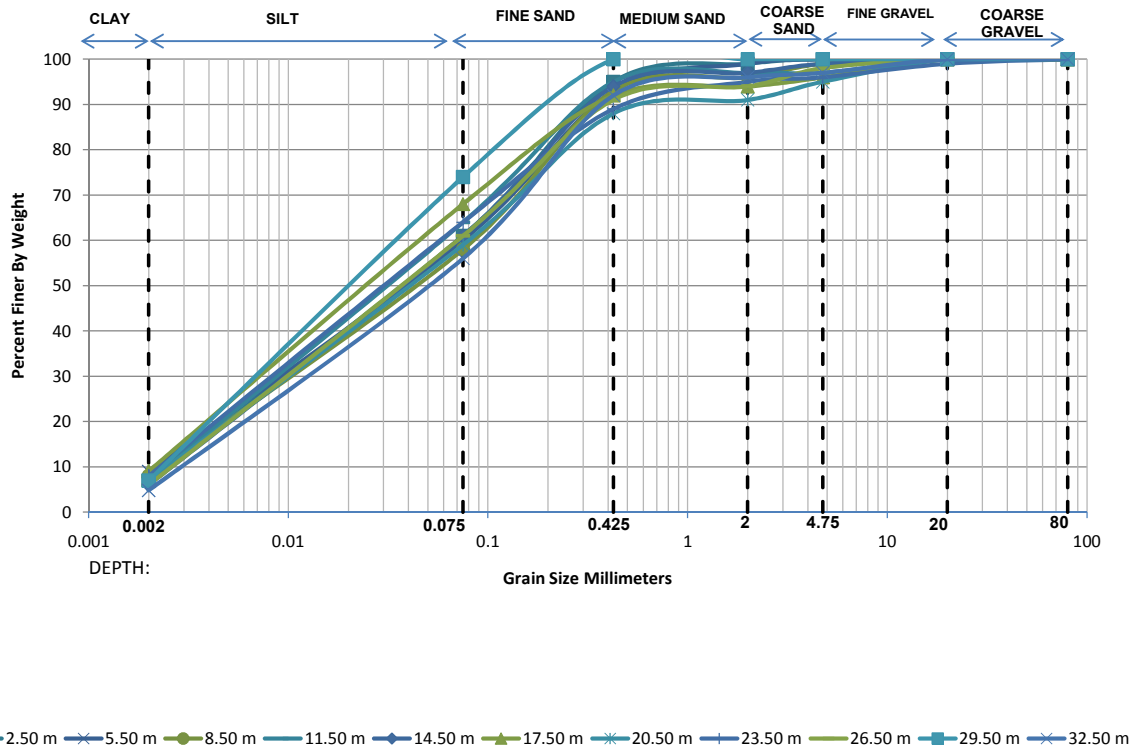
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P6



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	58.00	27.00	4.00	3.00	1.00	0.00	0.0035	0.0186	0.0641	18.39	1.55
4.00 m	9.00	58.00	24.00	5.00	2.00	2.00	0.00	0.0024	0.0158	0.0598	25.02	1.74
7.00 m	13.00	71.00	11.00	3.00	1.00	1.00	0.00	-	0.0090	0.0361	-	-
10.00 m	12.00	66.00	15.00	3.00	2.00	2.00	0.00	-	0.0105	0.0426	-	-
13.00 m	12.00	61.00	18.00	4.00	1.00	4.00	0.00	-	0.0115	0.0490	-	-
16.00 m	13.00	57.00	16.00	5.00	3.00	5.00	1.00	-	0.0113	0.0530	-	-
19.00 m	8.00	58.00	28.00	2.00	1.00	3.00	0.00	0.0029	0.0172	0.0620	21.54	1.66
22.00 m	6.00	52.00	32.00	3.00	1.00	6.00	0.00	0.0044	0.0232	0.0808	18.54	1.53
25.00 m	7.00	62.00	21.00	4.00	1.00	5.00	0.00	0.0034	0.0171	0.0569	16.53	1.49
28.00 m	8.00	63.00	22.00	1.00	0.00	6.00	0.00	0.0029	0.0155	0.0536	18.77	1.58
34.00 m	7.00	59.00	26.00	7.00	1.00	0.00	0.00	0.0035	0.0182	0.0622	17.90	1.54

GRAIN SIZE DISTRIBUTION CURVES

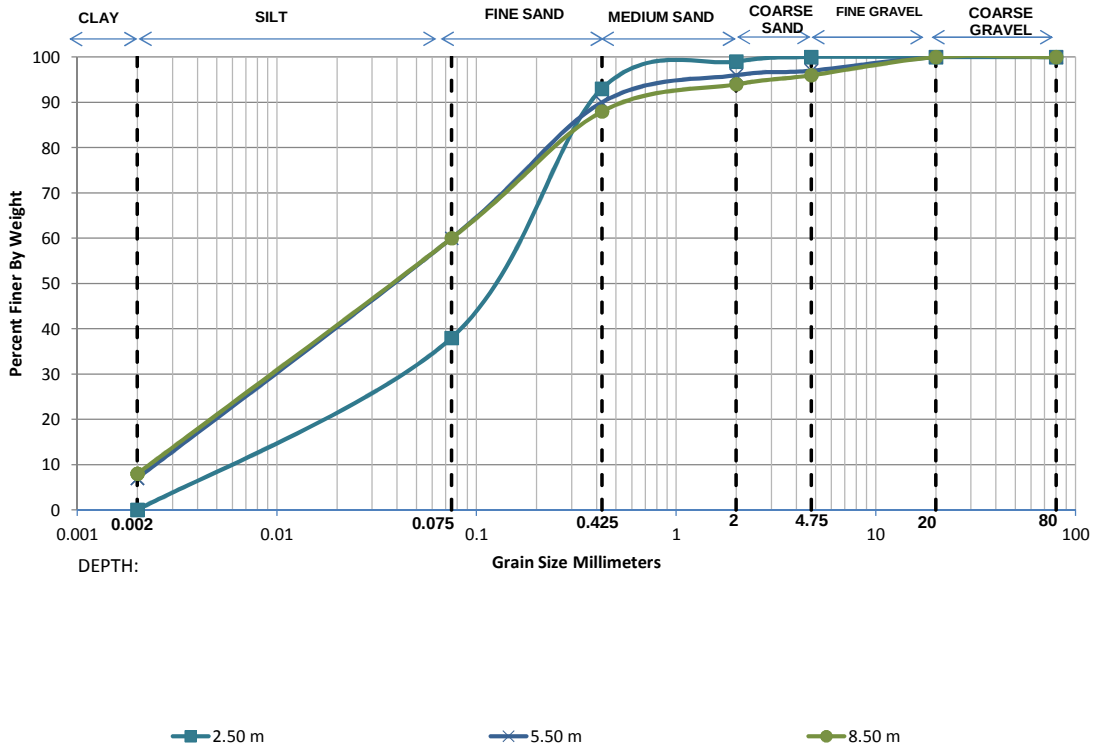
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	54.00	34.00	4.00	1.00	0.00	0.00	0.0035	0.0206	0.0726	20.53	1.65
5.50 m	9.00	51.00	33.00	6.00	1.00	0.00	0.00	0.0024	0.0189	0.0750	31.19	1.98
8.50 m	8.00	50.00	35.00	3.00	3.00	1.00	0.00	0.0029	0.0211	0.0807	27.53	1.88
11.50 m	7.00	57.00	31.00	2.00	0.00	3.00	0.00	0.0035	0.0192	0.0661	18.90	1.59
14.50 m	6.00	55.00	33.00	3.00	2.00	1.00	0.00	0.0043	0.0217	0.0727	16.90	1.51
17.50 m	9.00	59.00	24.00	2.00	2.00	4.00	0.00	0.0024	0.0155	0.0581	24.31	1.72
20.50 m	7.00	52.00	29.00	3.00	4.00	5.00	0.00	0.0036	0.0213	0.0778	21.88	1.65
23.50 m	8.00	56.00	25.00	6.00	1.00	3.00	1.00	0.0029	0.0178	0.0658	22.79	1.67
26.50 m	6.00	55.00	30.00	3.00	4.00	2.00	0.00	0.0043	0.0216	0.0726	16.93	1.49
29.50 m	7.00	67.00	26.00	0.00	0.00	0.00	0.00	0.0034	0.0159	0.0502	14.72	1.49
32.50 m	4.80	51.20	36.00	4.00	1.00	3.00	0.00	0.0056	0.0262	0.0874	15.51	1.39

GRAIN SIZE DISTRIBUTION CURVES

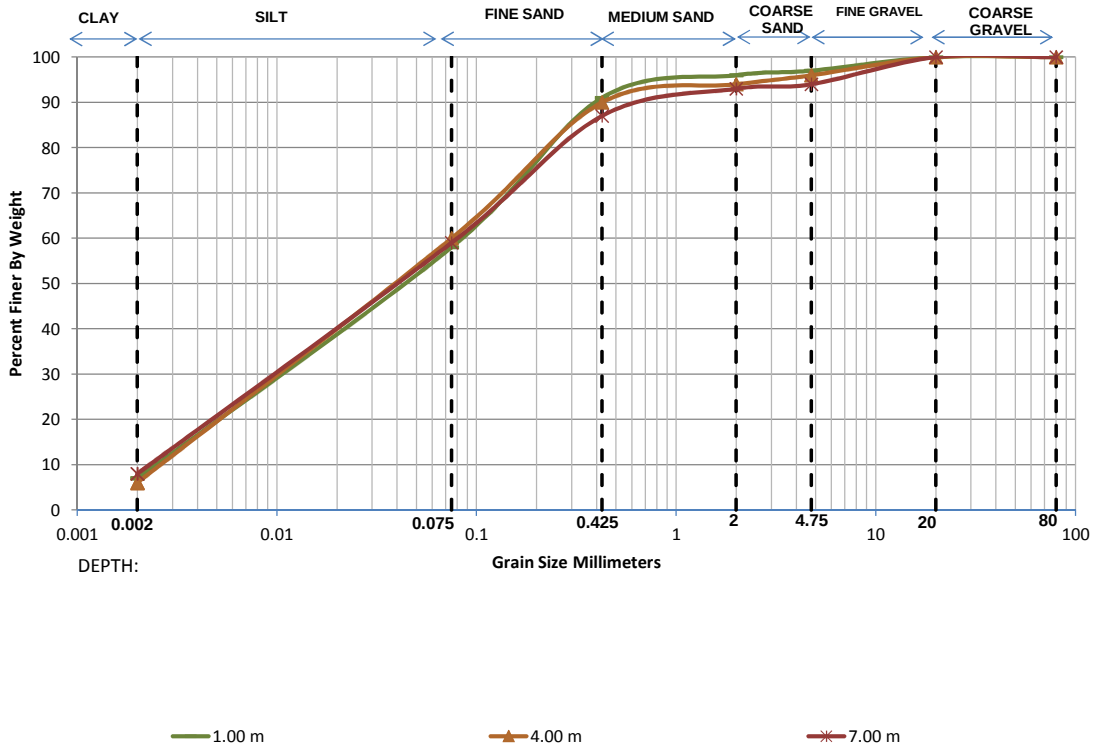
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+837 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	38.00	55.00	6.00	1.00	0.00	0.00	0.0088	0.0519	0.1560	17.76	1.97
5.50 m	7.00	53.00	30.00	6.00	1.00	3.00	0.00	0.0035	0.0209	0.0750	21.16	1.64
8.50 m	8.00	52.00	28.00	6.00	2.00	4.00	0.00	0.0029	0.0197	0.0750	25.74	1.78

GRAIN SIZE DISTRIBUTION CURVES

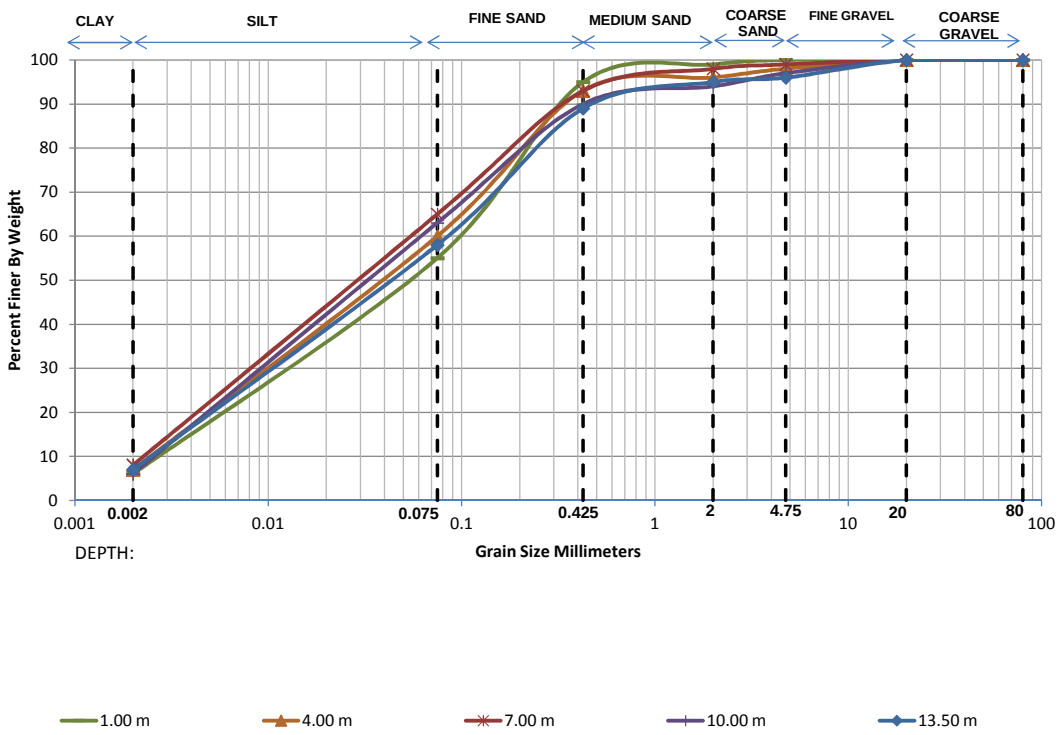
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	59+071 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	51.00	33.00	5.00	1.00	3.00	0.00	0.0036	0.0221	0.0808	22.61	1.69
4.00 m	6.00	54.00	30.00	4.00	2.00	4.00	0.00	0.0043	0.0220	0.0750	17.39	1.50
7.00 m	8.00	51.00	28.00	6.00	1.00	6.00	0.00	0.0029	0.0202	0.0779	26.67	1.79

GRAIN SIZE DISTRIBUTION CURVES

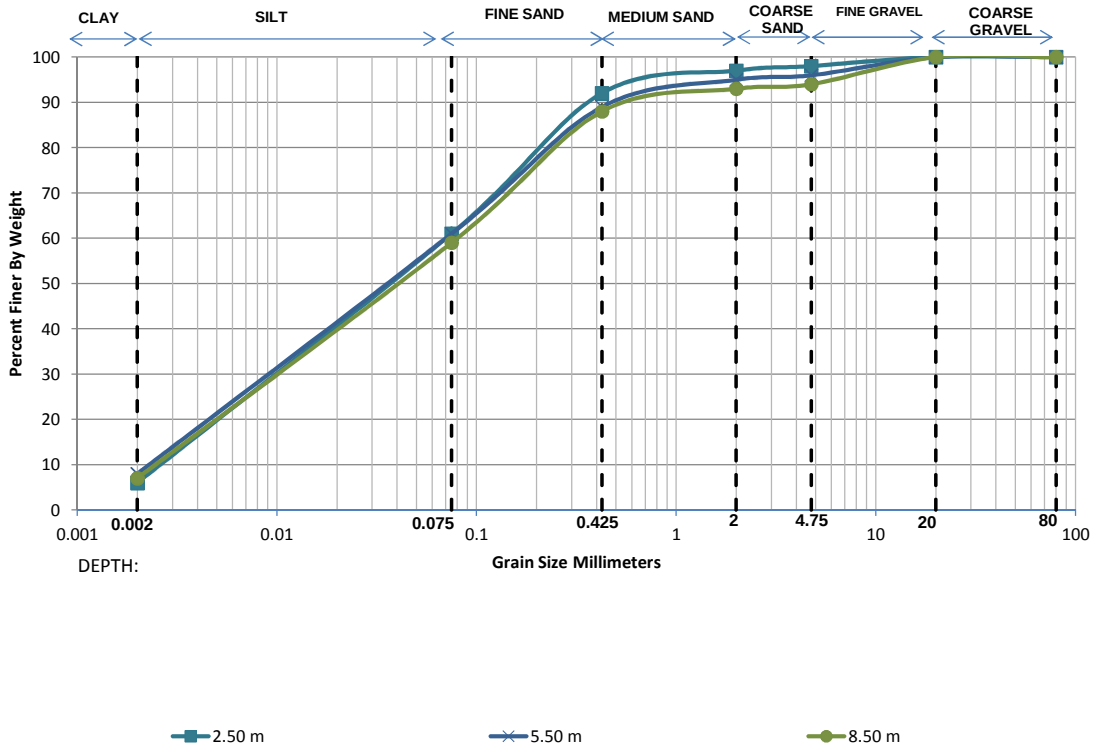
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	59+206 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	49.00	40.00	4.00	1.00	0.00	0.00	0.0045	0.0255	0.0904	20.30	1.62
4.00 m	7.00	53.00	33.00	3.00	2.00	2.00	0.00	0.0035	0.0210	0.0750	21.14	1.66
7.00 m	8.00	57.00	28.00	5.00	1.00	1.00	0.00	0.0029	0.0176	0.0639	22.15	1.68
10.00 m	6.00	57.00	27.00	4.00	3.00	3.00	0.00	0.0042	0.0205	0.0682	16.05	1.46
13.50 m	7.00	51.00	31.00	6.00	1.00	4.00	0.00	0.0036	0.0220	0.0810	22.68	1.67

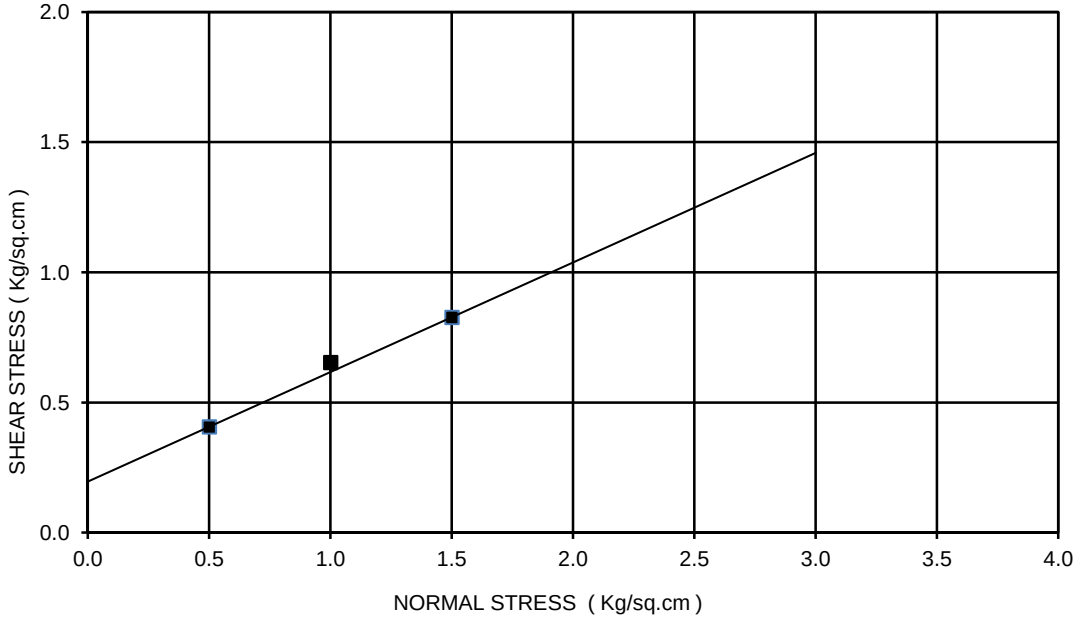
GRAIN SIZE DISTRIBUTION CURVES

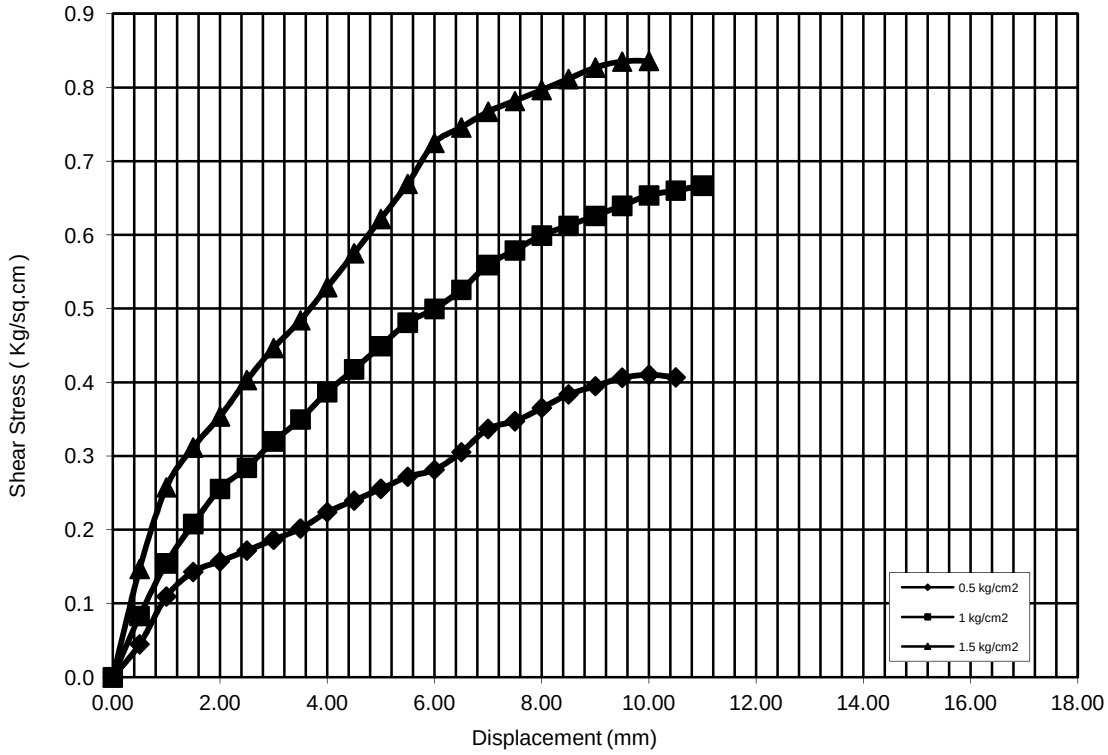
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	59+270 Minor Bridge
B.H. No.	BH-CL



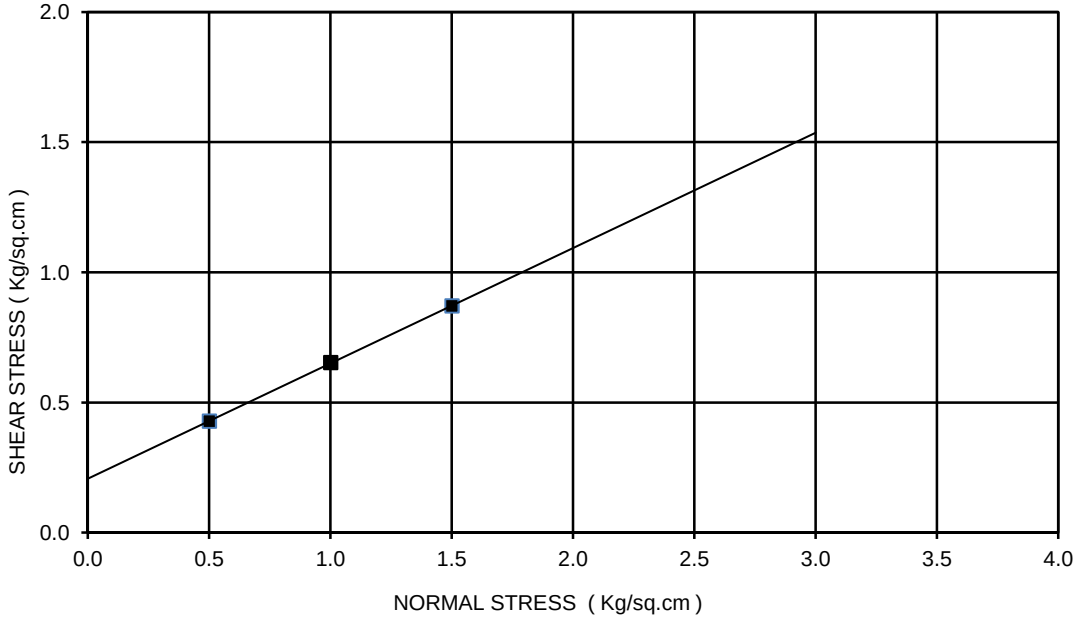
Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	55.00	31.00	5.00	1.00	2.00	0.00	0.0043	0.0216	0.0726	16.92	1.50
5.50 m	8.00	53.00	28.00	6.00	1.00	4.00	0.00	0.0029	0.0192	0.0725	24.95	1.75
8.50 m	7.00	52.00	29.00	5.00	1.00	6.00	0.00	0.0036	0.0213	0.0778	21.88	1.65

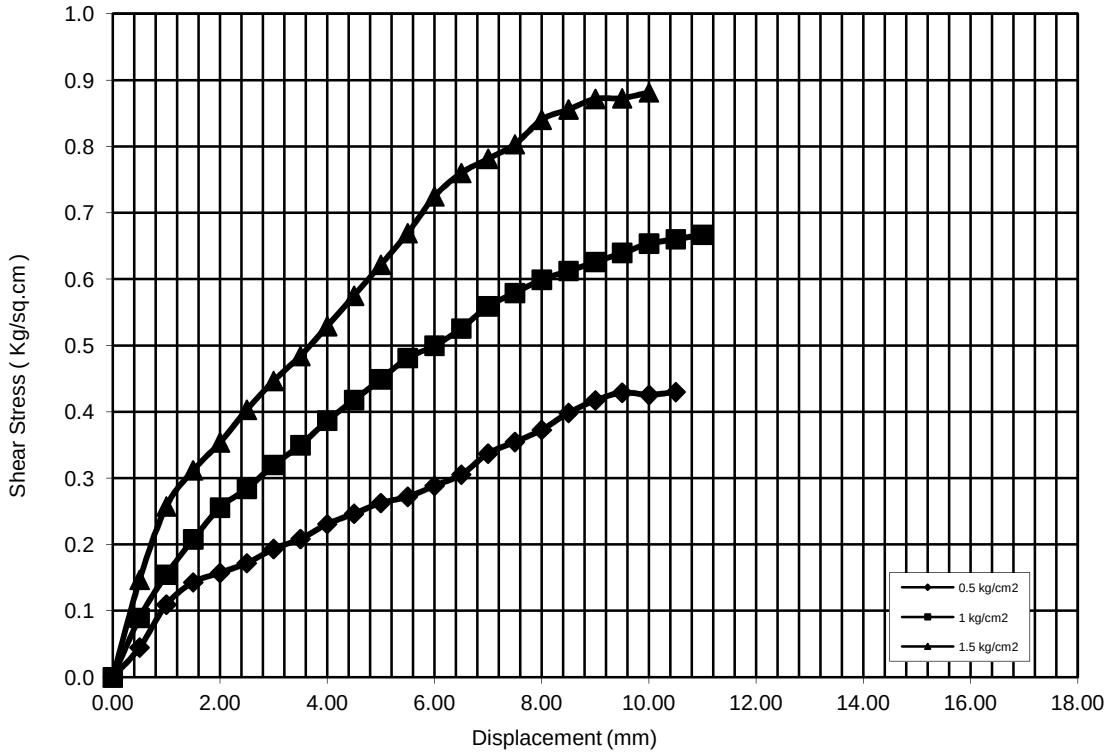
Ch. 52+518
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



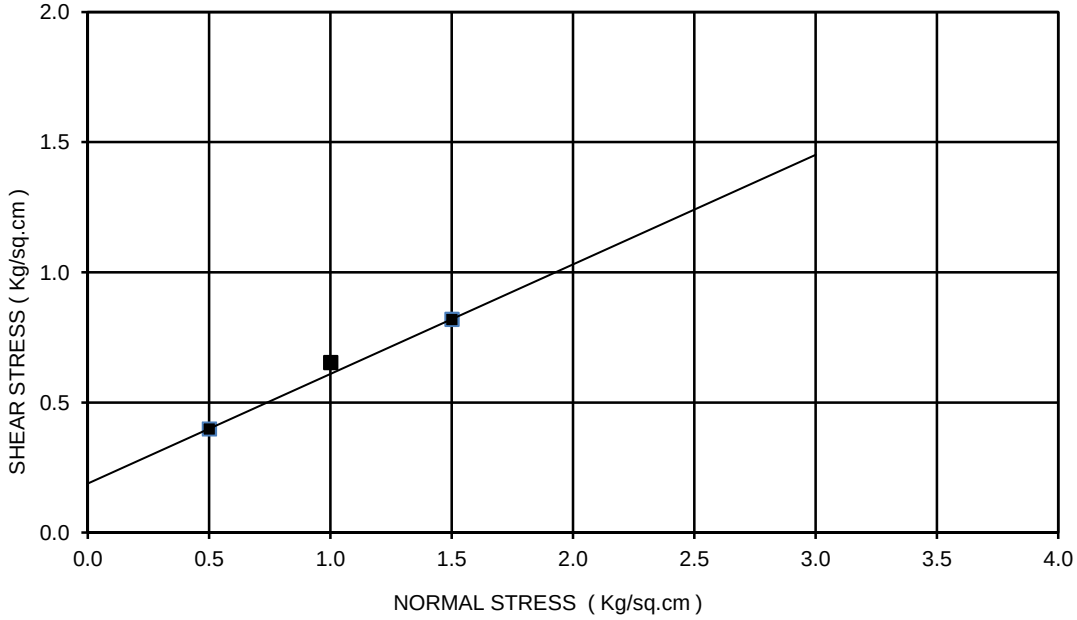


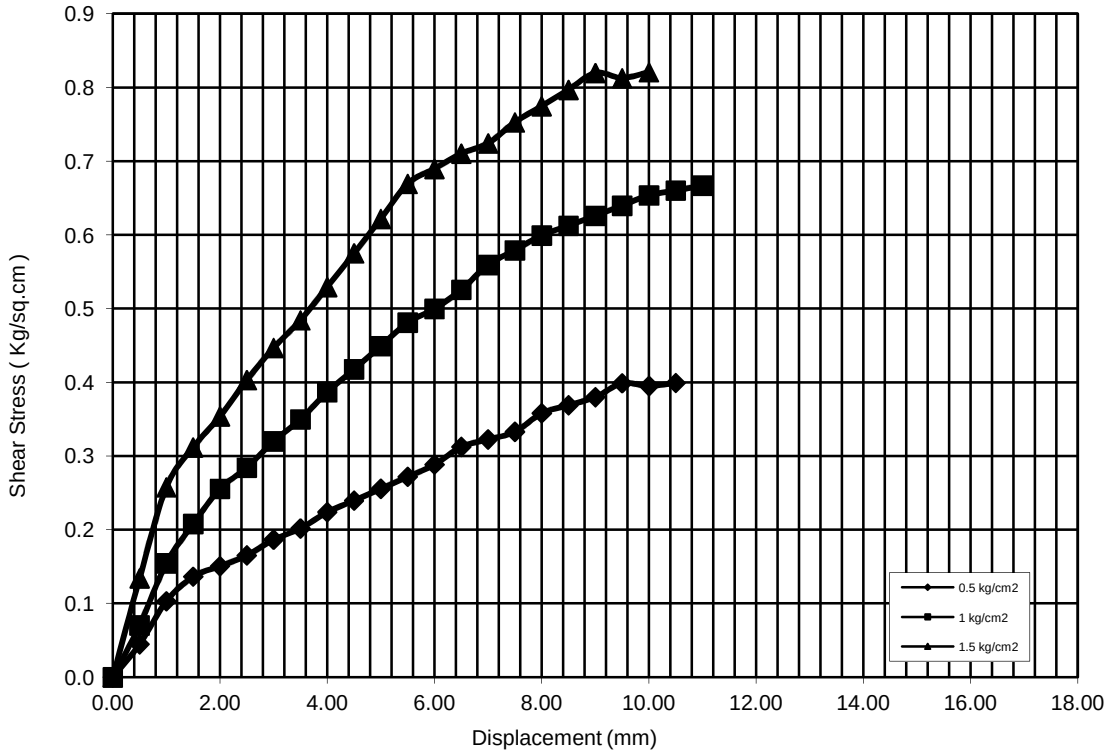
Ch. 52+518
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



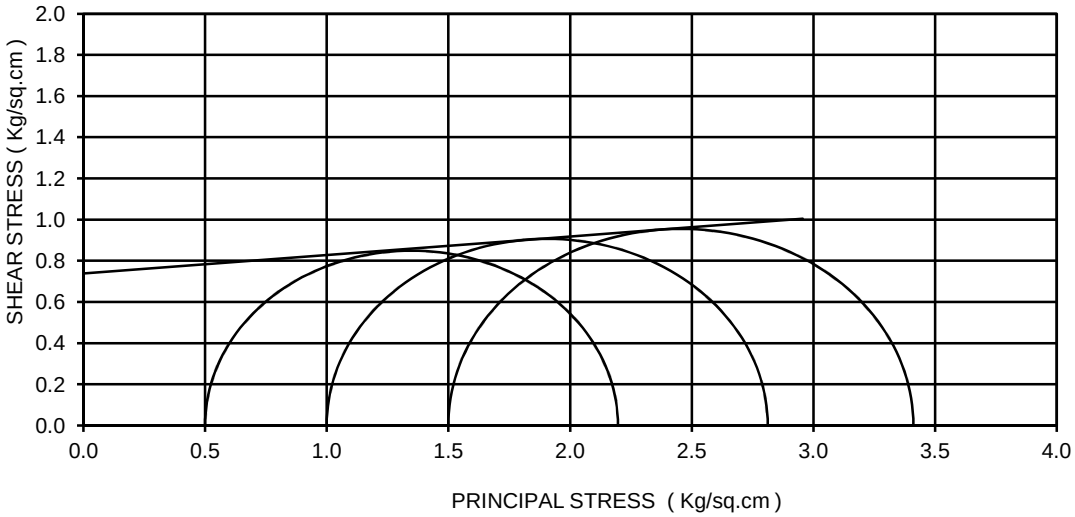


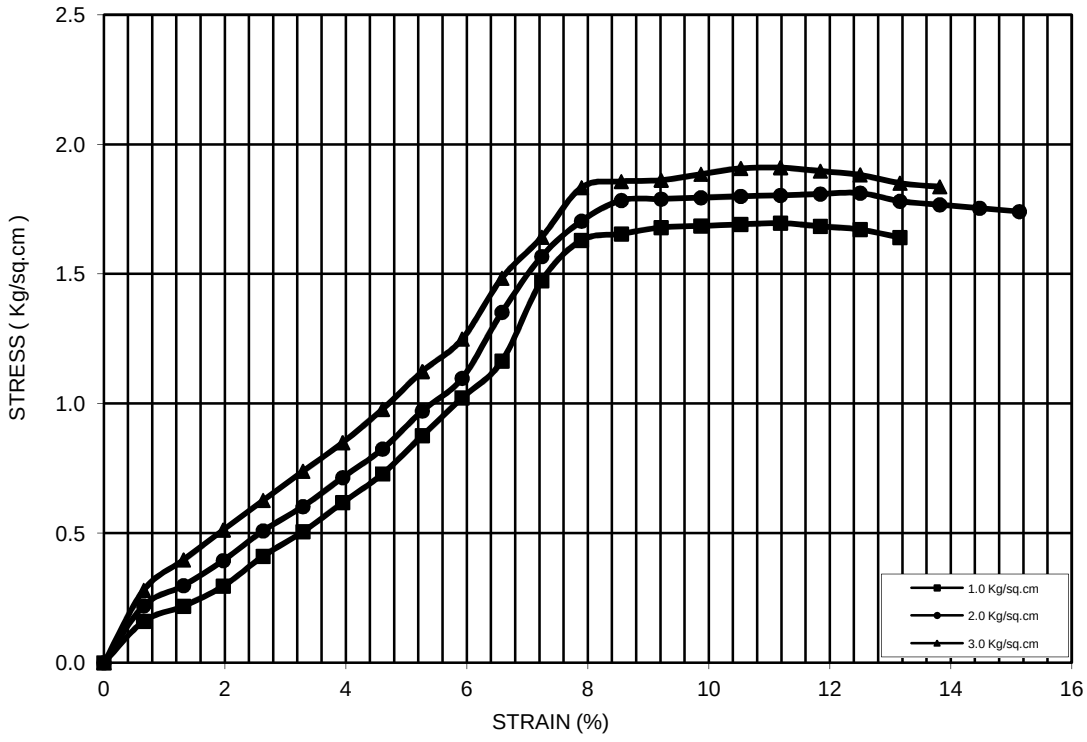
Ch. 52+518
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



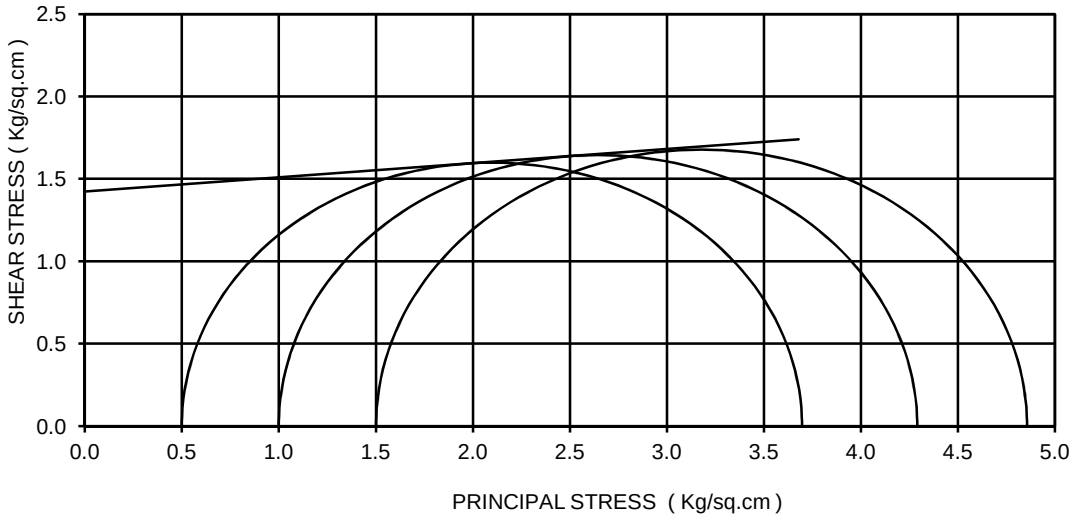


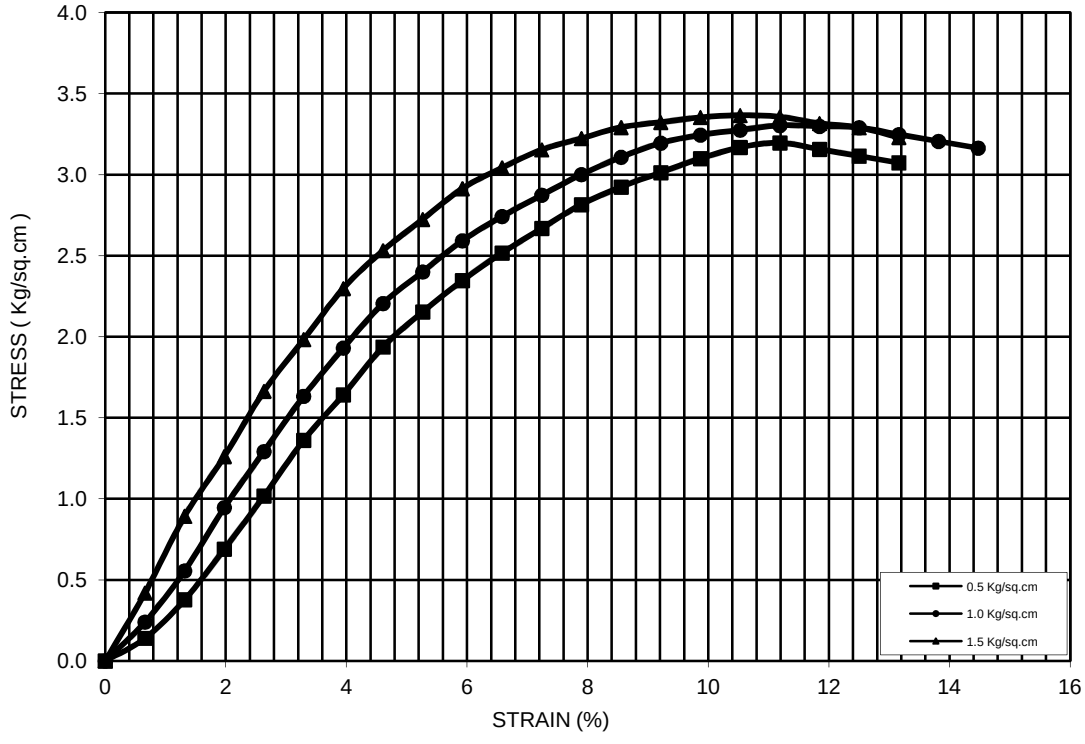
Ch. 52+518
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-5
DEPTH: 16.00 m
COHESION(C)= 0.62 kg/sq.cm
ANGLE OF FRICTION(Phi): 11 deg
TYPE OF THE TEST: UUT



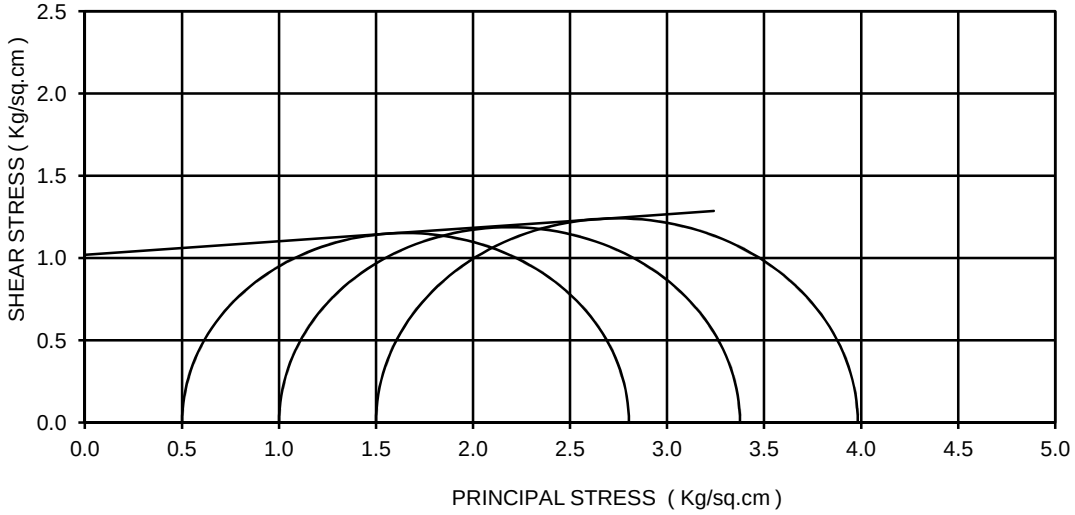


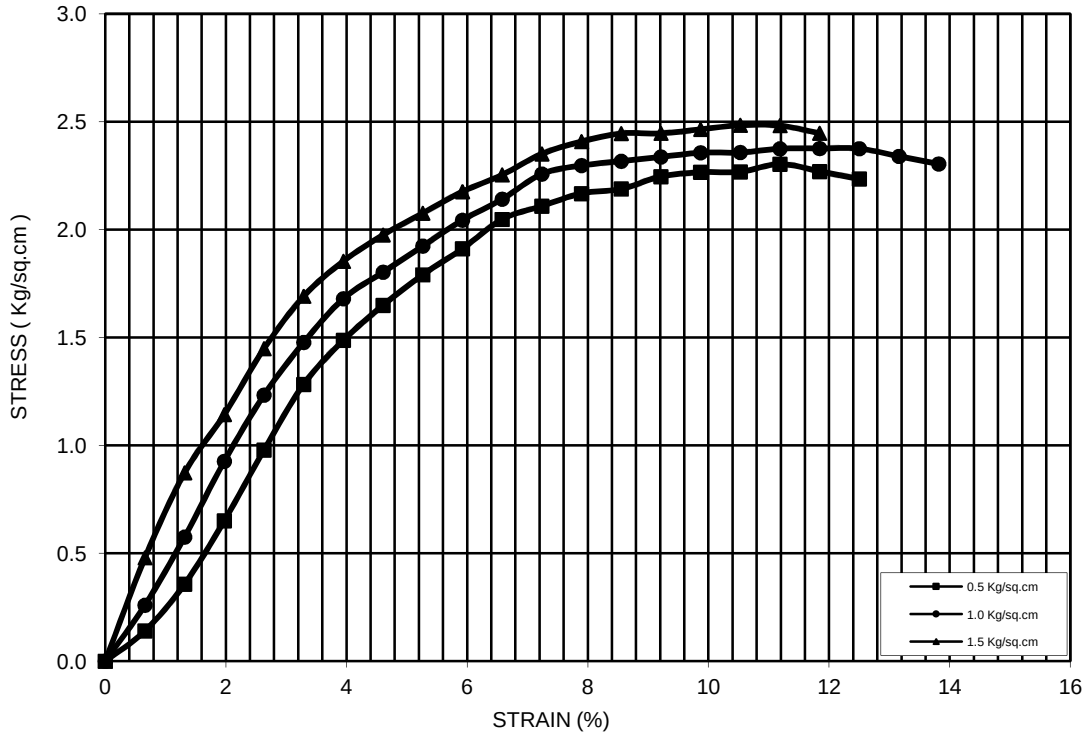
Ch. 53+107
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.42 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



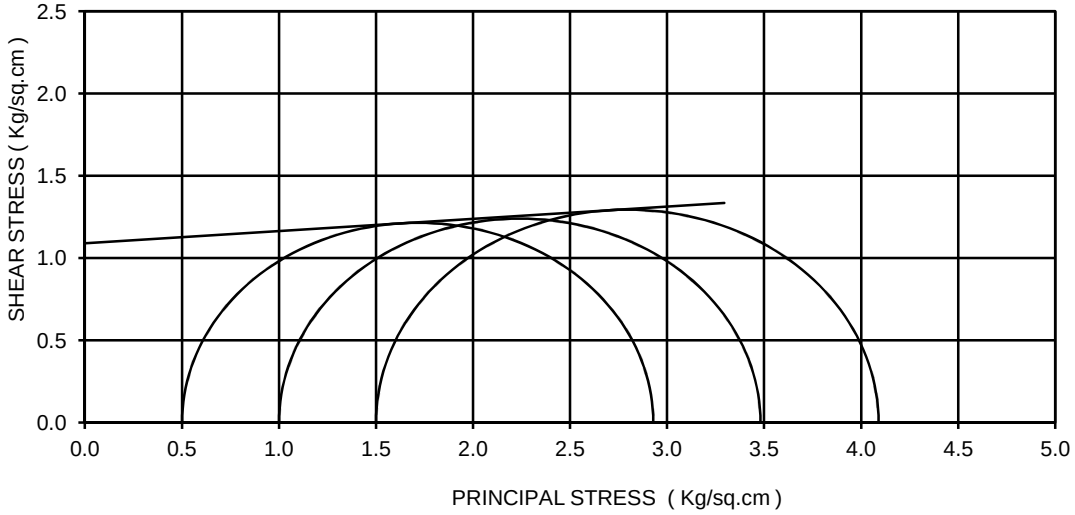


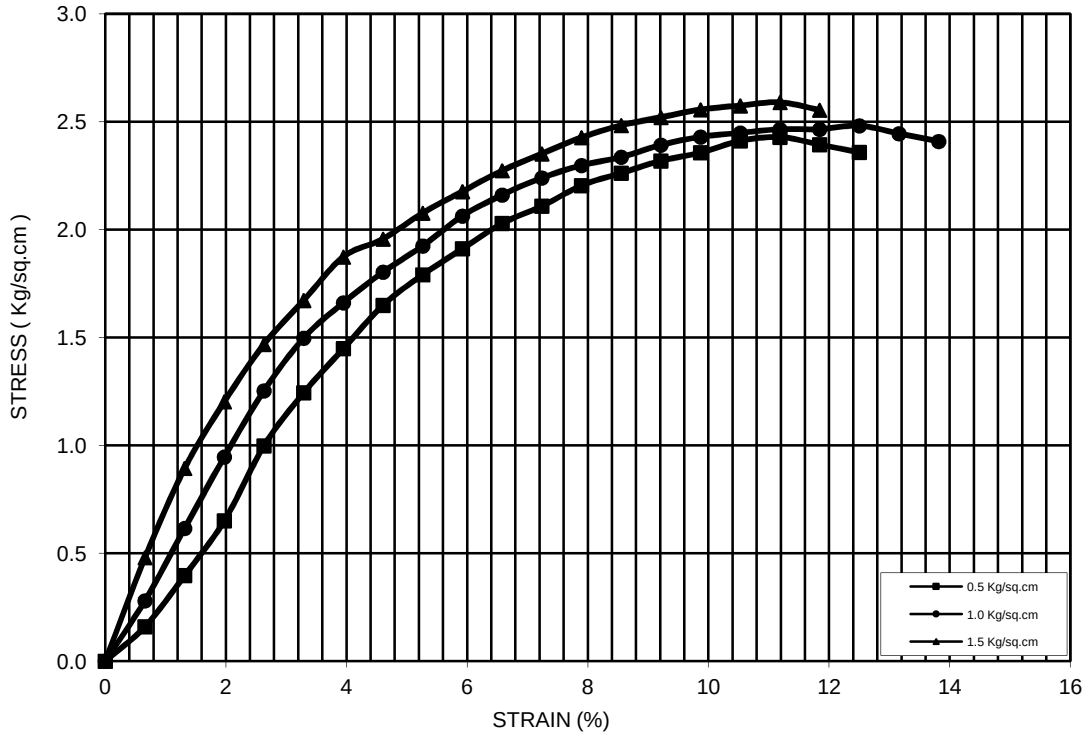
Ch. 53+282
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.02 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



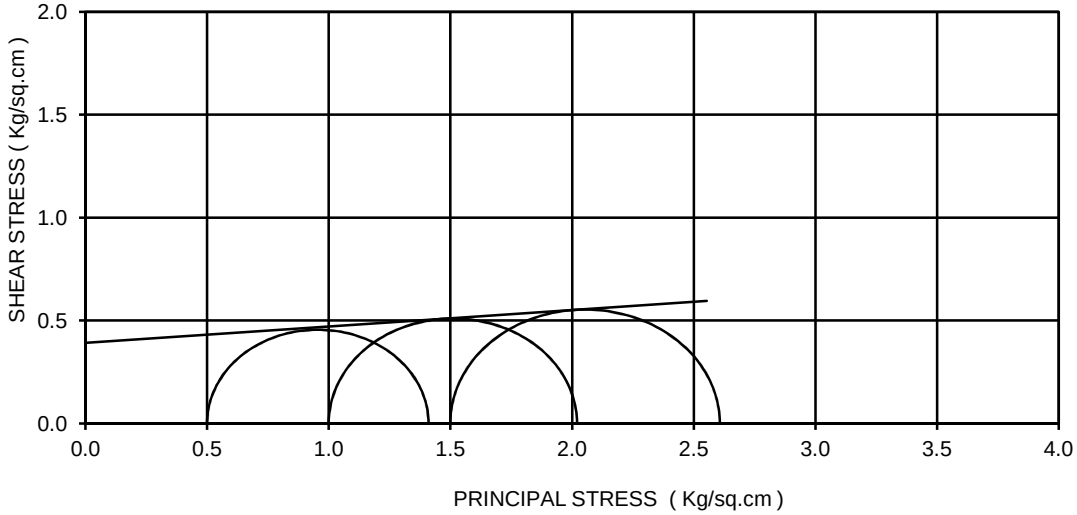


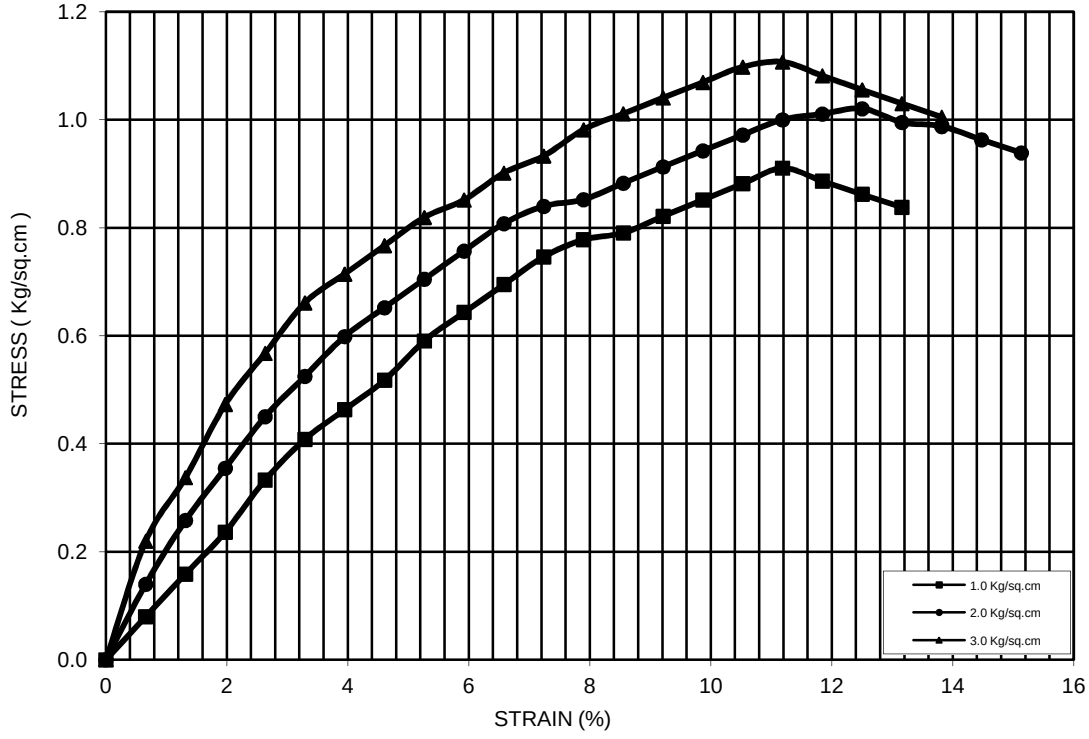
Ch. 53+572
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



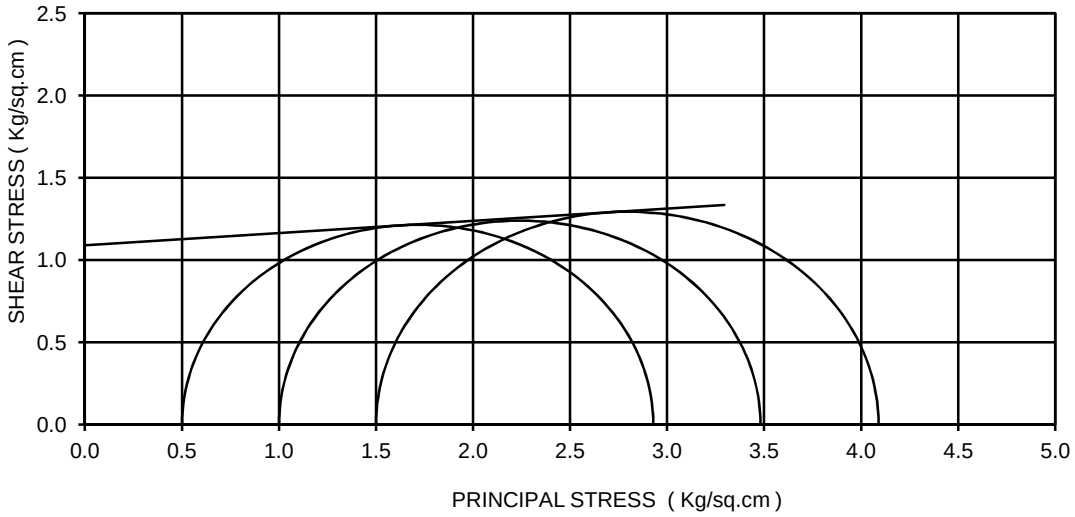


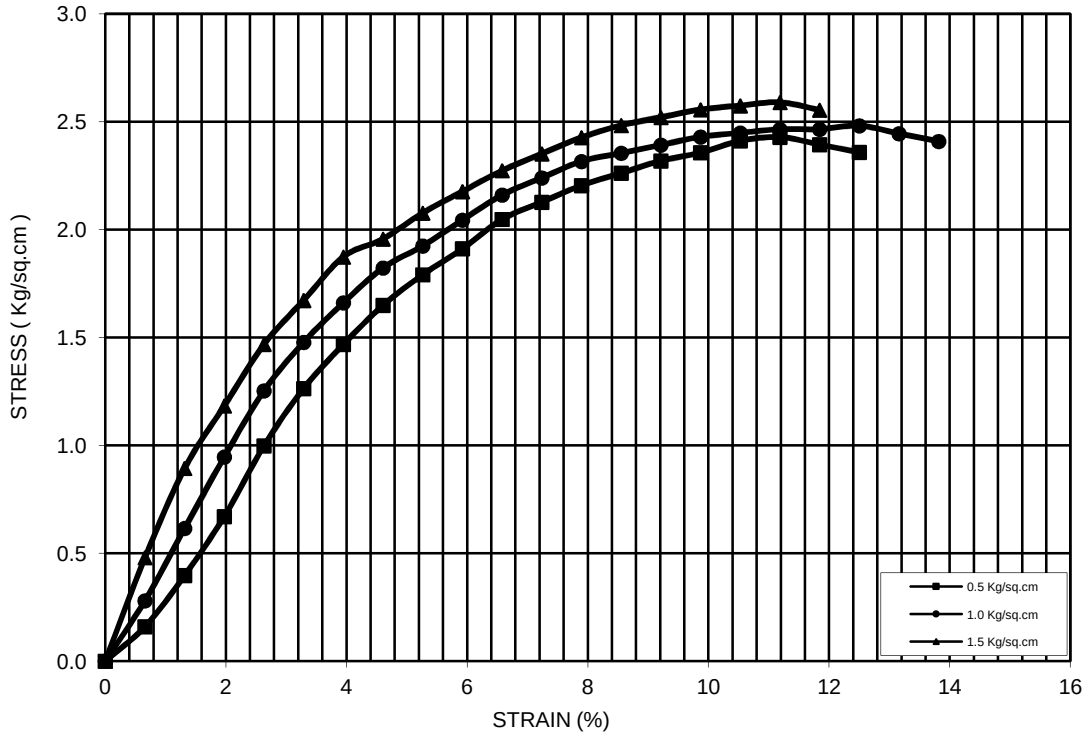
Ch. 53+982
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.39 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



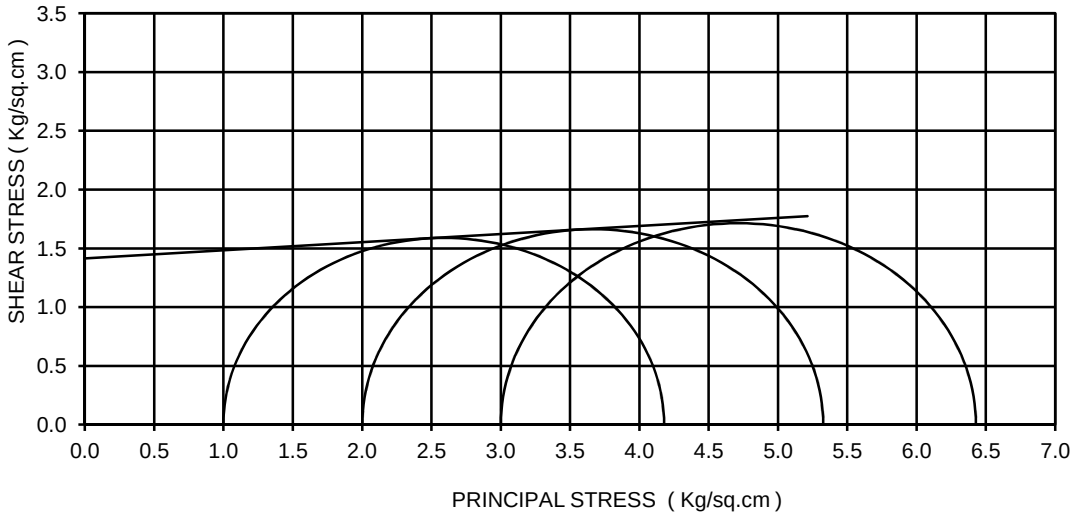


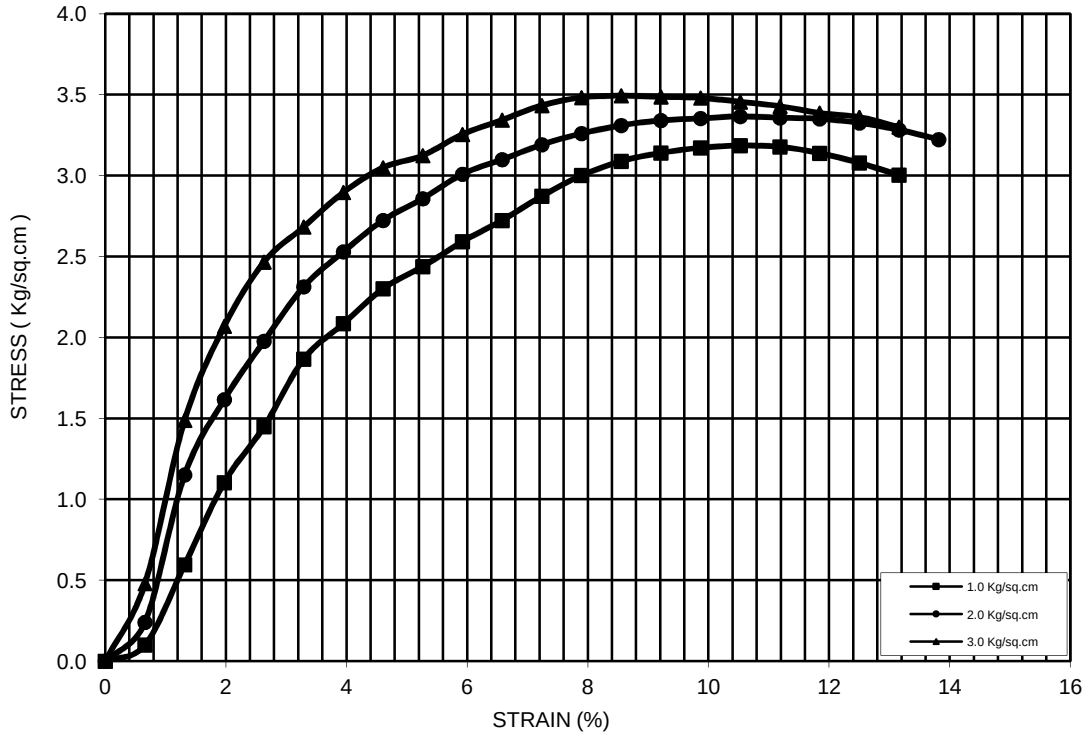
Ch. 54+363
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



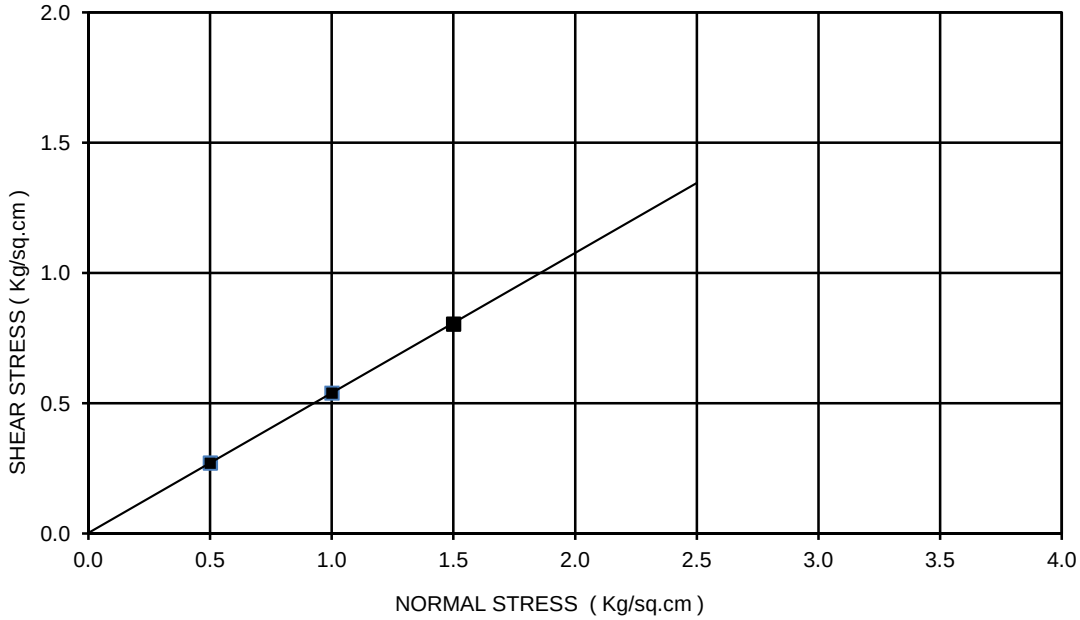


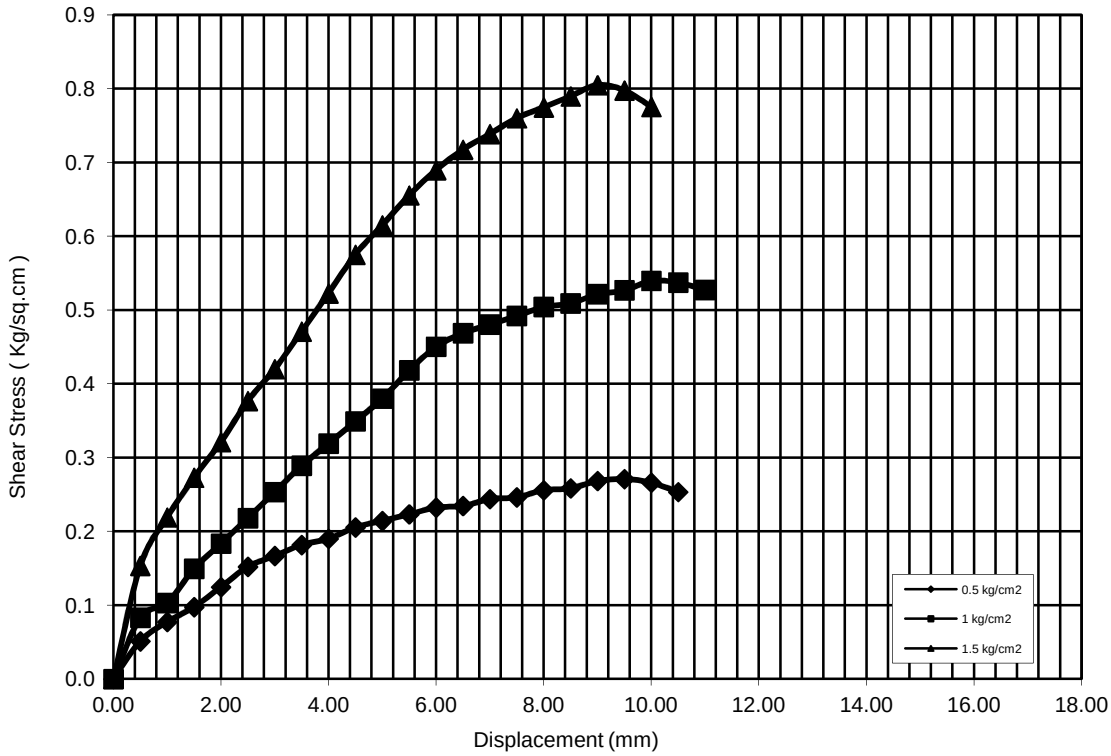
Ch. 54+496
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-3
DEPTH: 11.25 m
COHESION(C)= 1.42 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



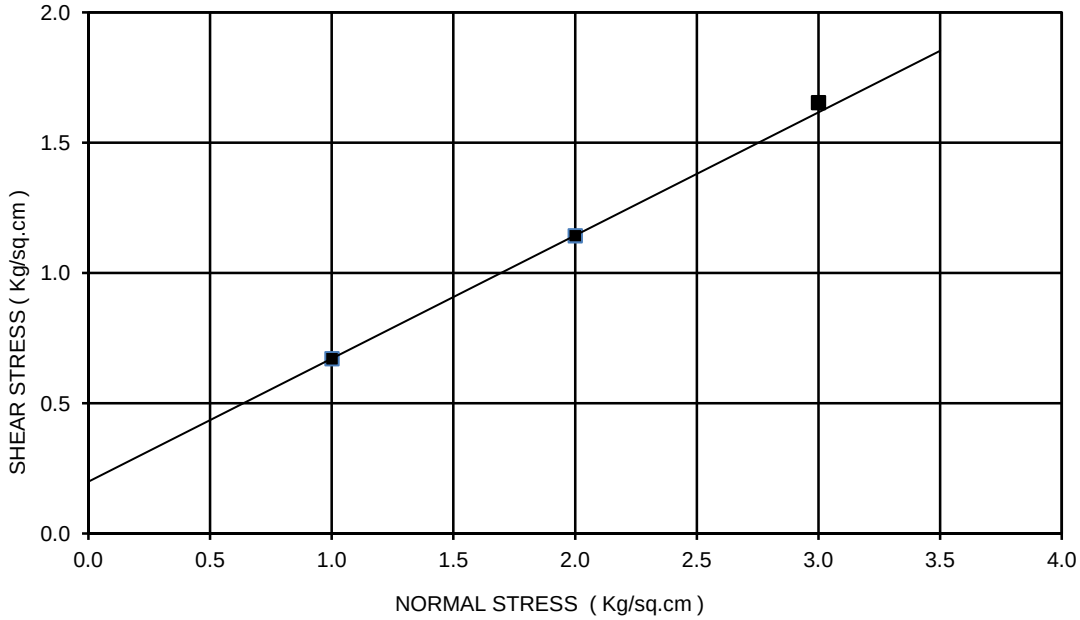


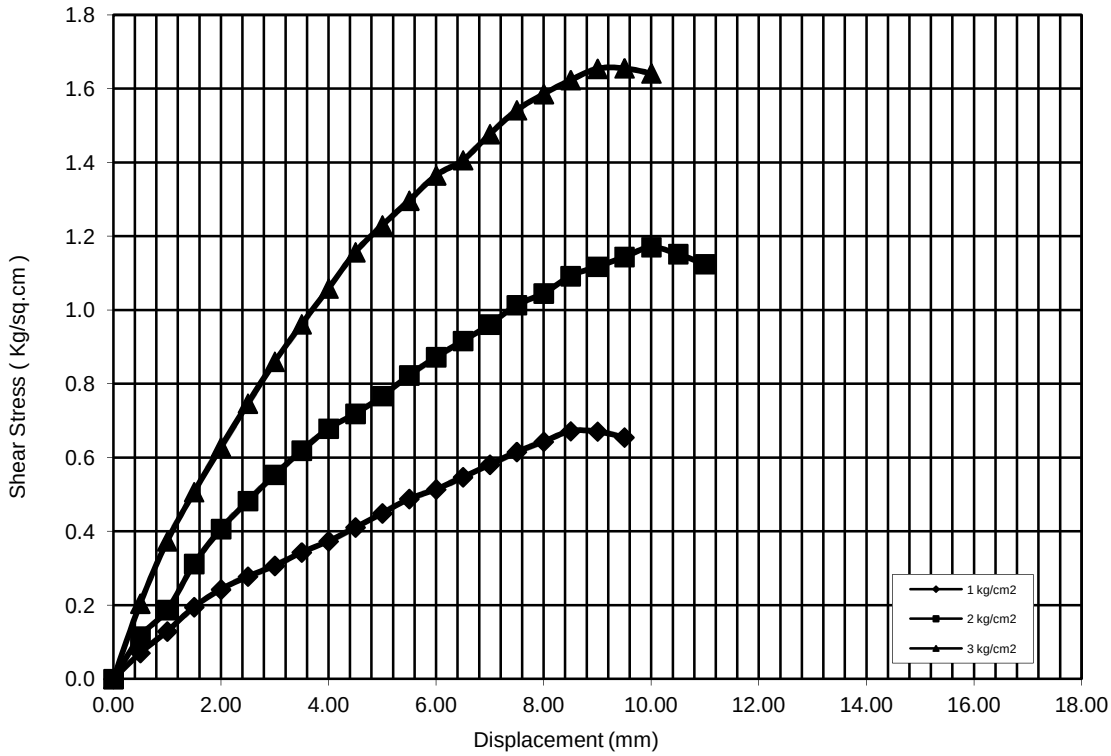
Ch. 55+910
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-1
DEPTH: 2.5 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



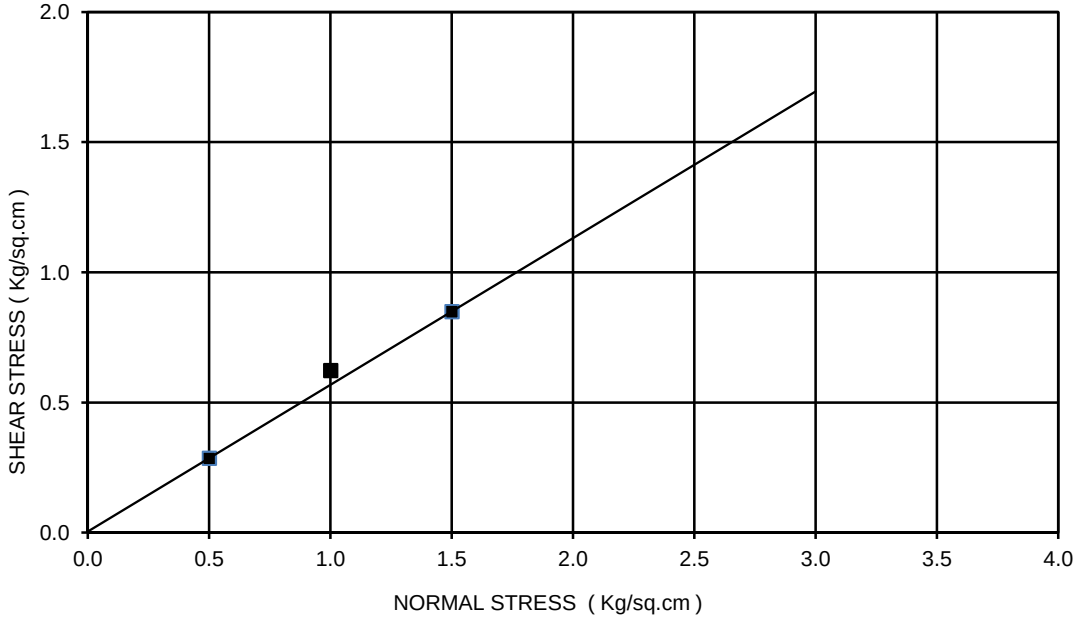


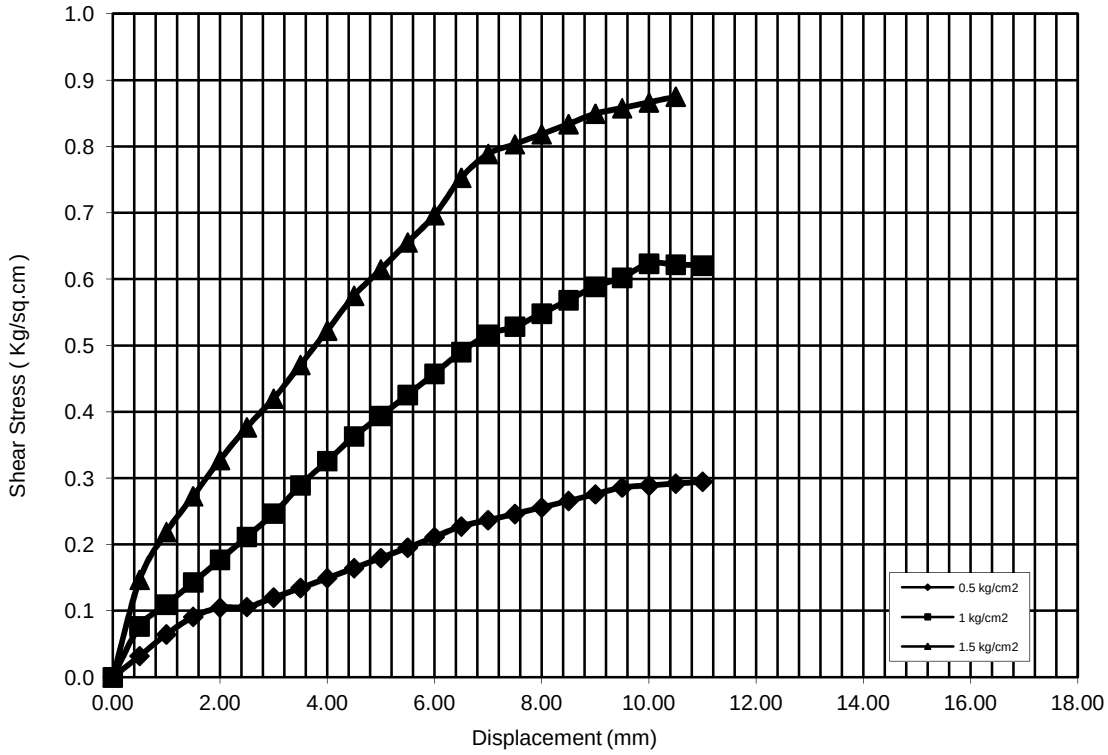
Ch. 55+910
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



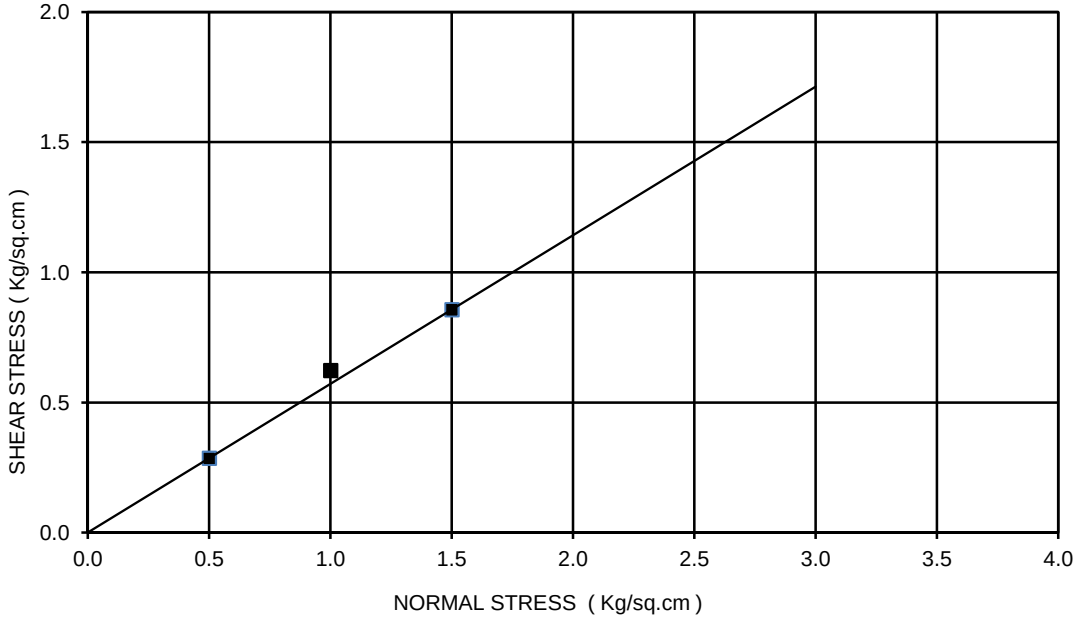


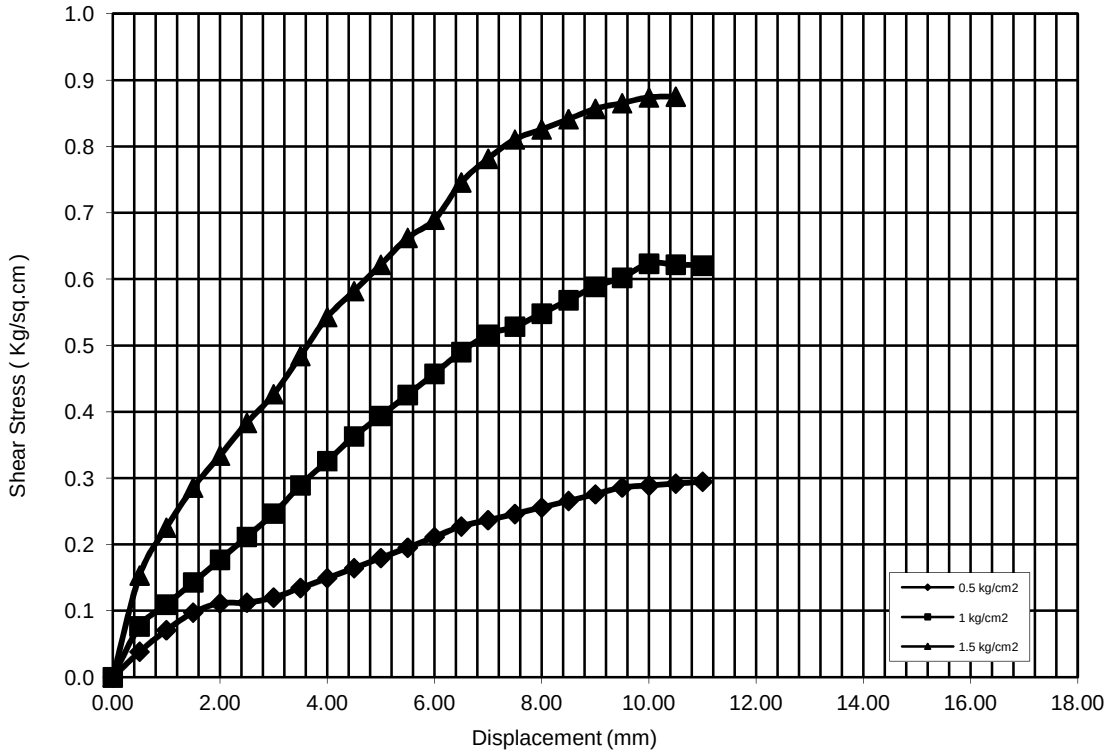
Ch. 55+910
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



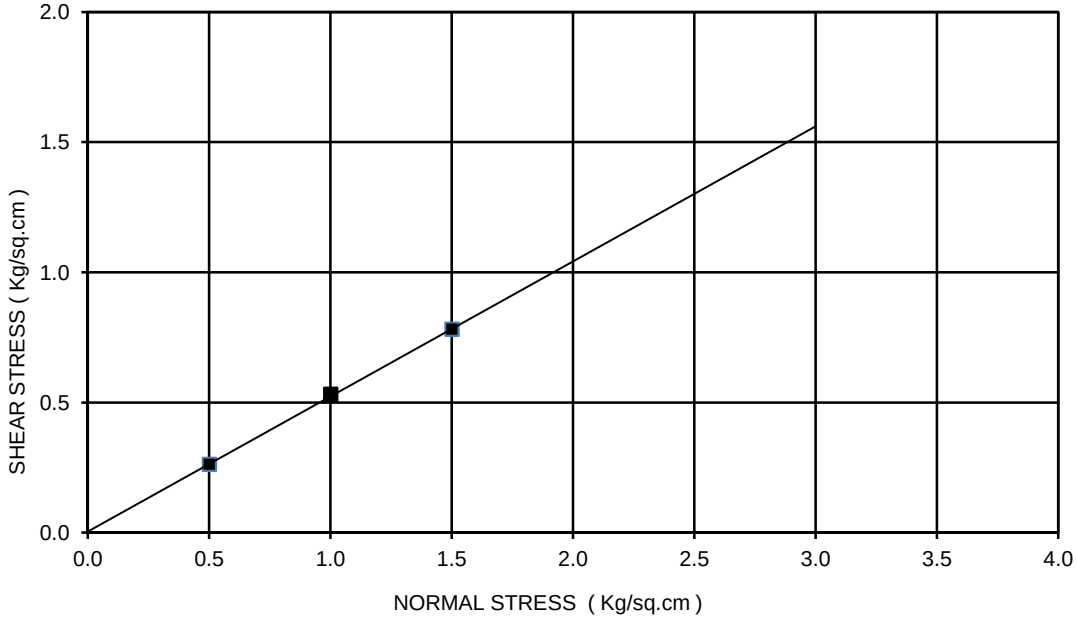


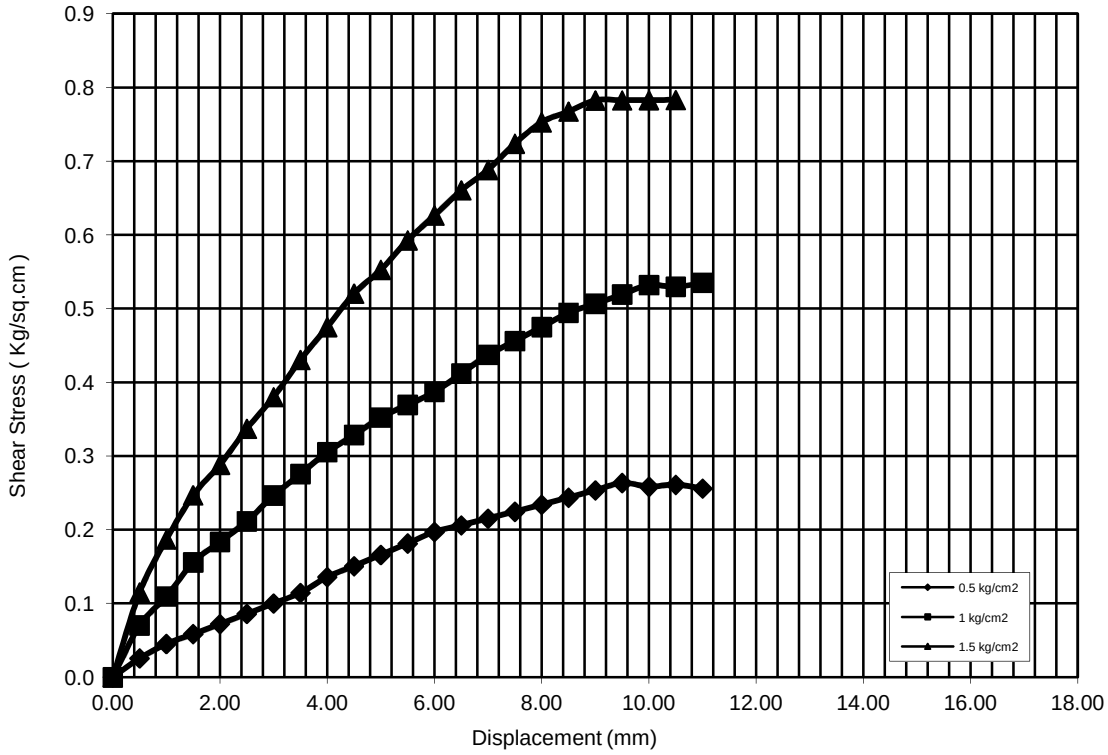
Ch. 55+910
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



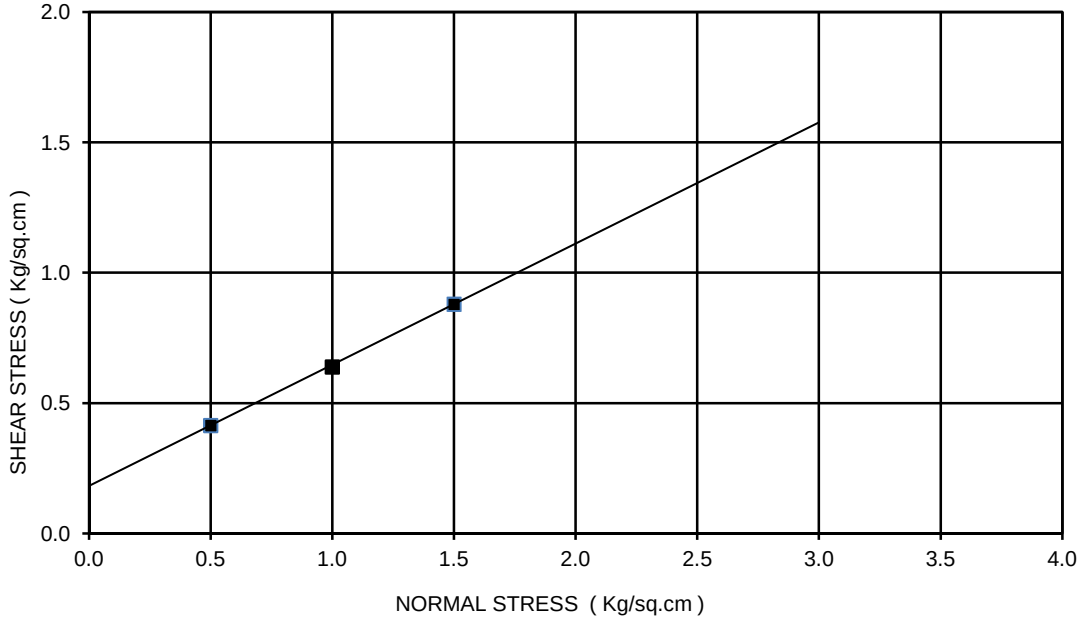


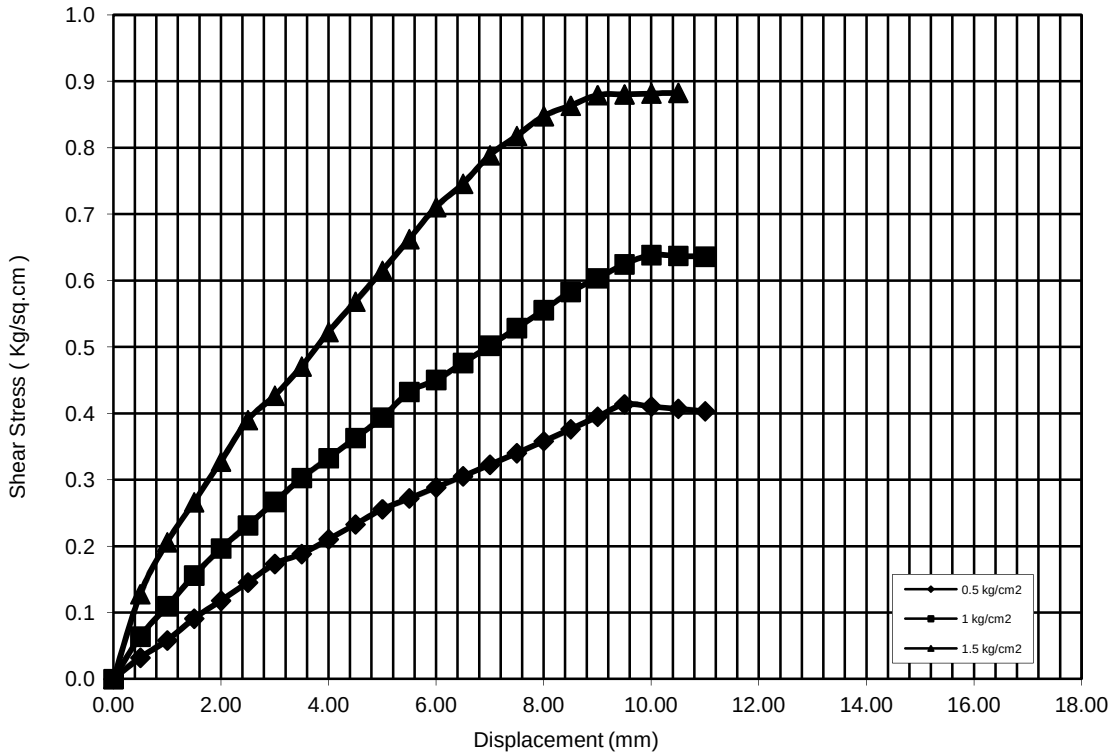
Ch. 56+403
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



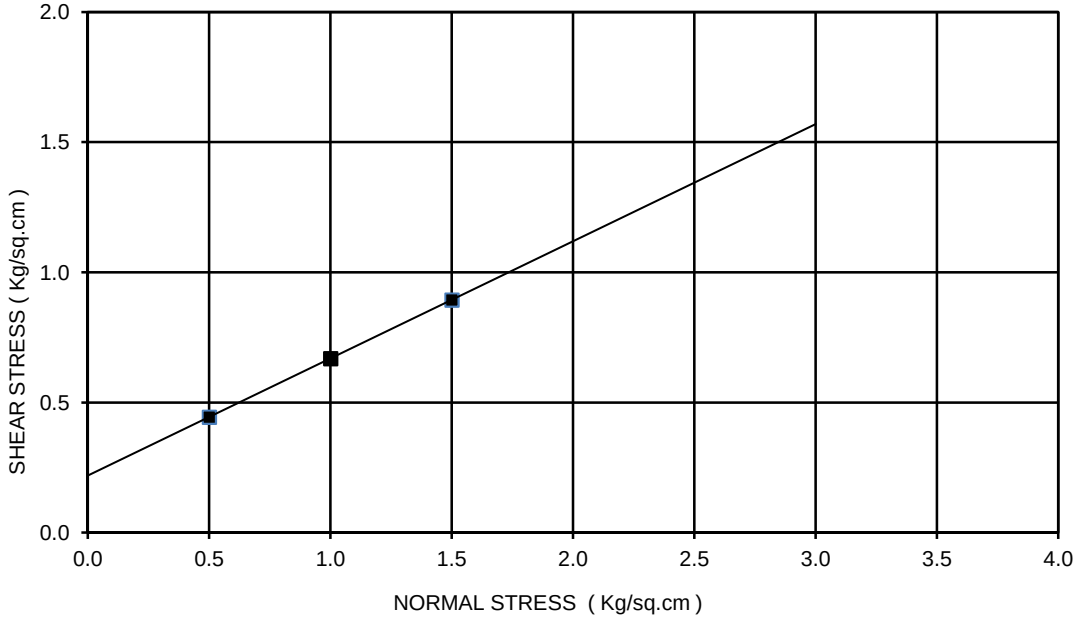


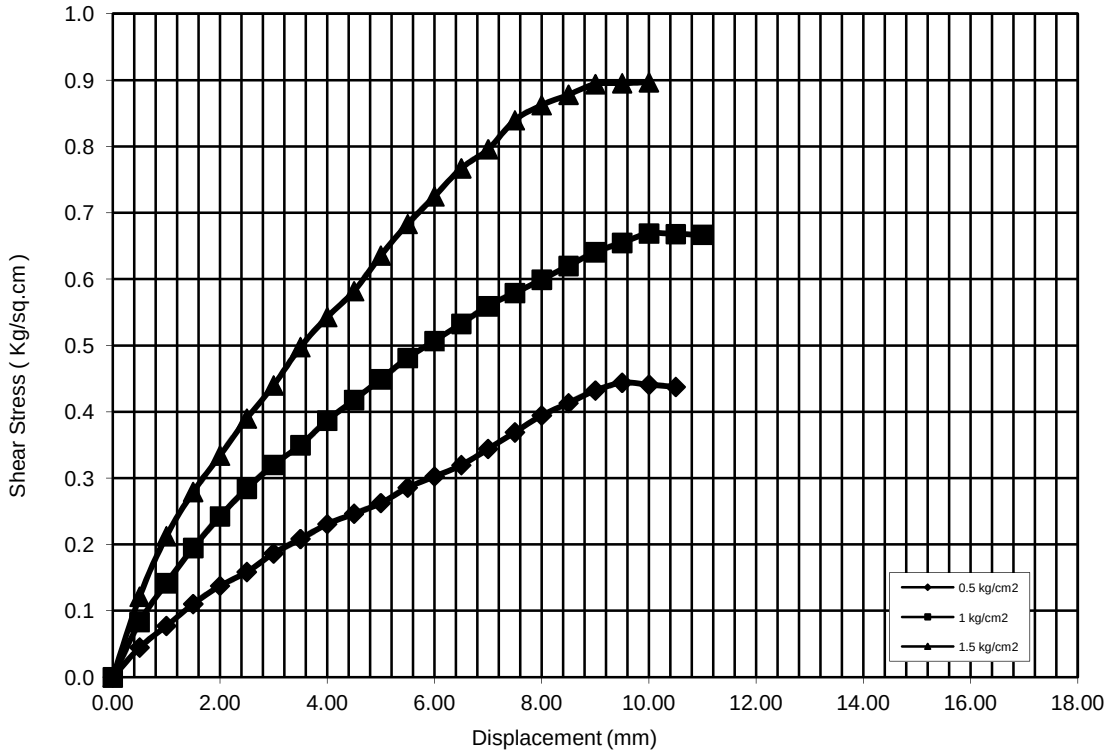
Ch. 56+701
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



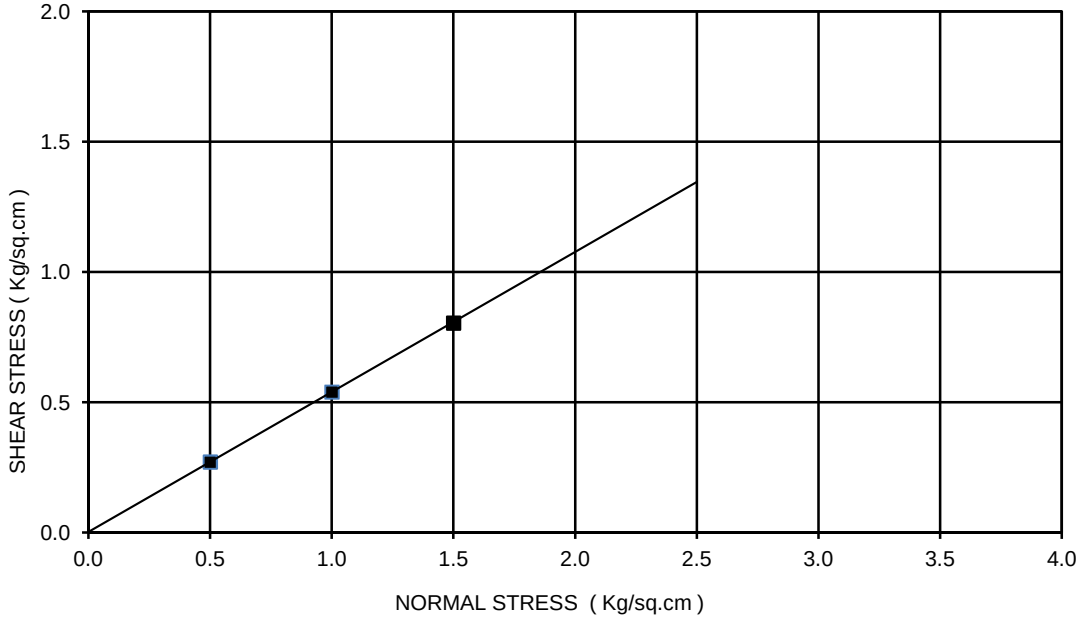


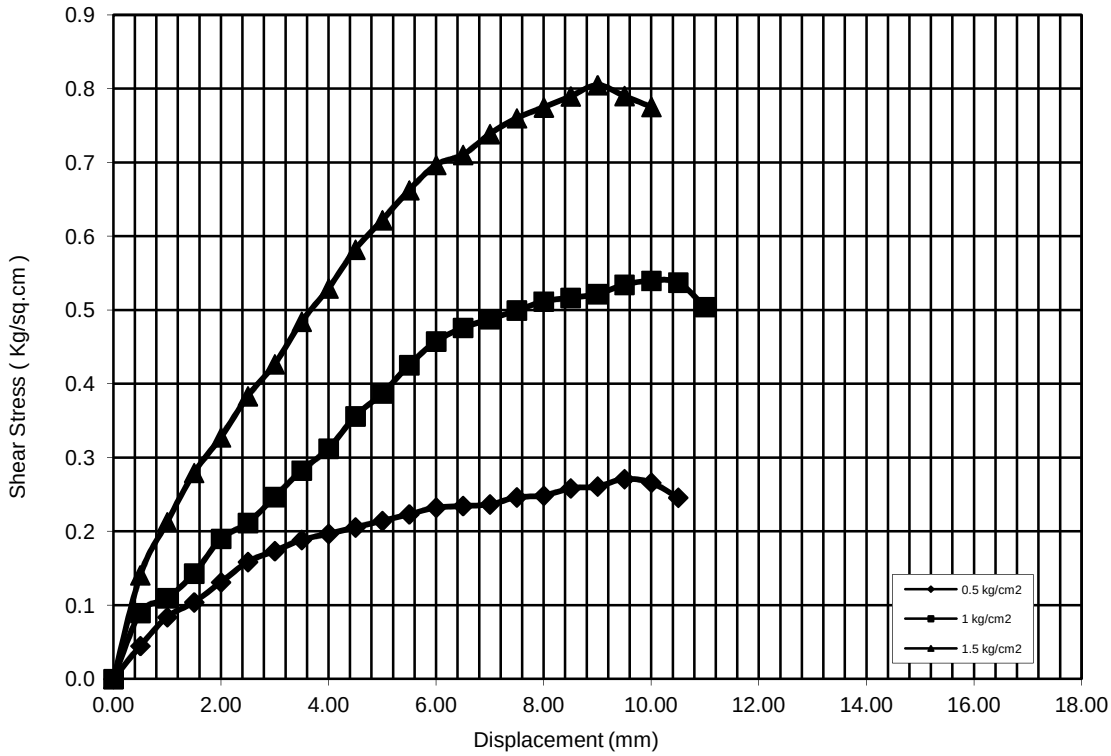
Ch. 56+978
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



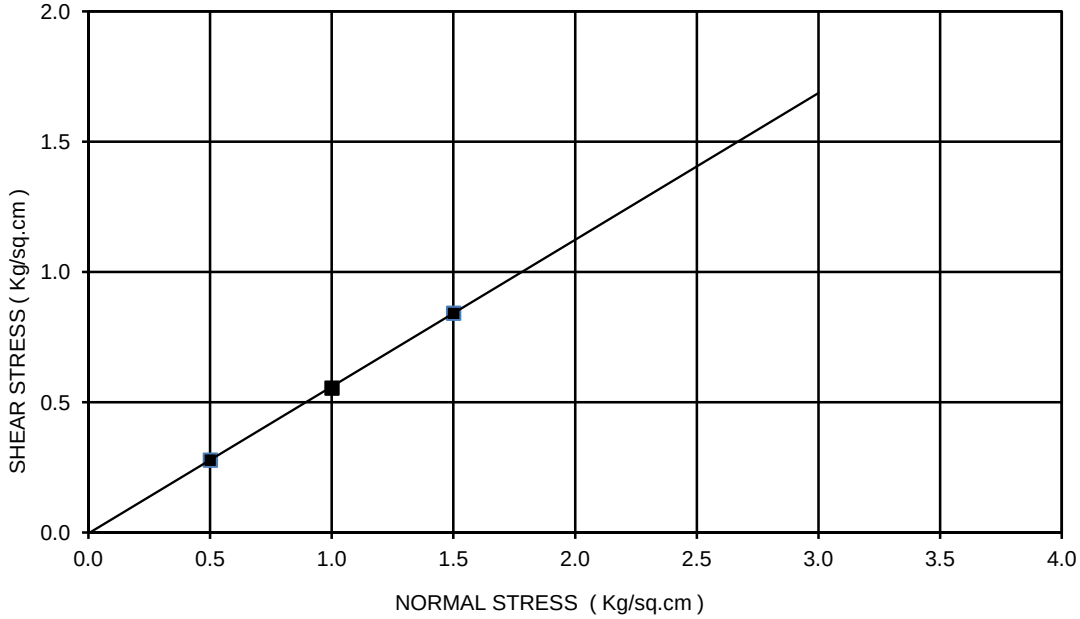


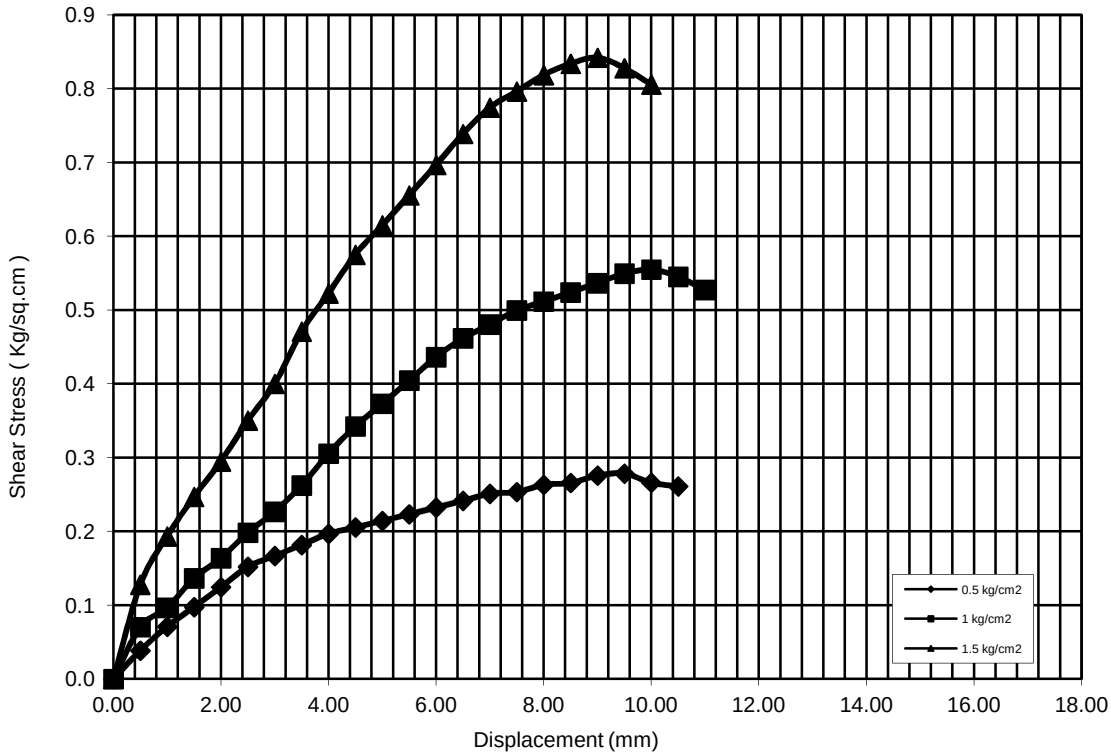
Ch. 57+400
BORE HOLE NO: P5
SAMPLE NO.: UDS-1
DEPTH: 2.5 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



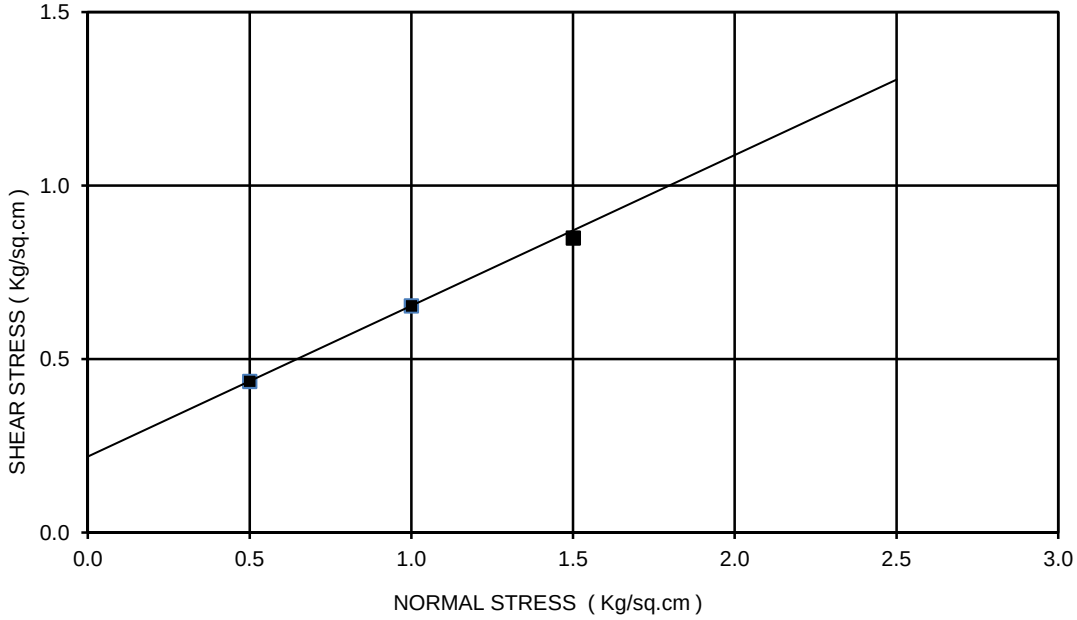


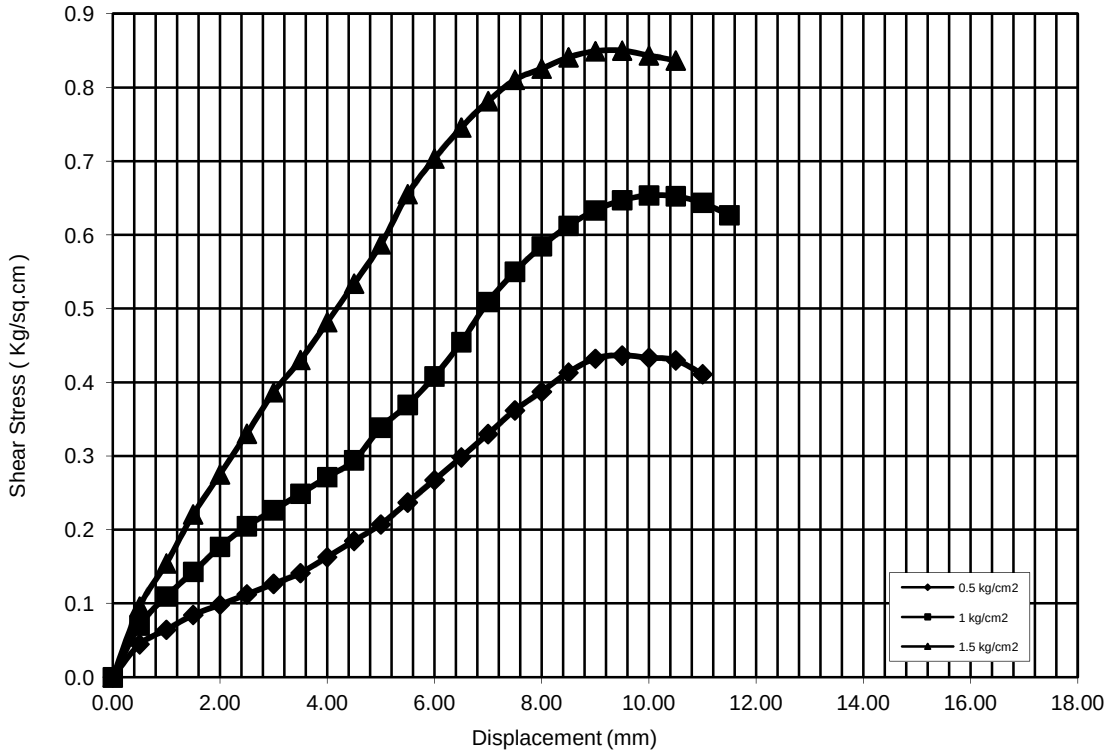
Ch. 57+400
BORE HOLE NO: BH-P5
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



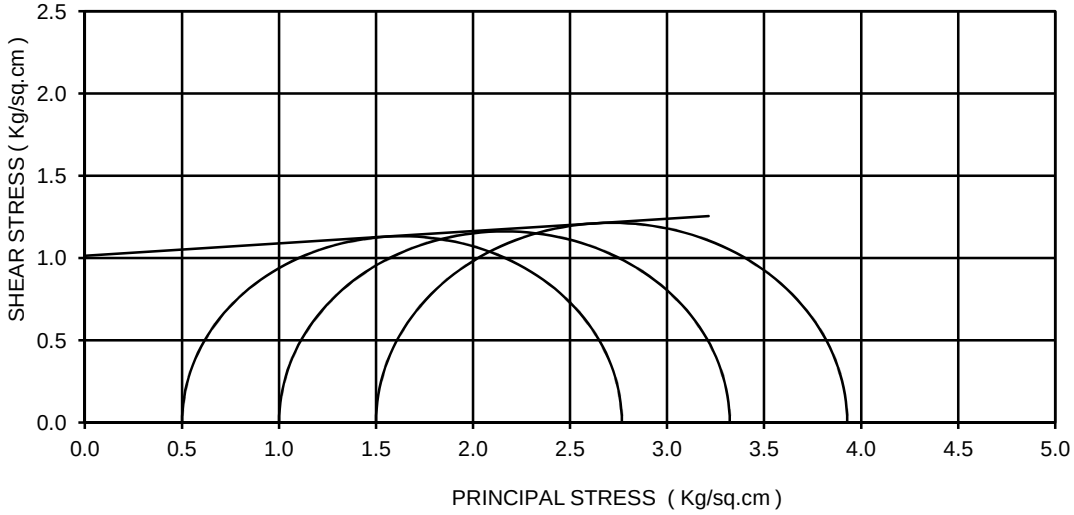


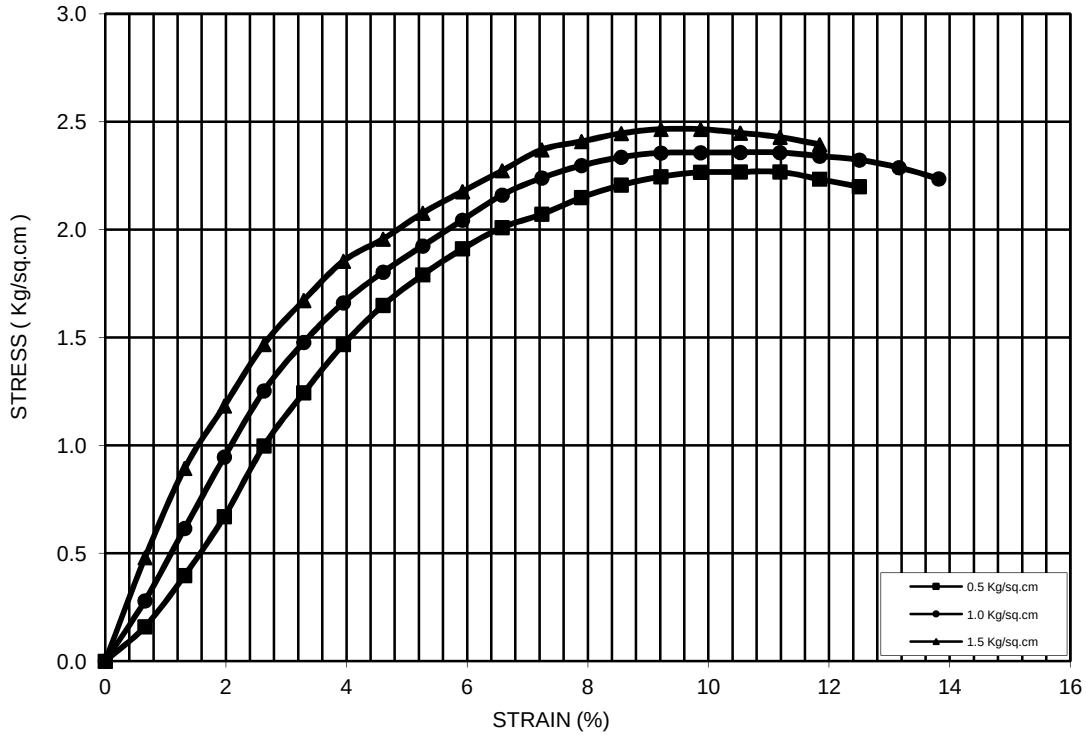
Ch. 57+400
BORE HOLE NO: BH-P9
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.06 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



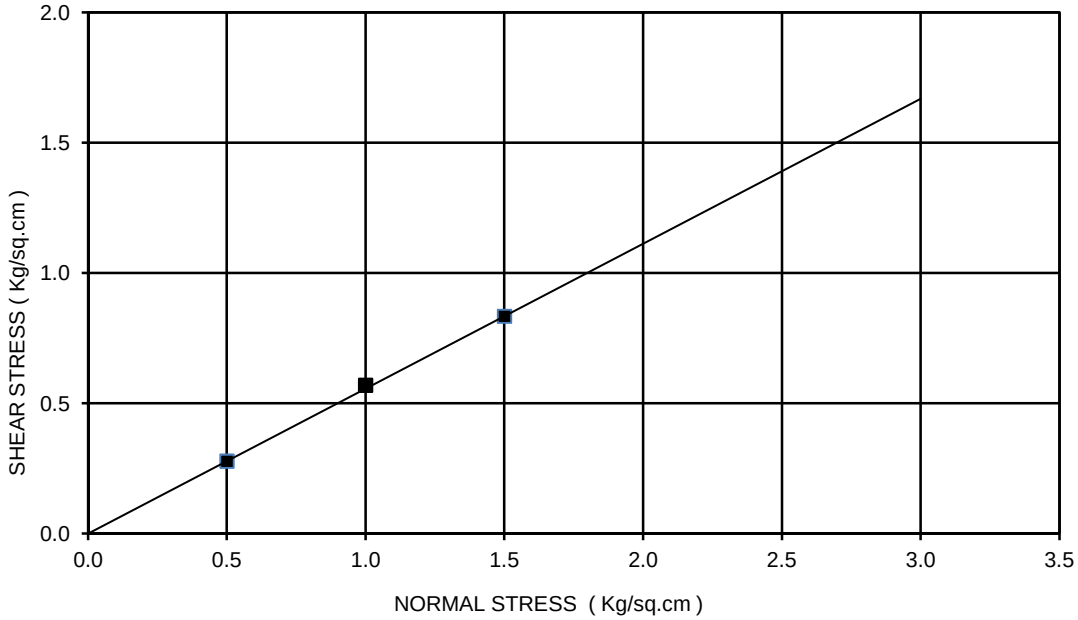


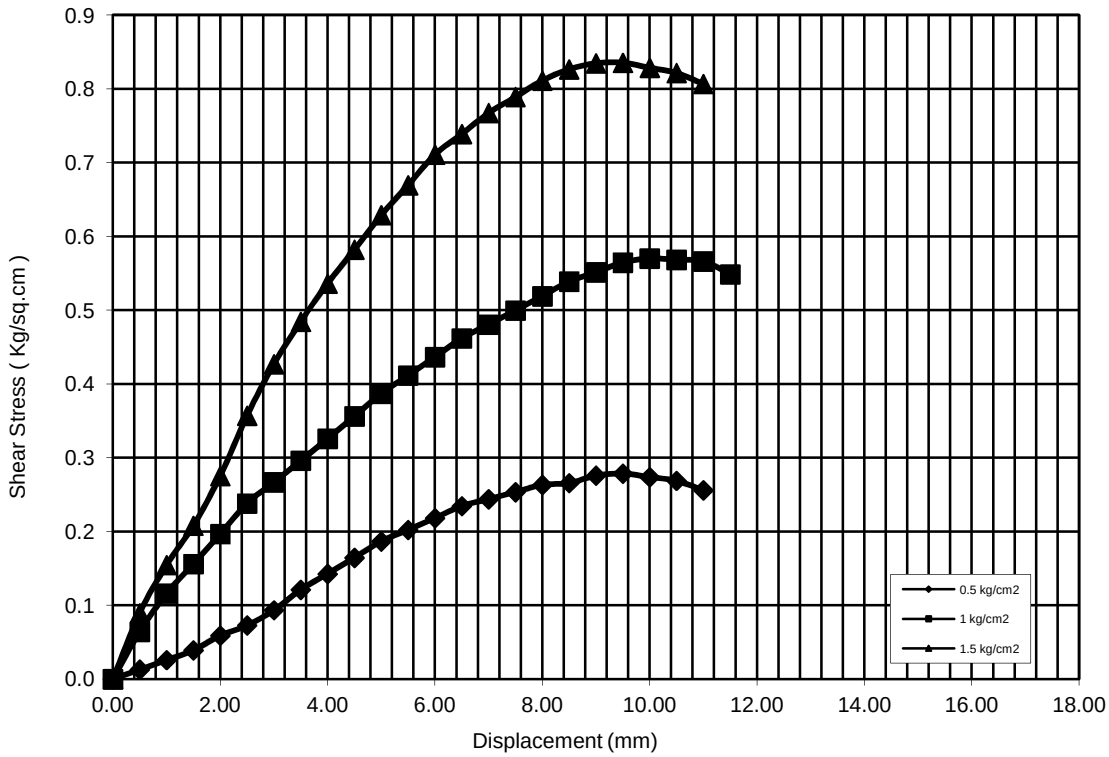
Ch. 57+400
BORE HOLE NO: BH-P9
SAMPLE NO.: UDS-3
DEPTH: 10.00 m
COHESION(C)= 1.39 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



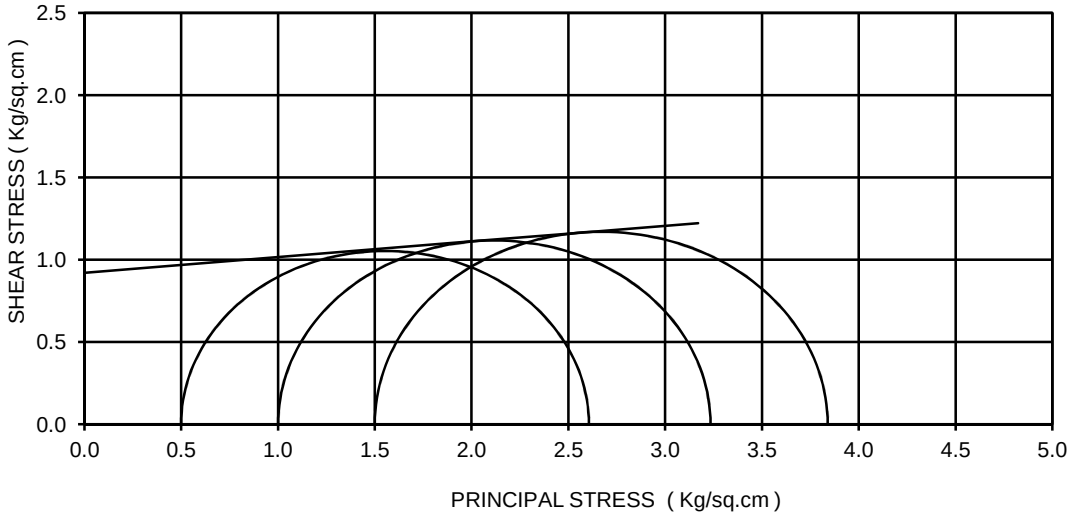


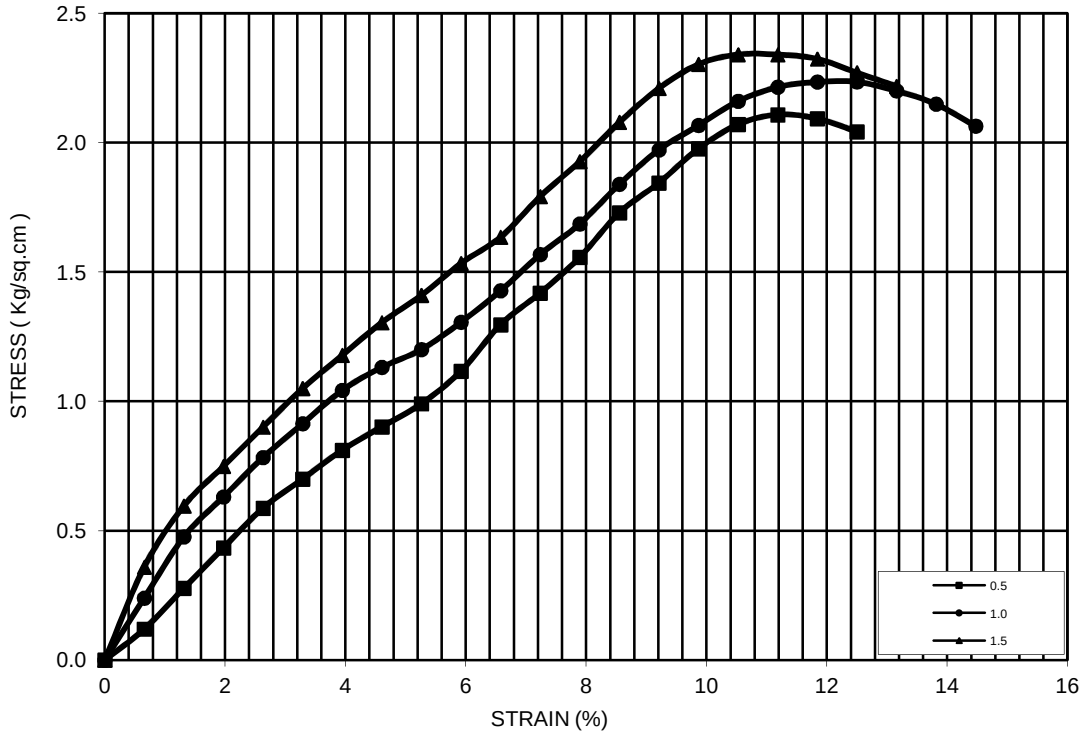
Ch. 57+400
BORE HOLE NO: BH-P10
SAMPLE NO.: UDS-5
DEPTH: 16.00 m
COHESION(C)= 0 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



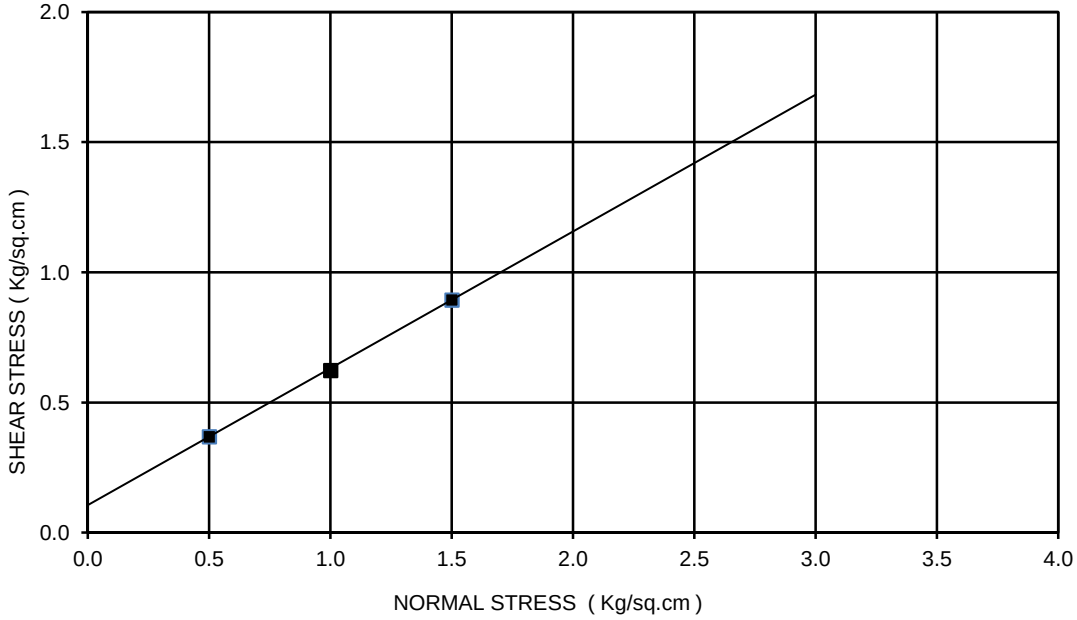


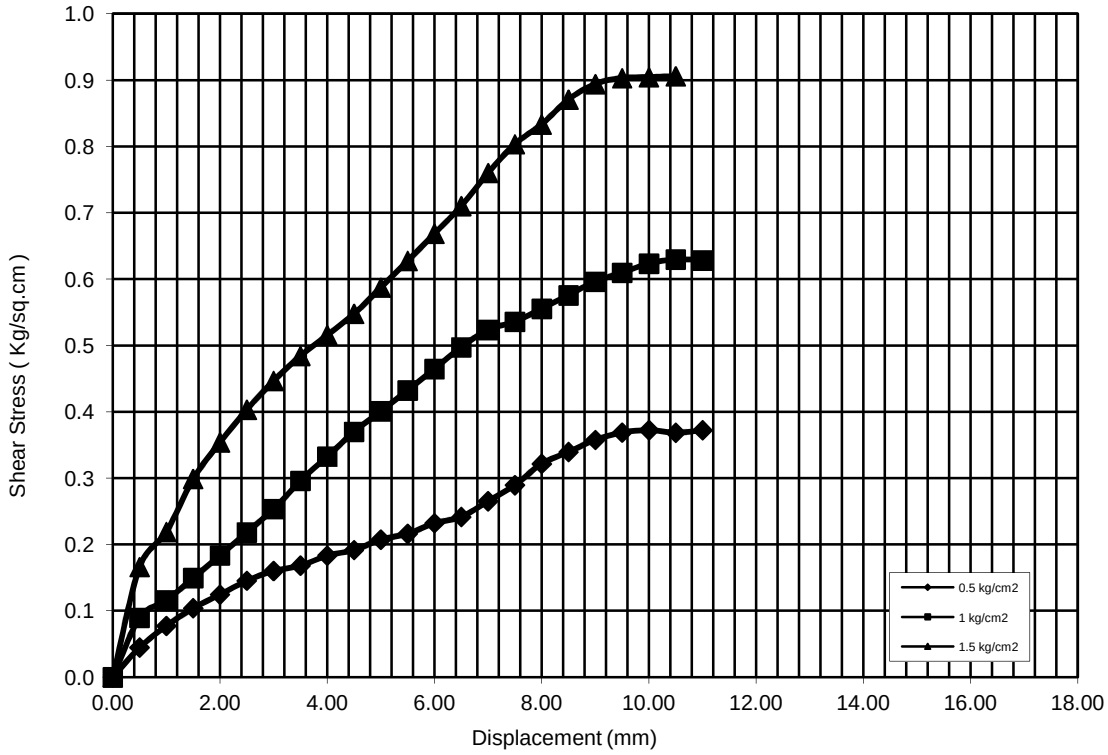
Ch. 57+400
BORE HOLE NO: BH-P10
SAMPLE NO.: UDS-2
DEPTH: 7.00 m
COHESION(C)= 0.78 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



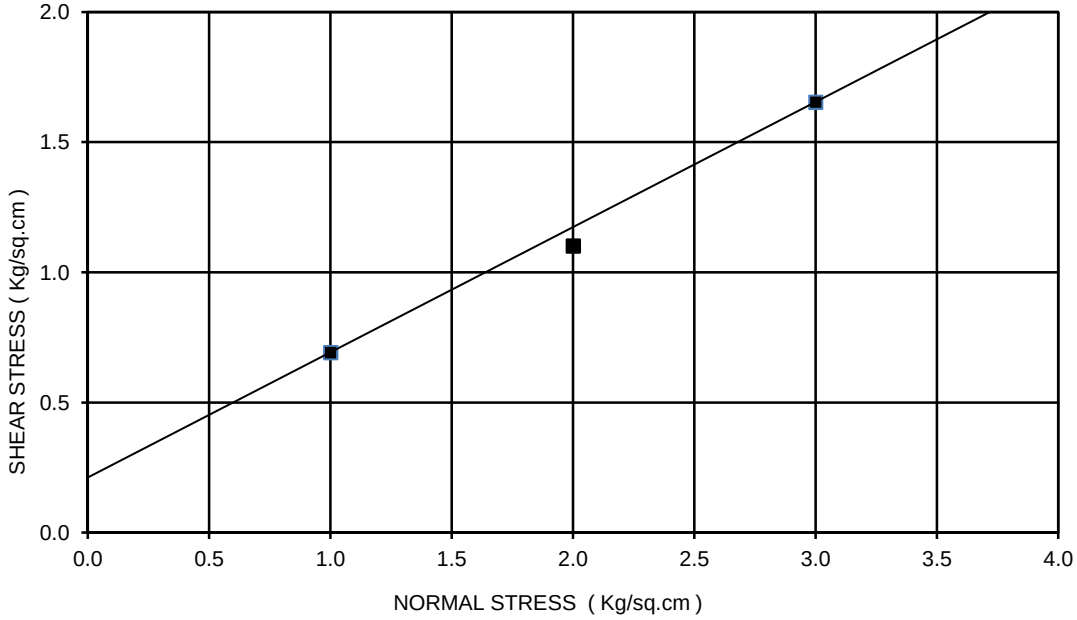


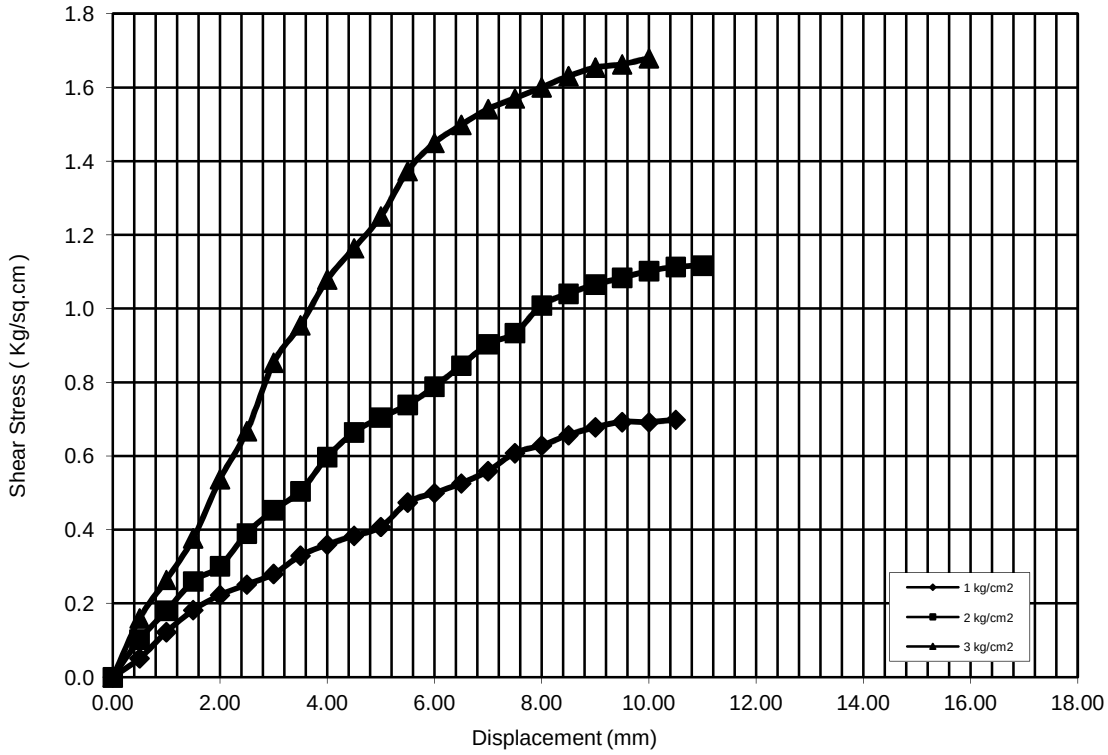
Ch. 57+400
BORE HOLE NO: BH-P12
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



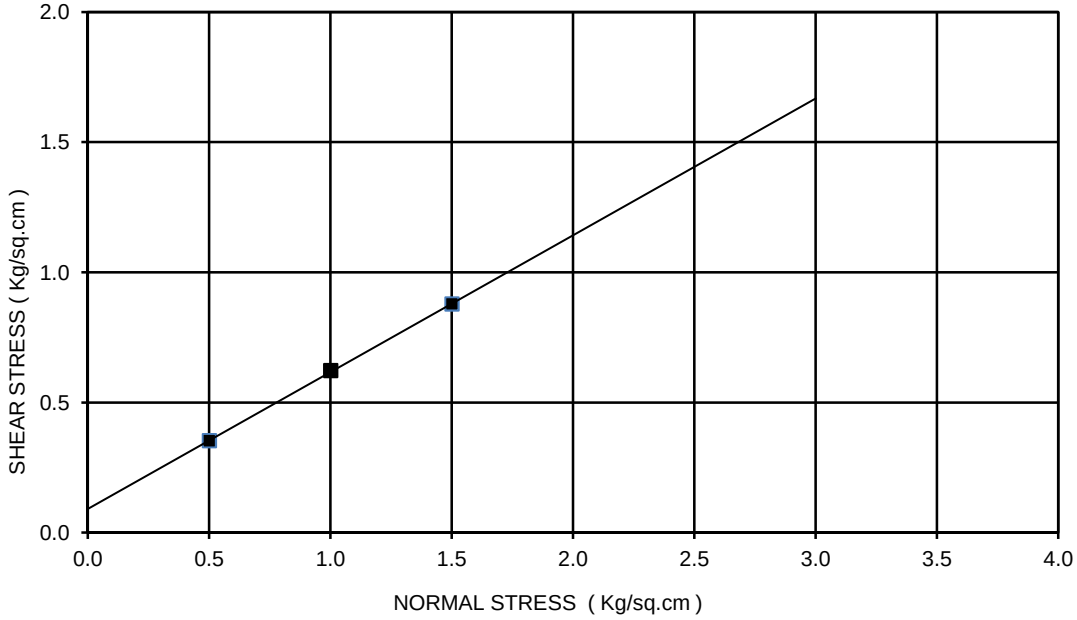


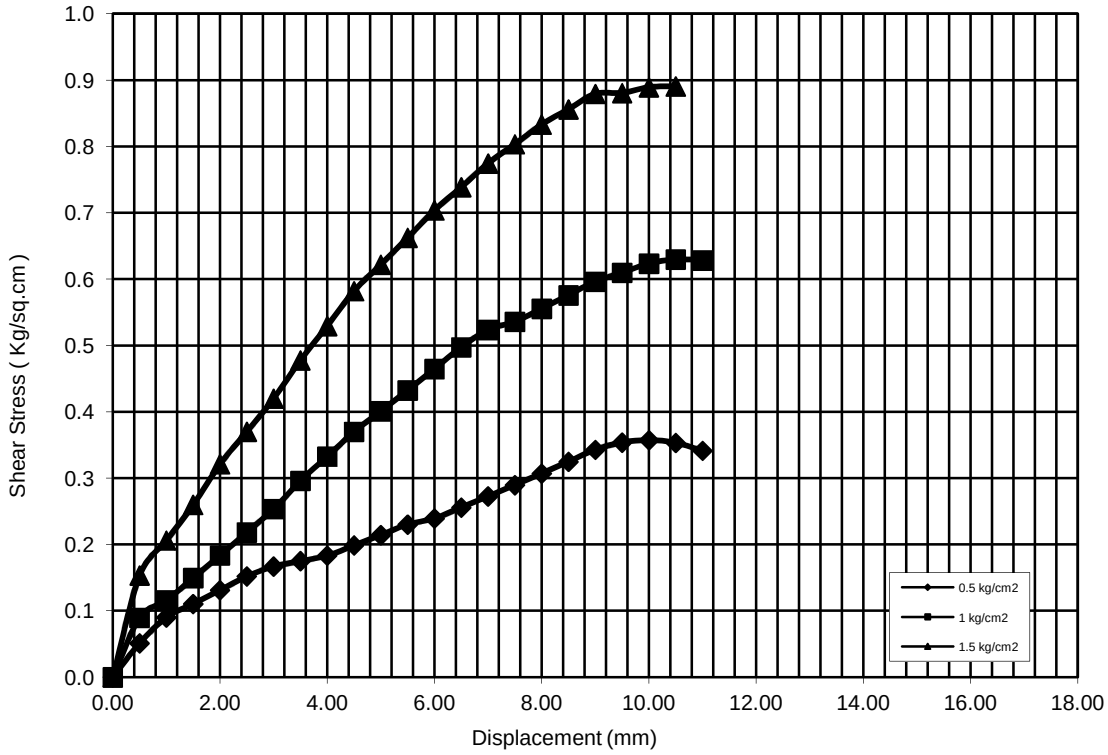
Ch. 57+400
BORE HOLE NO: BH-P12
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



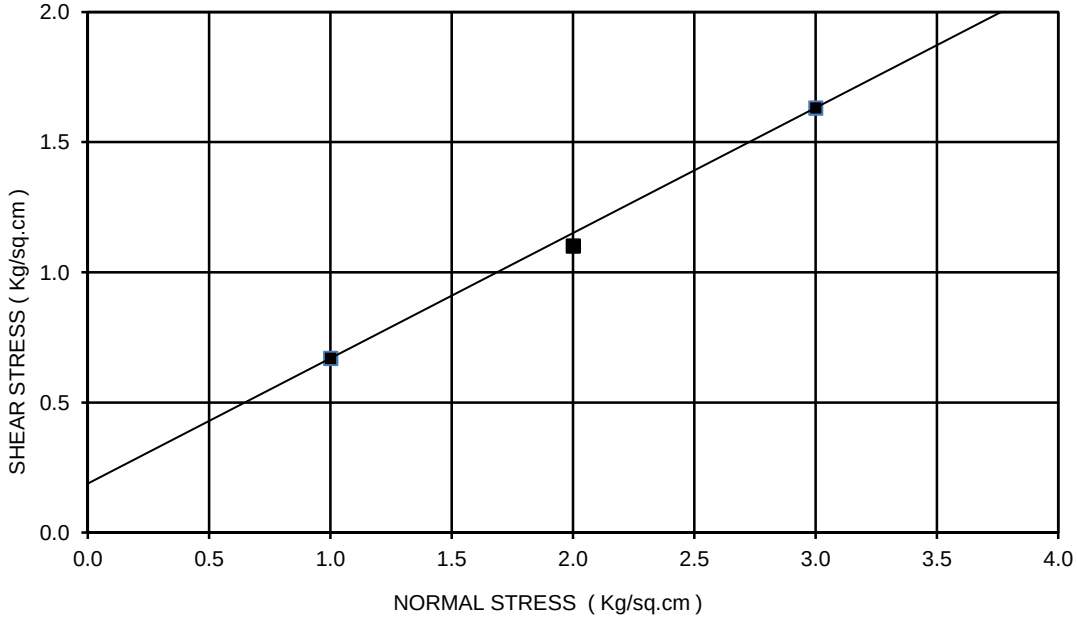


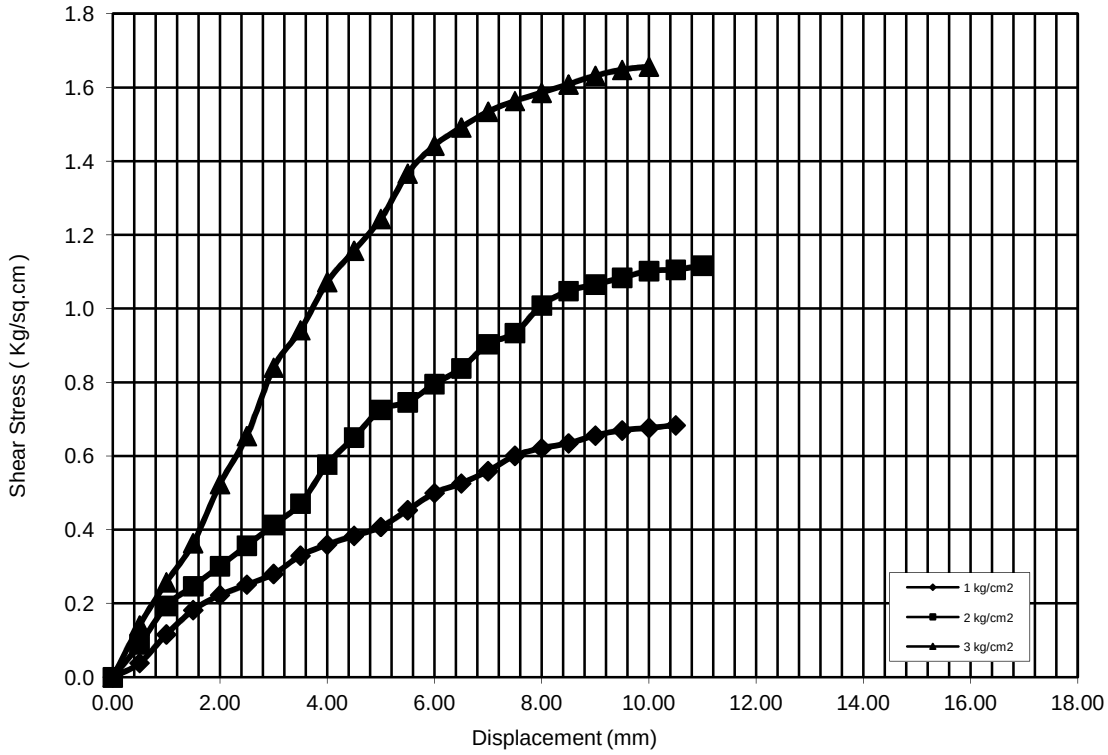
Ch. 57+400
BORE HOLE NO: BH-P15
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



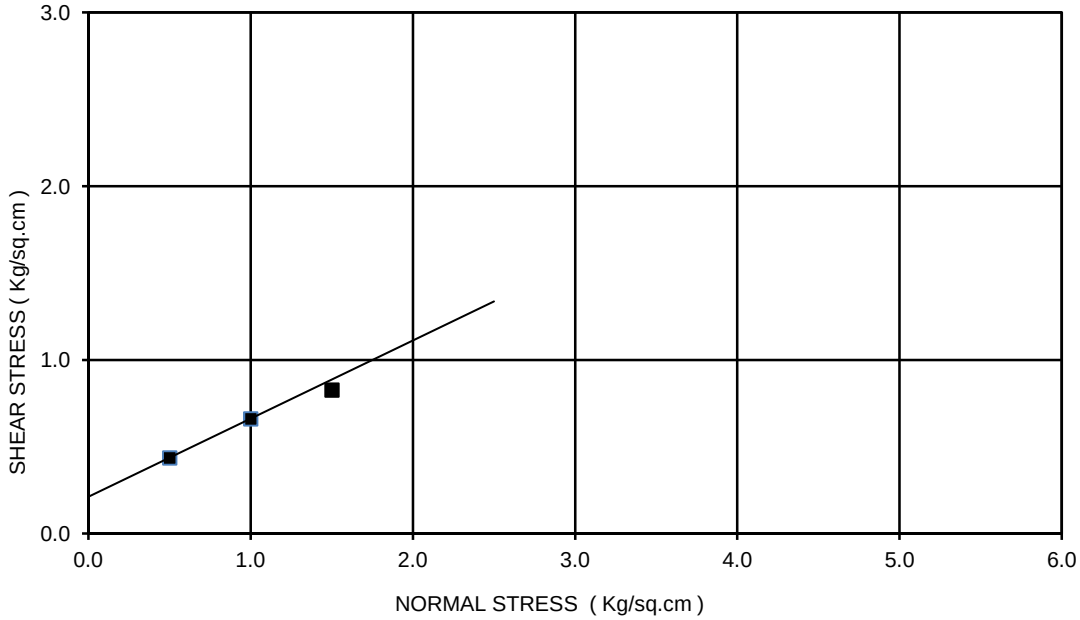


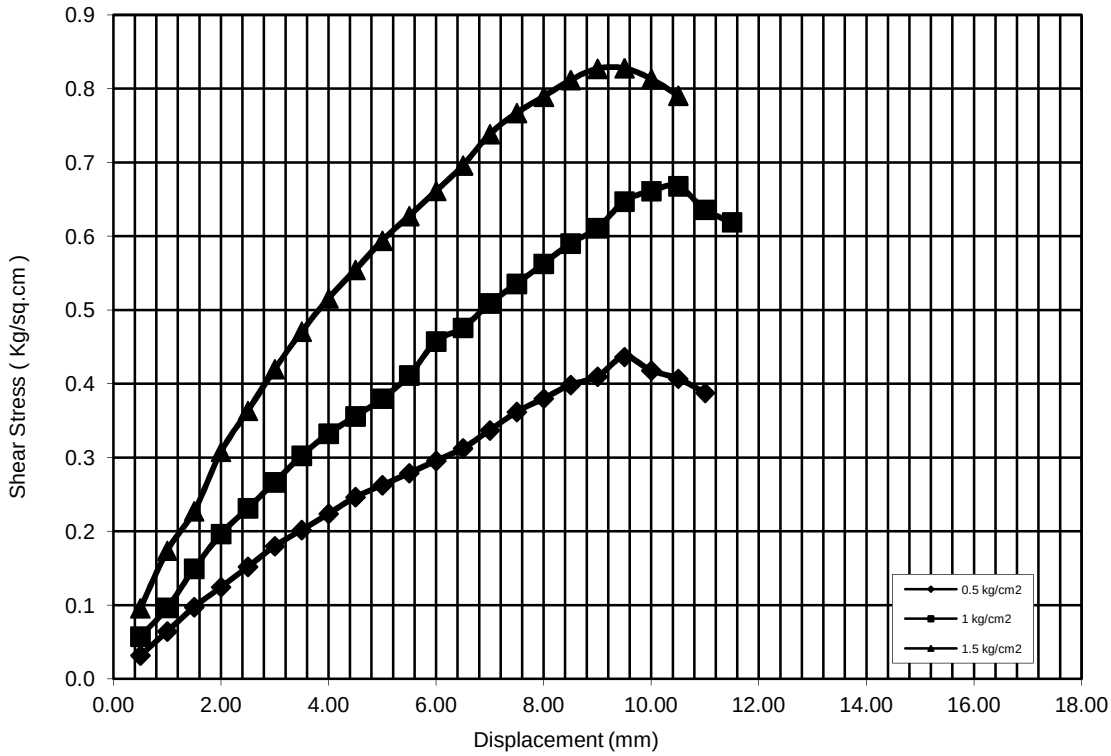
Ch. 57+400
BORE HOLE NO: BH-P15
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



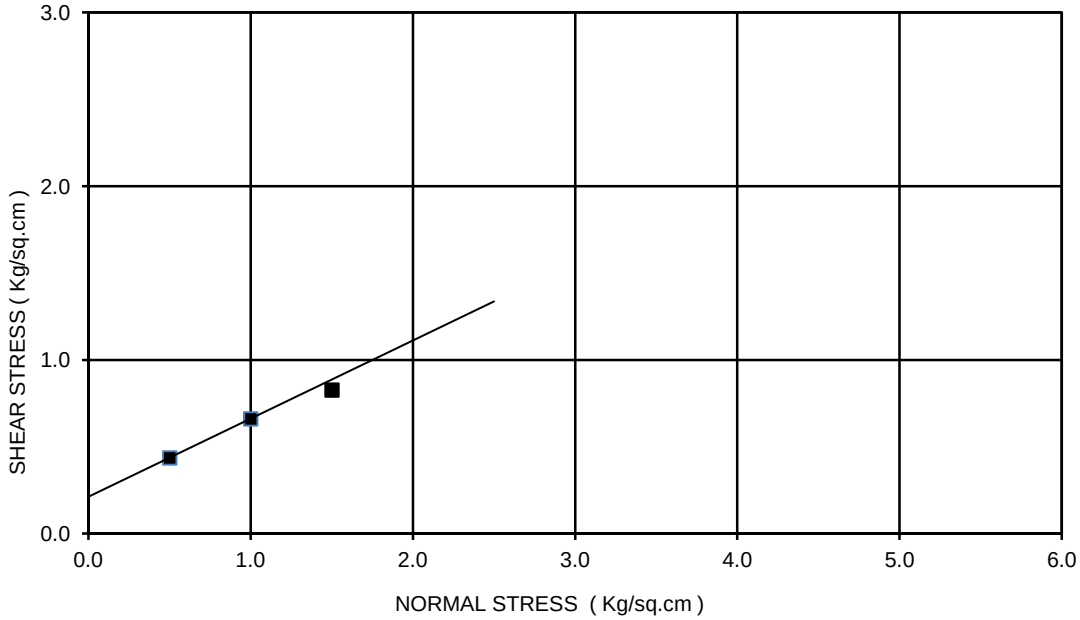


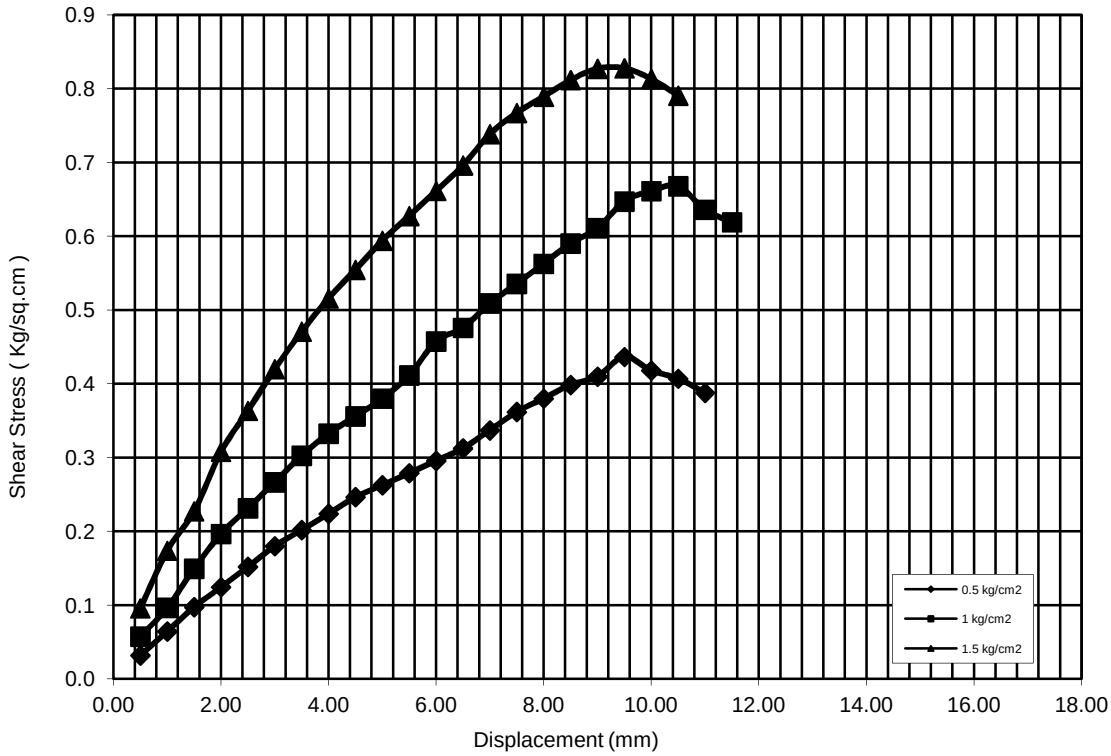
Ch. 57+400
BORE HOLE NO:BH-P16
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



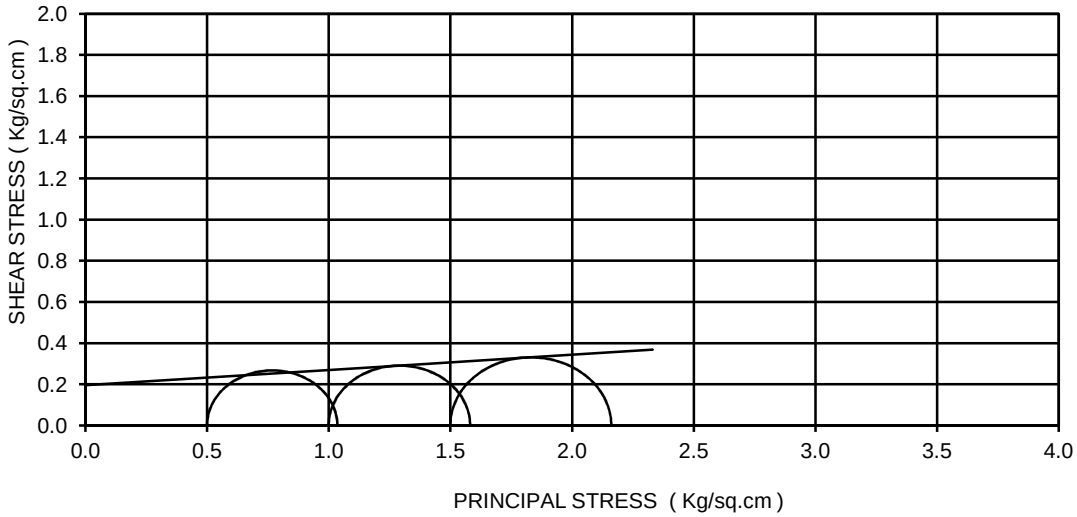


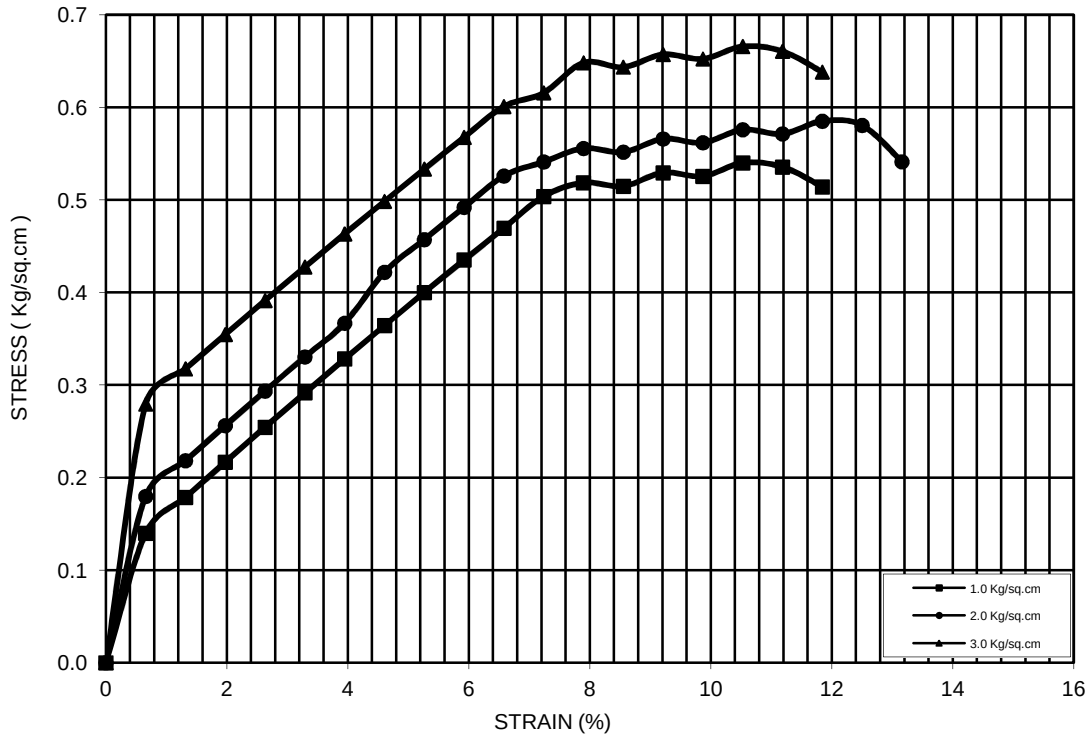
Ch. 57+400
BORE HOLE NO: BH-P16
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



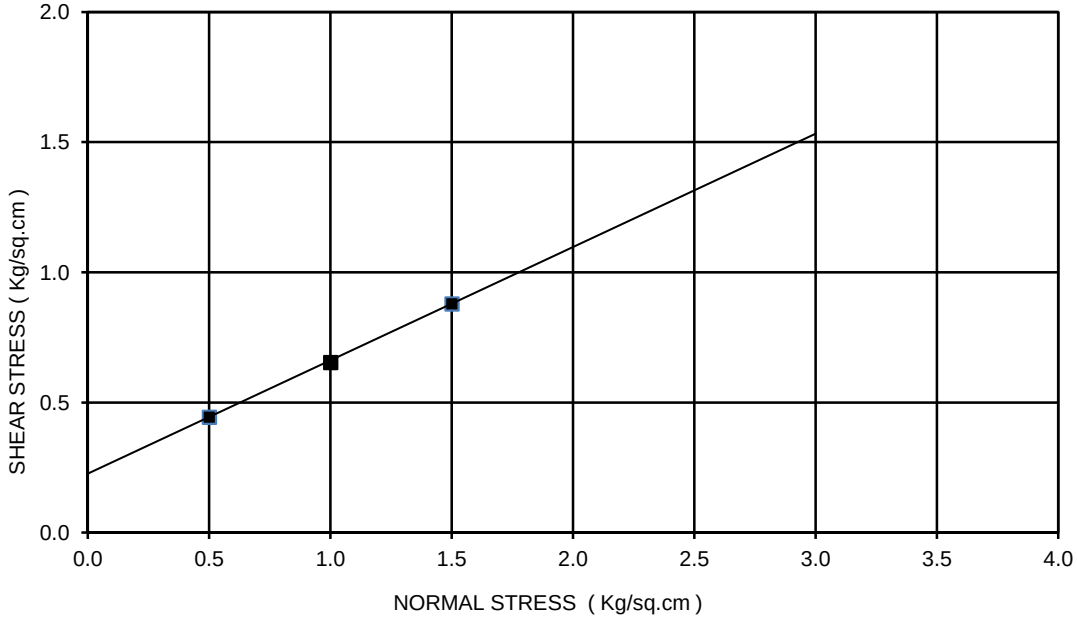


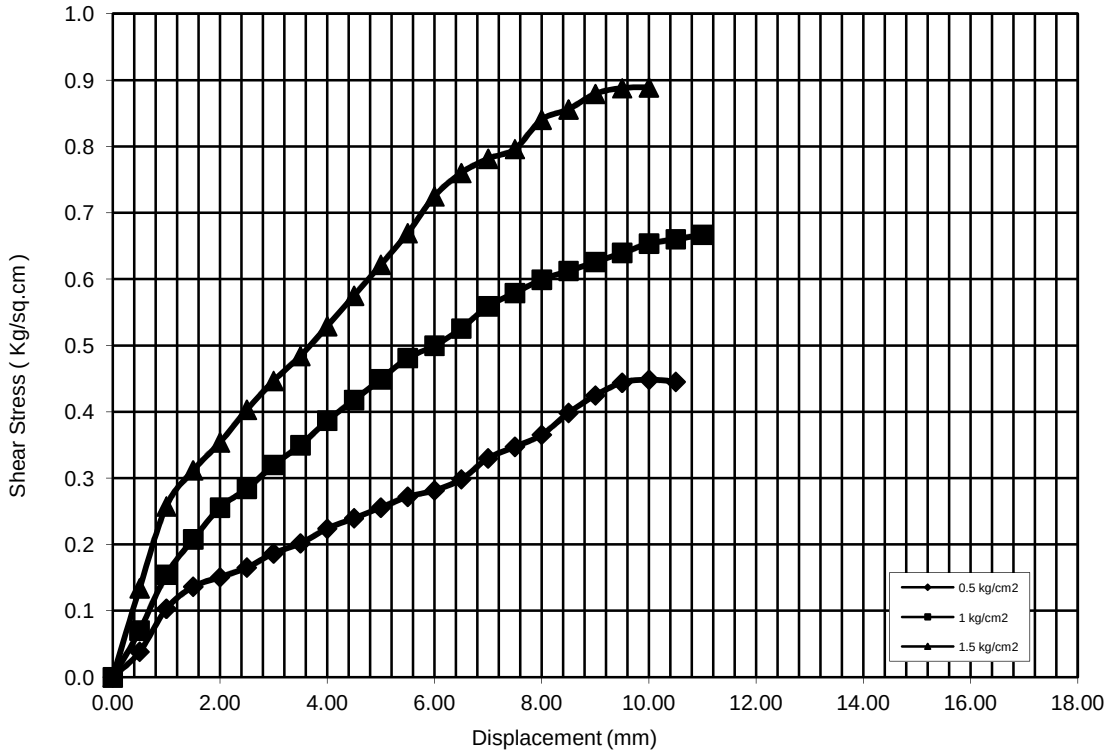
Ch. 57+400
BORE HOLE NO: BH-P17
SAMPLE NO.: UDS-5
DEPTH: 16.00 m
COHESION(C)= 0.62 kg/sq.cm
ANGLE OF FRICTION(Phi): 11 deg
TYPE OF THE TEST: UUT



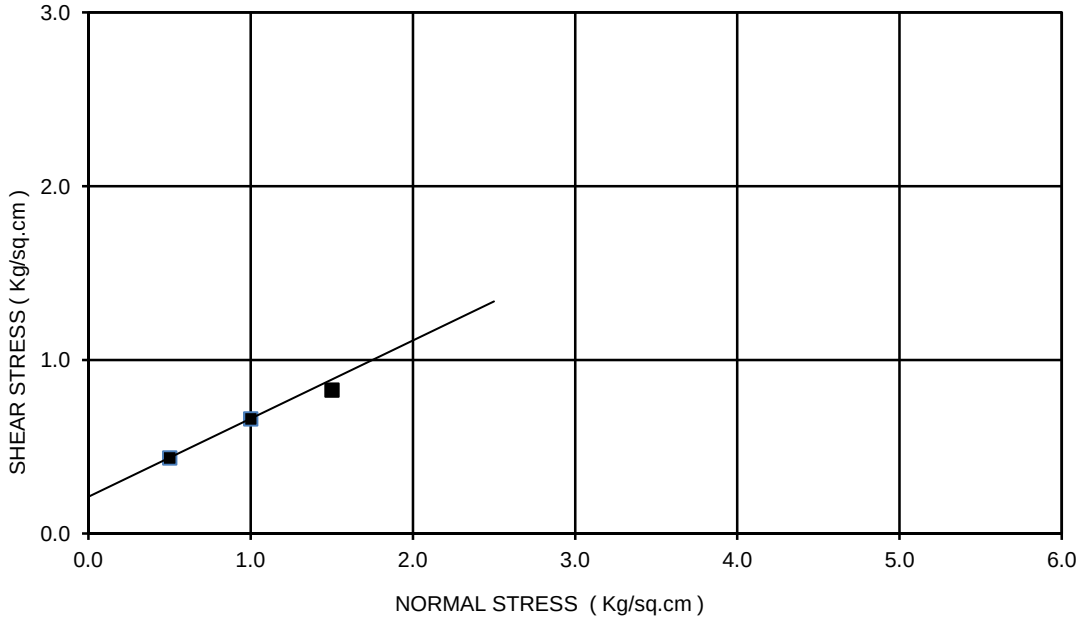


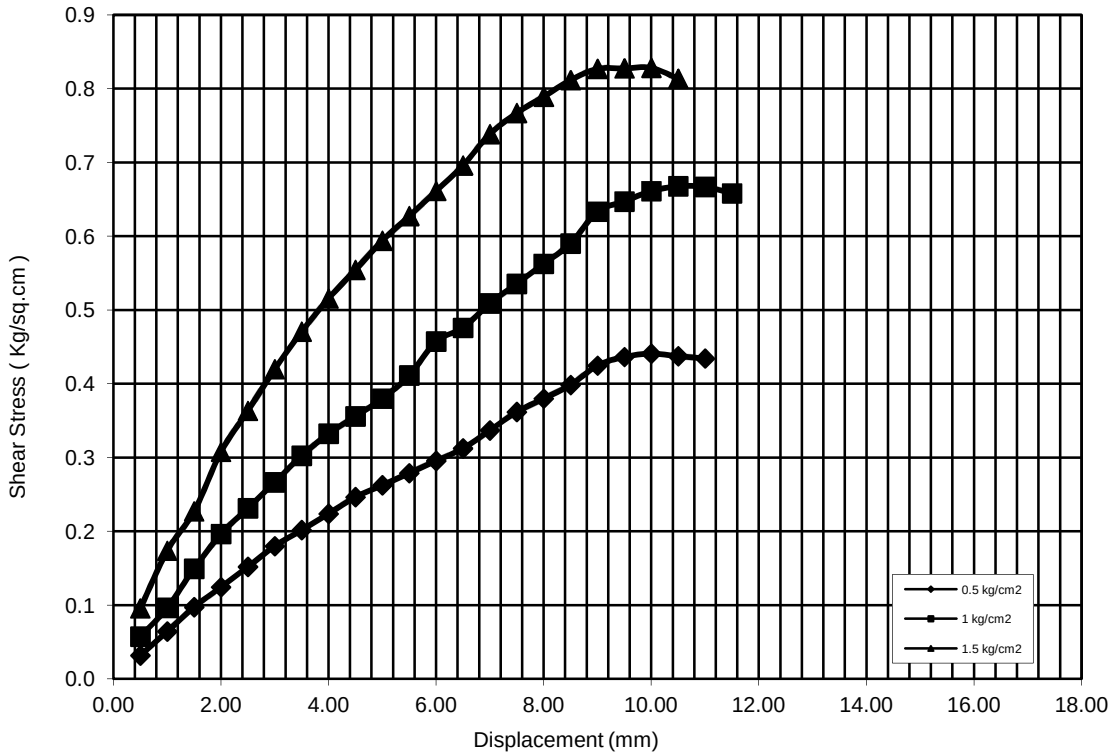
Ch. 57+400
BORE HOLE NO: BH-P17
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



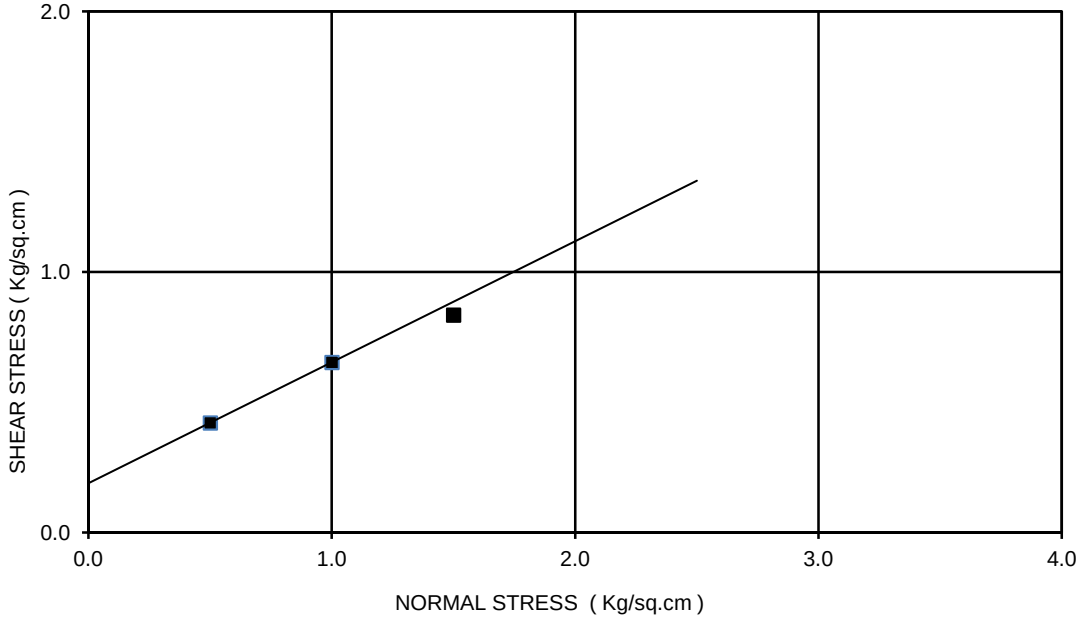


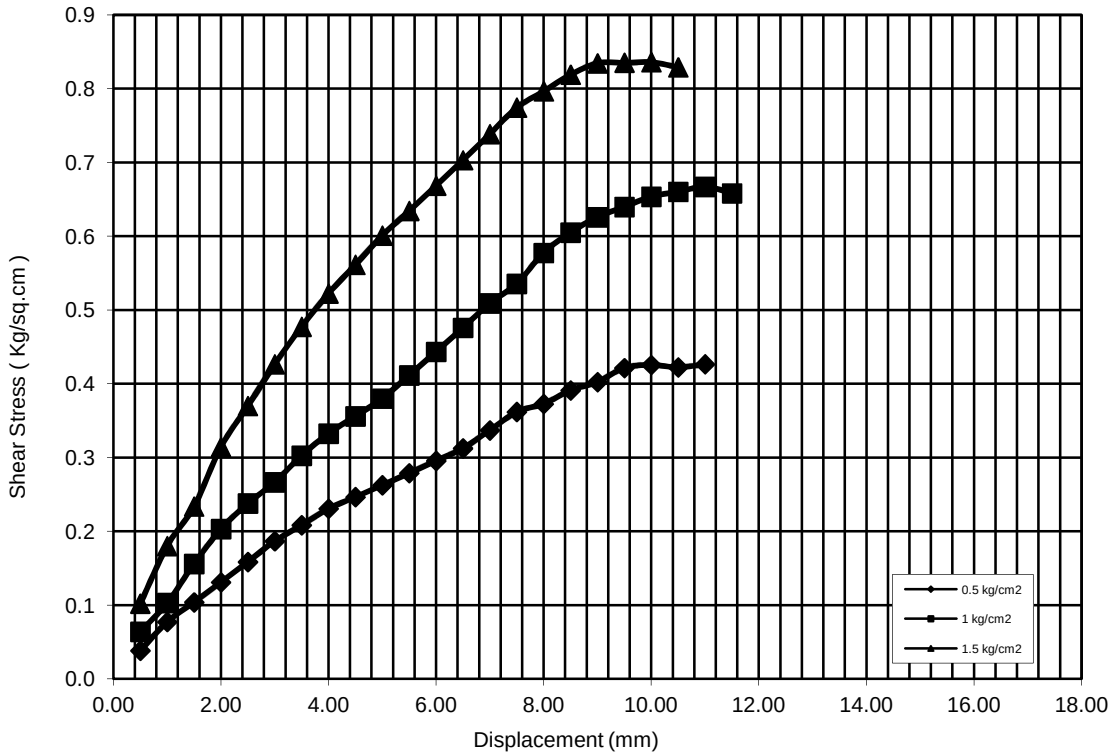
Ch. 57+400
BORE HOLE NO: BH-P18
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



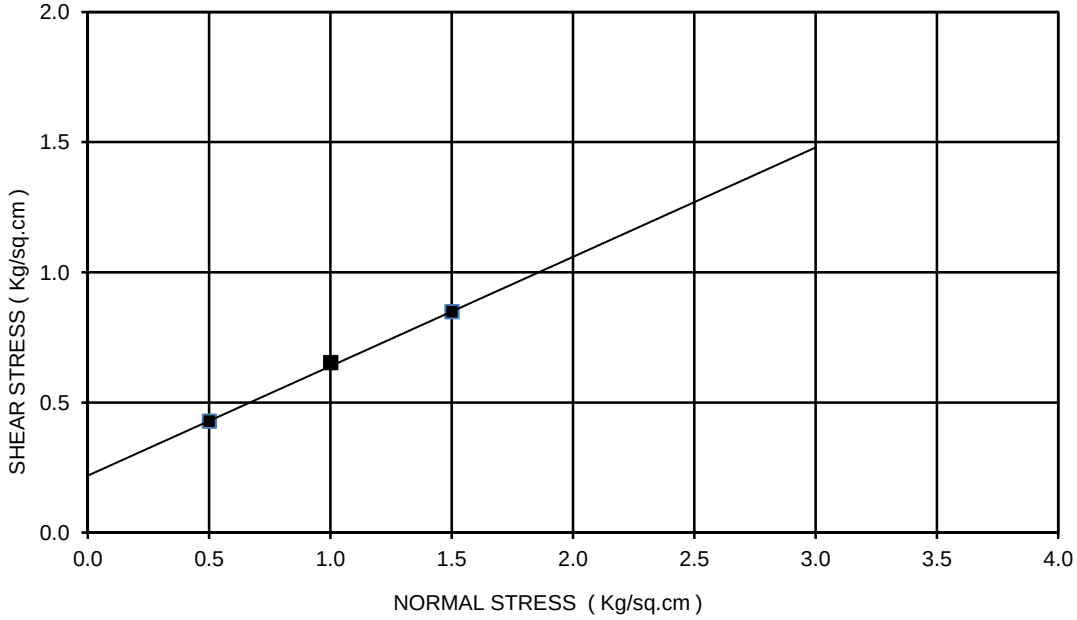


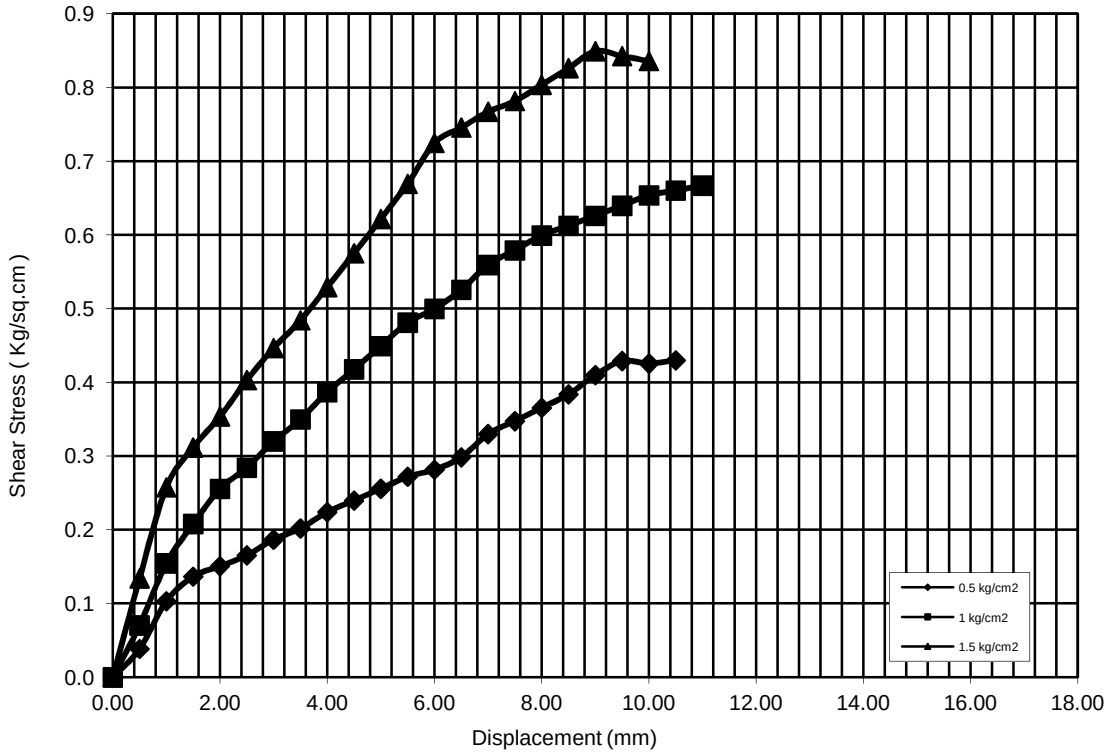
Ch. 57+400
BORE HOLE NO: BH-P18
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



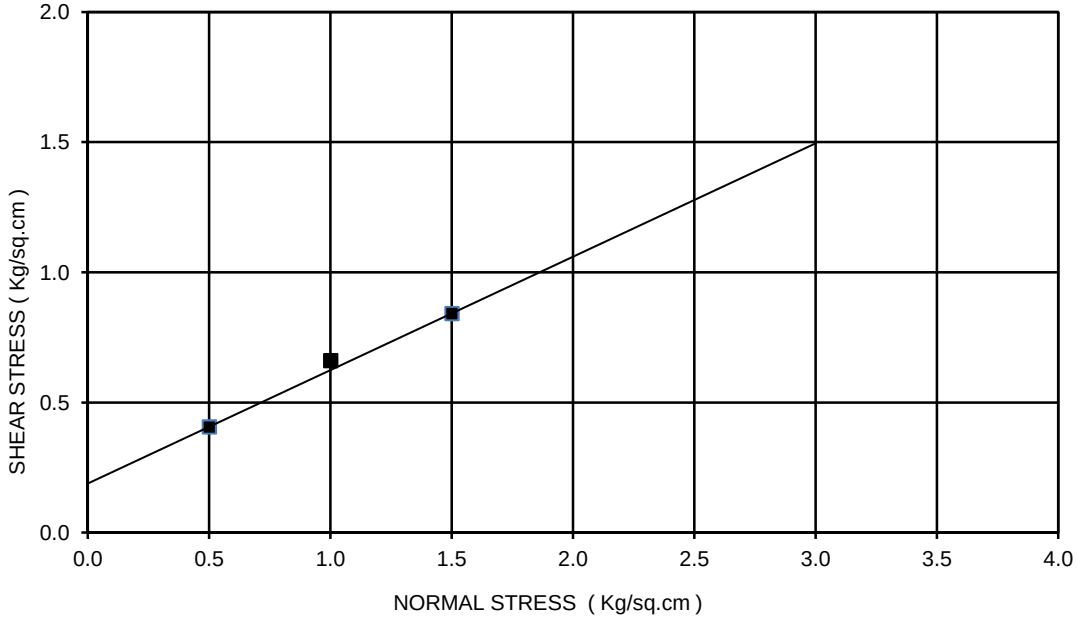


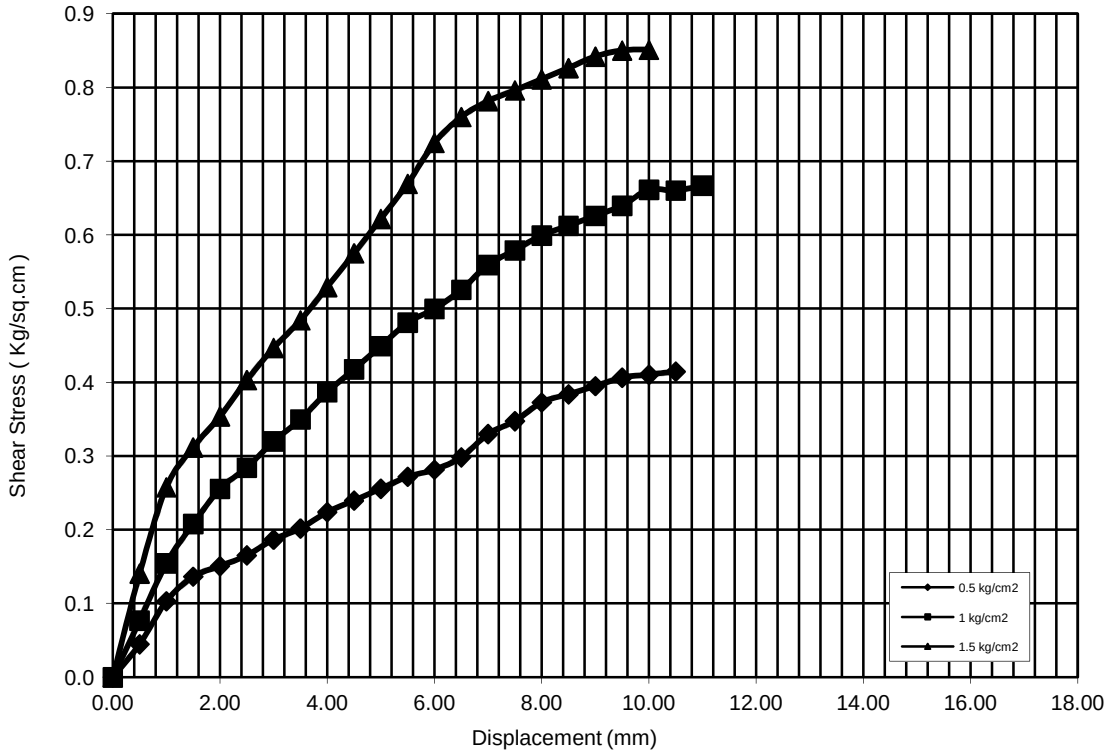
Ch. 57+400
BORE HOLE NO: BH-P19
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



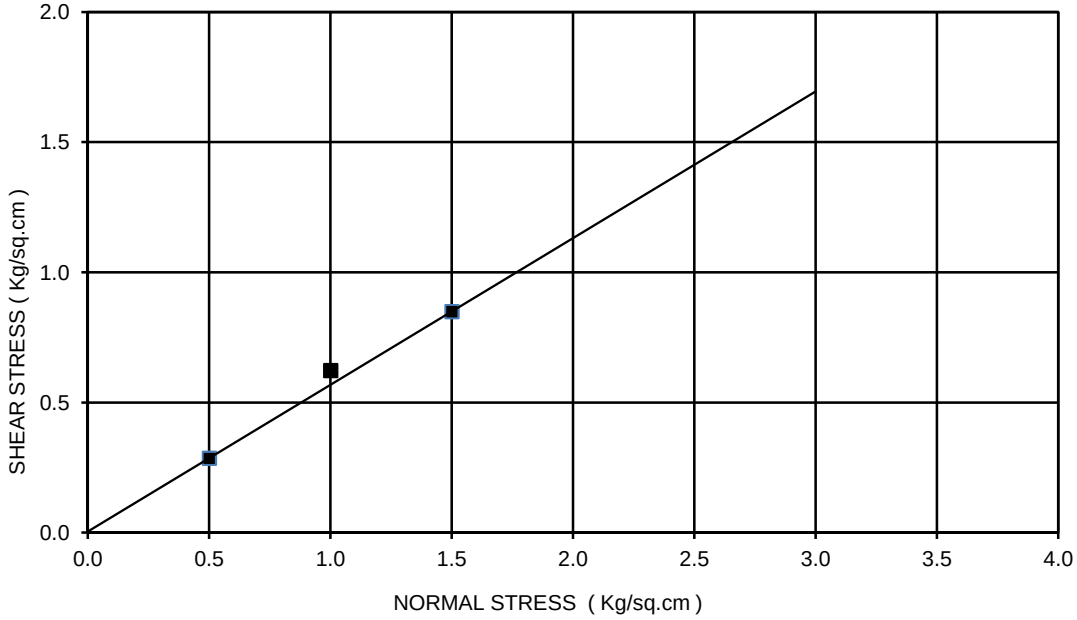


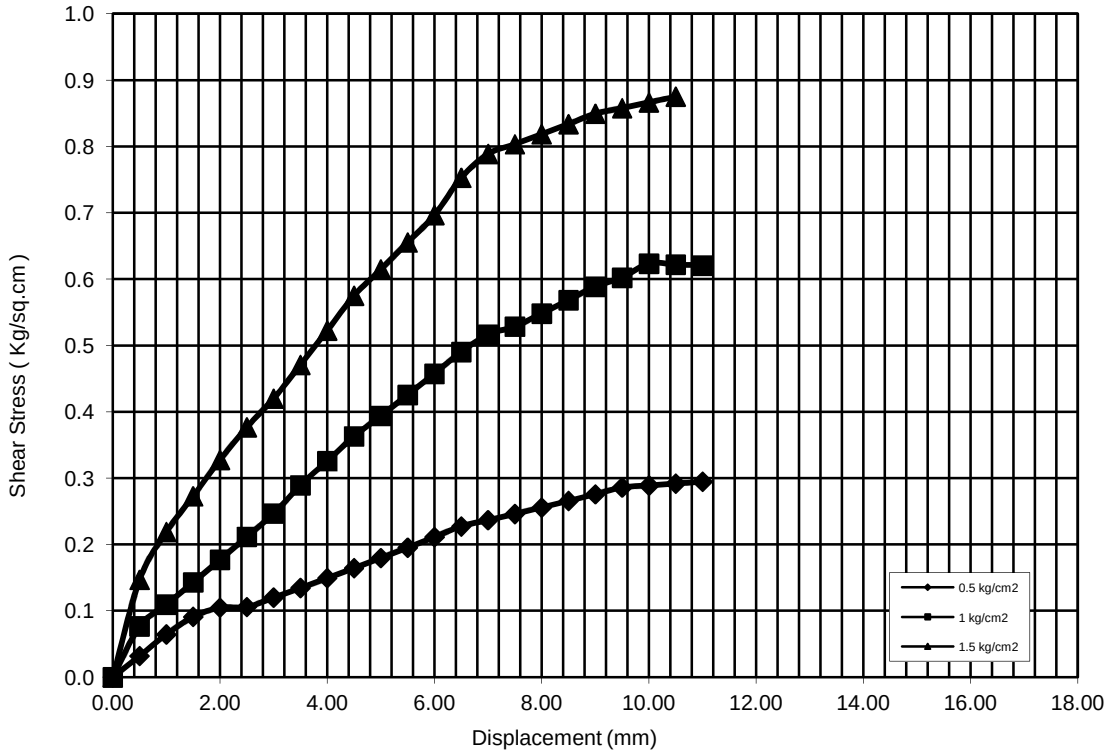
Ch. 57+400
BORE HOLE NO: BH-P19
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



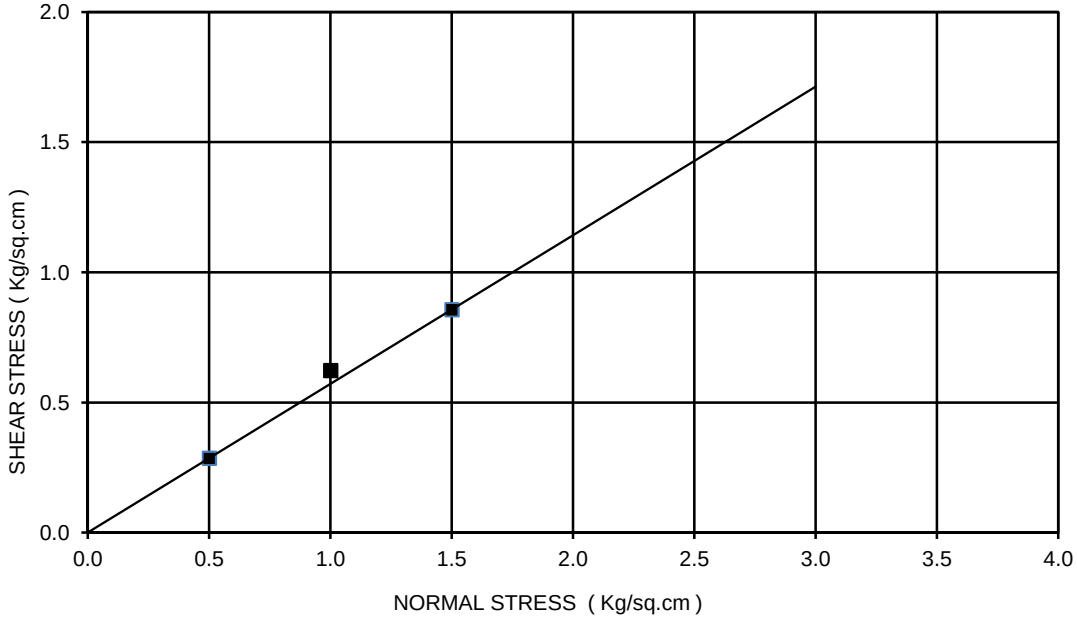


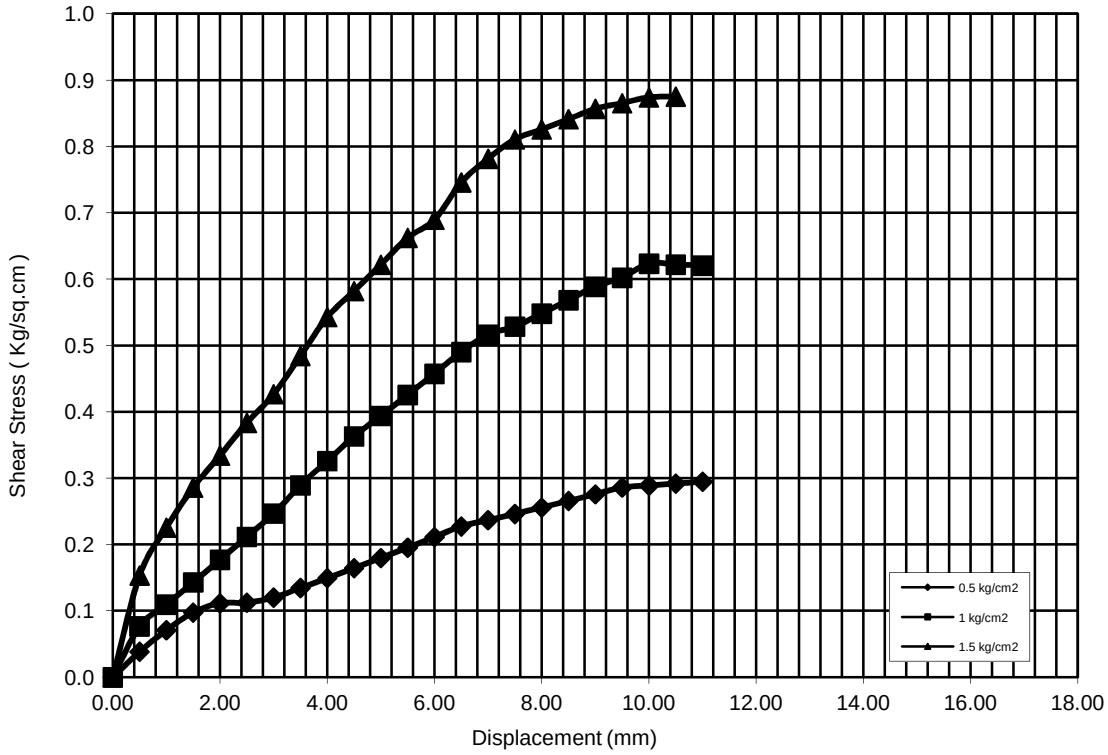
Ch. 57+400
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



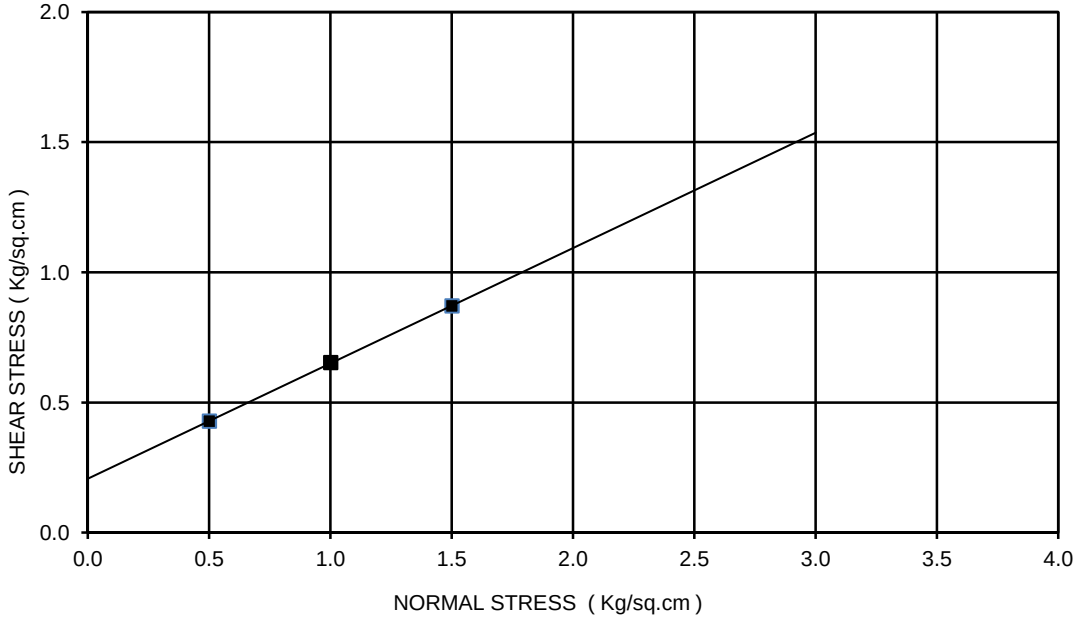


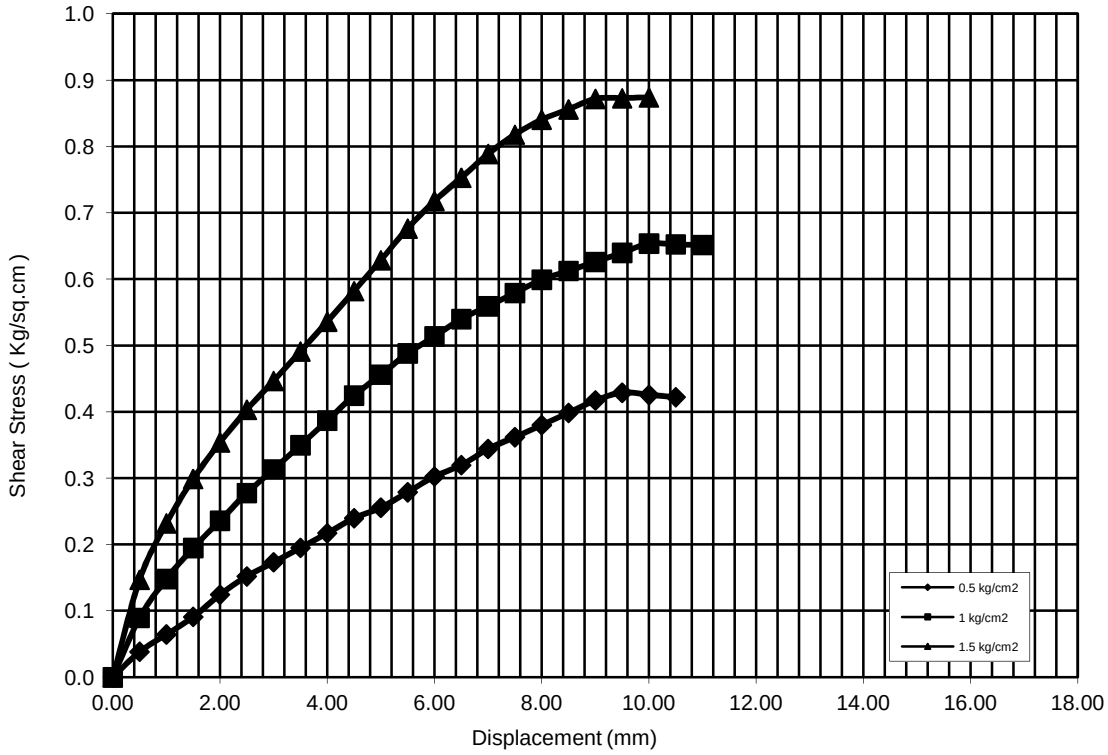
Ch. 57+400
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



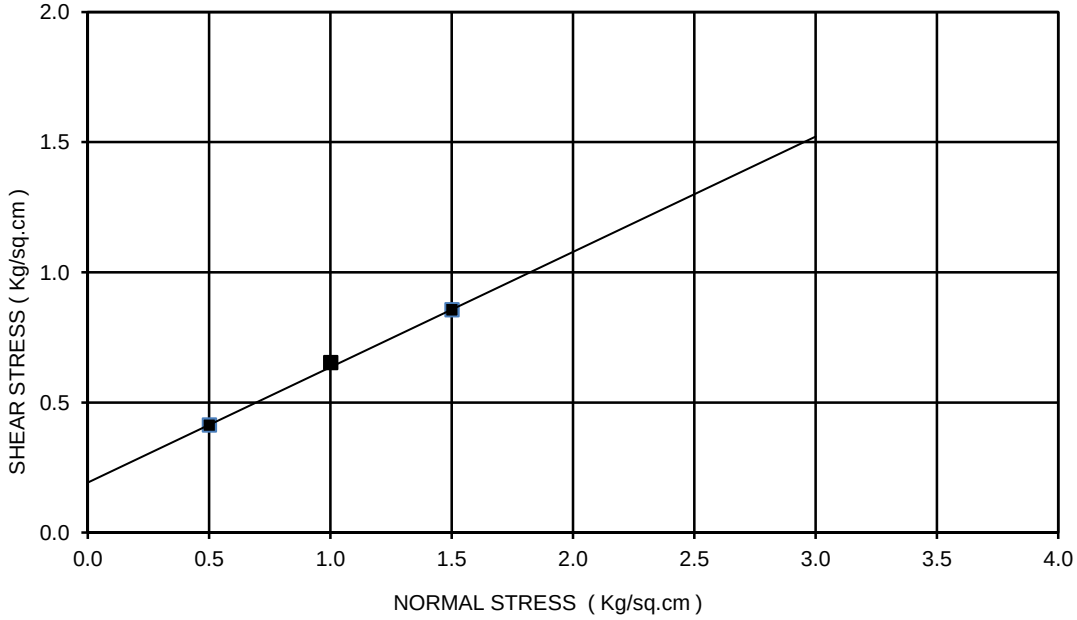


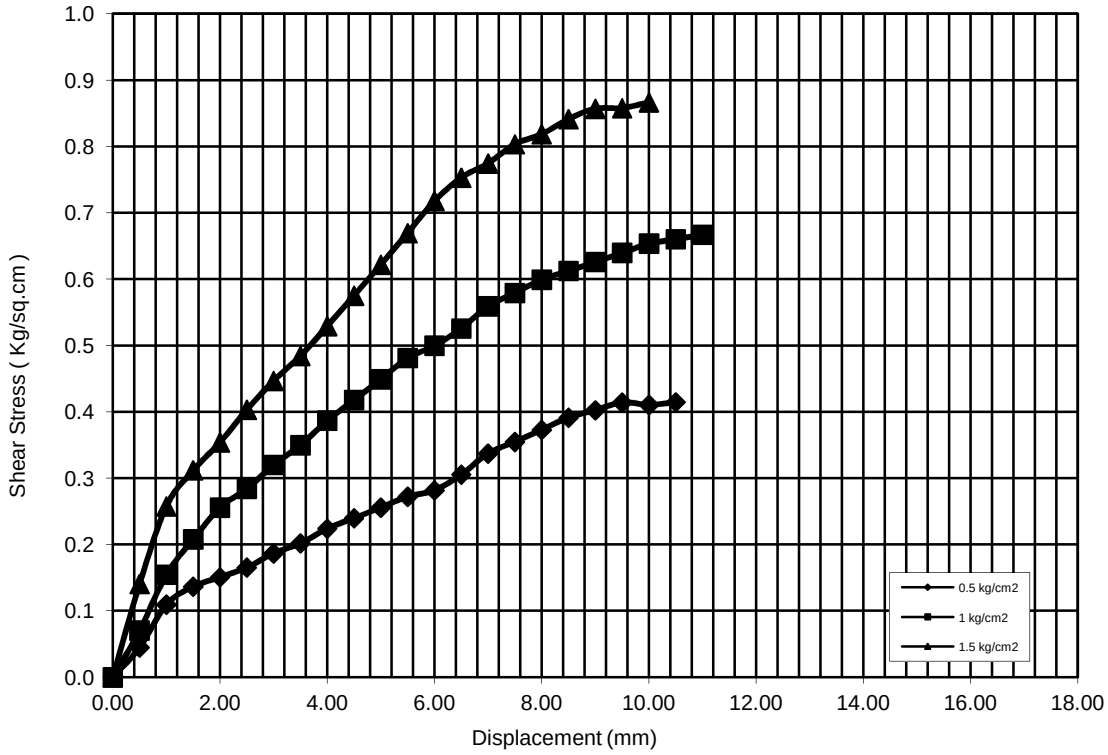
Ch. 58+191
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



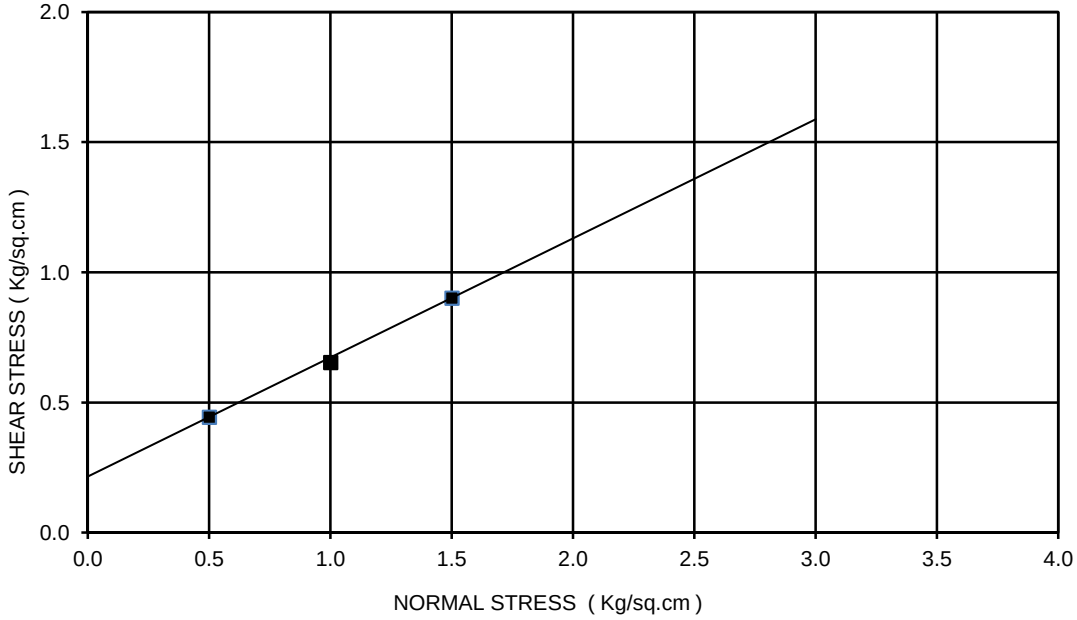


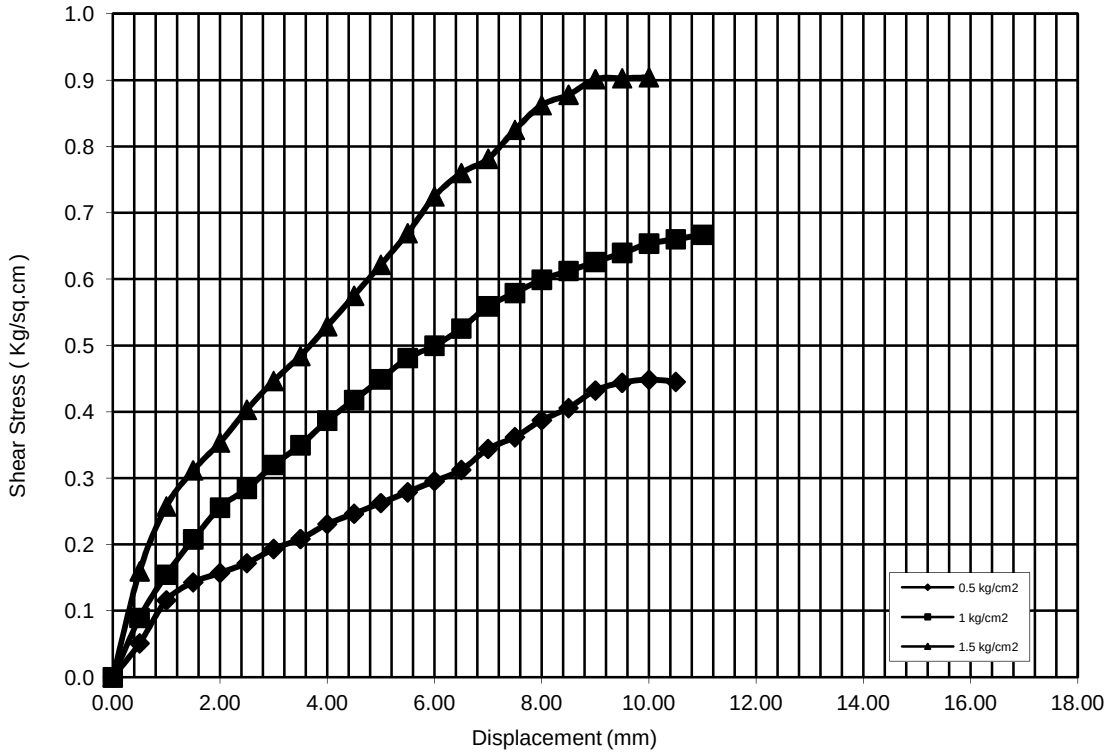
Ch. 58+497
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



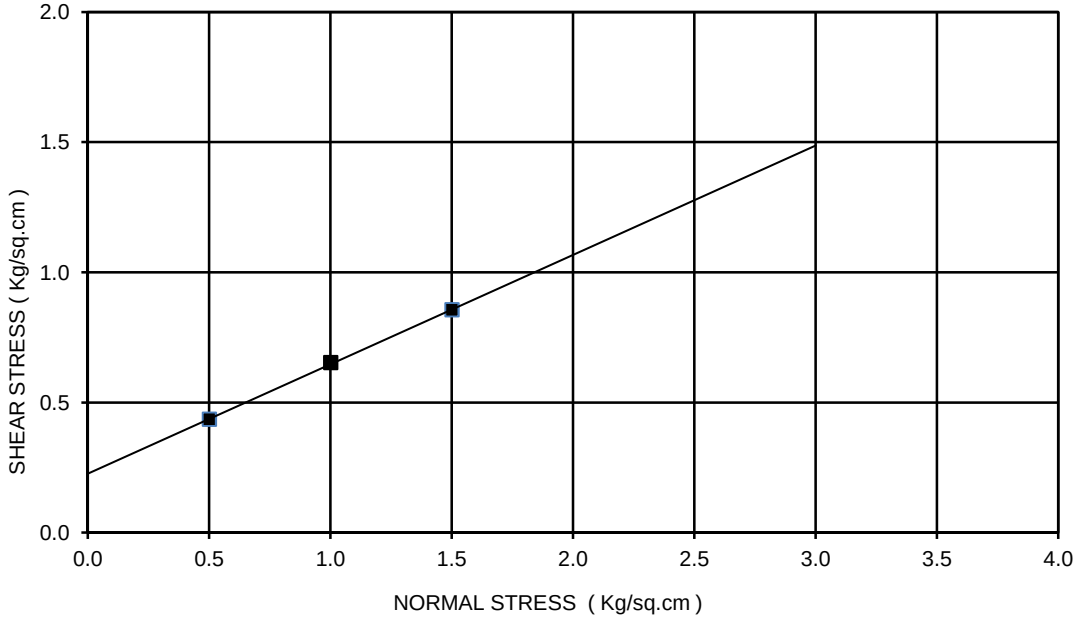


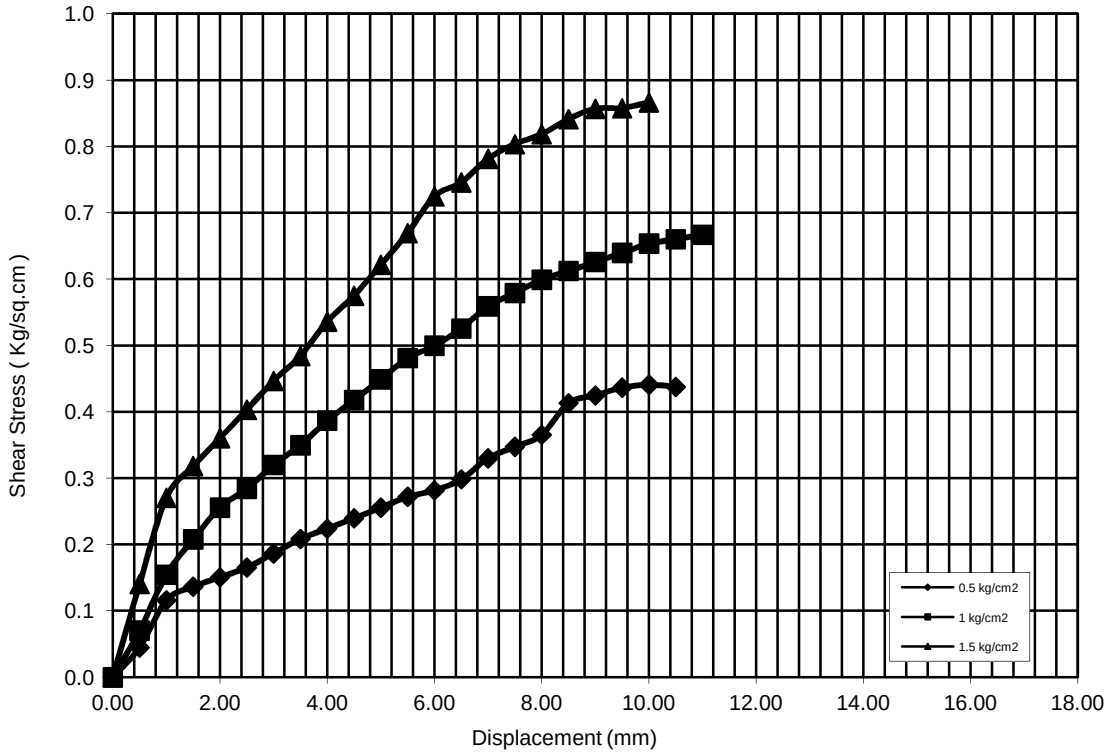
Ch. 58+497
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



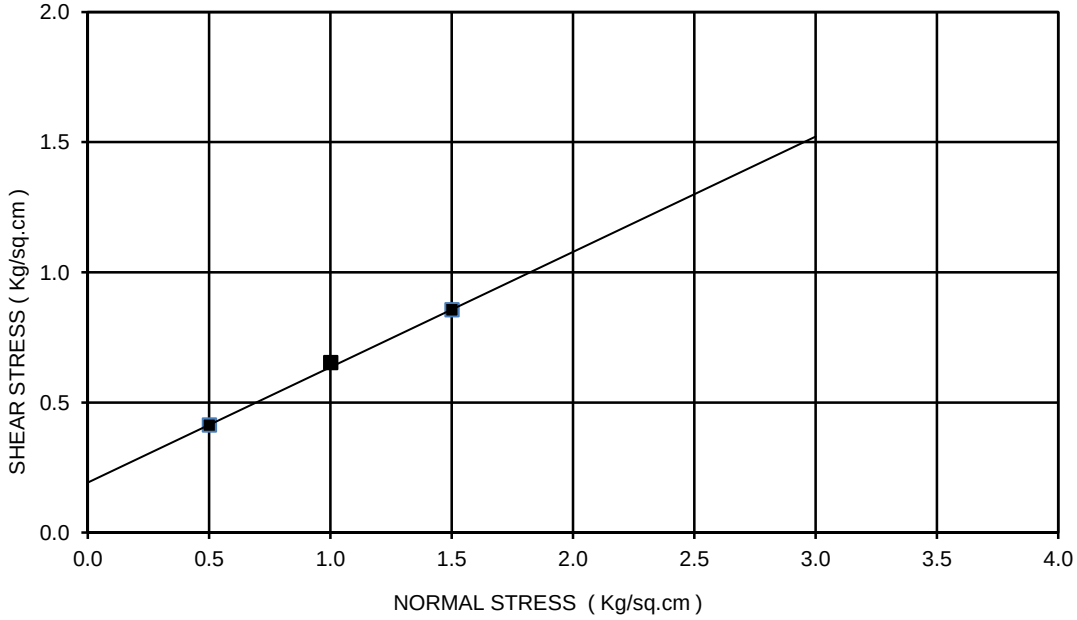


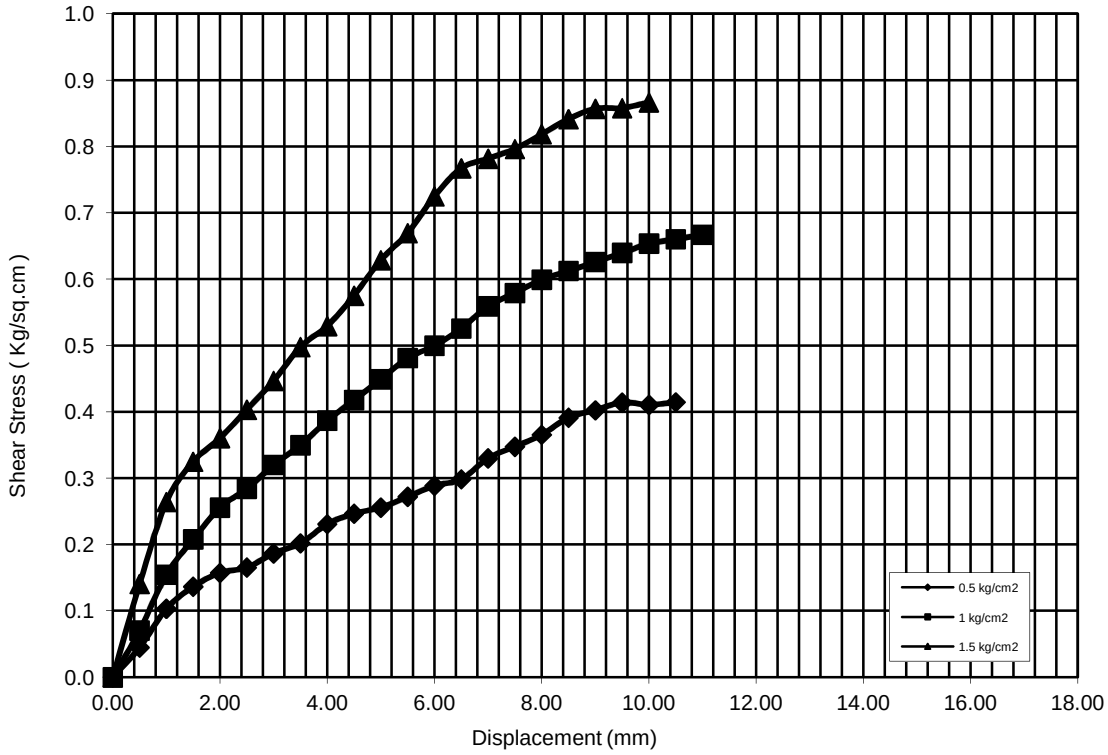
Ch. 58+497
BORE HOLE NO: BH-P1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



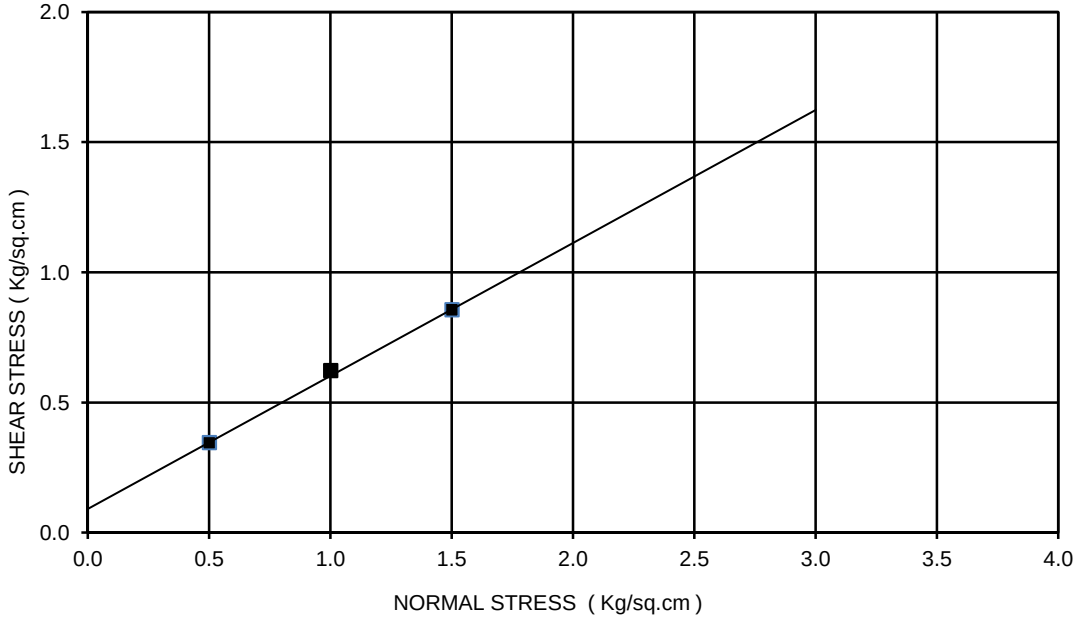


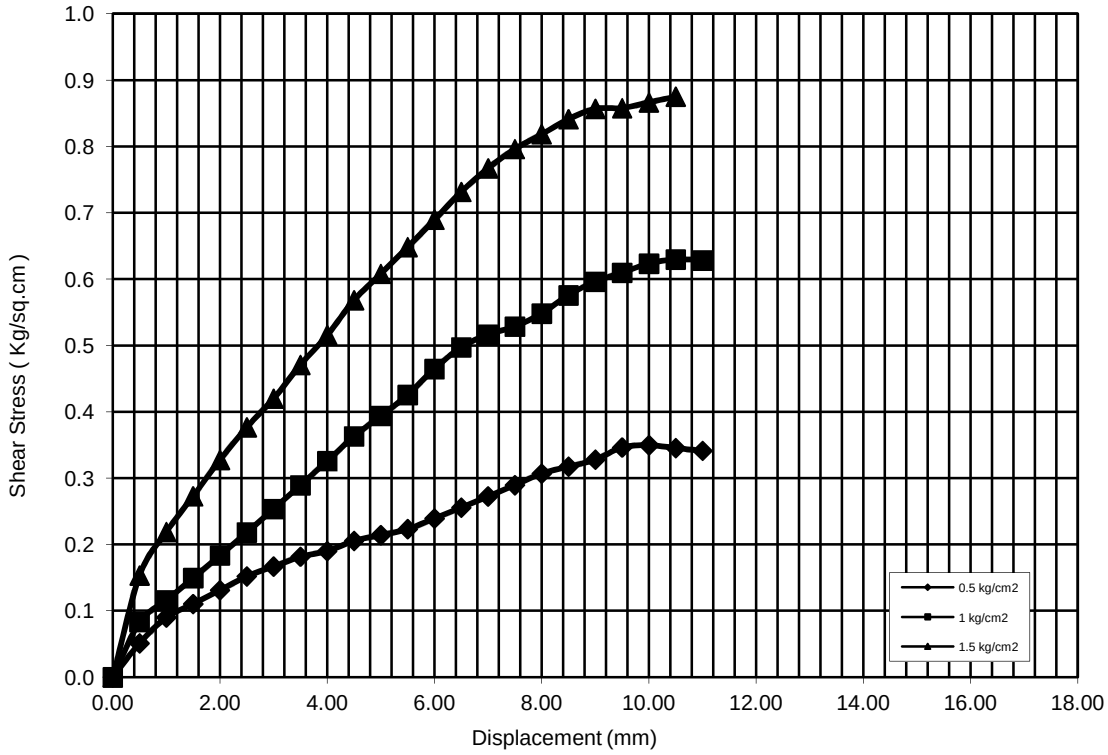
Ch. 58+497
BORE HOLE NO: BH-P1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



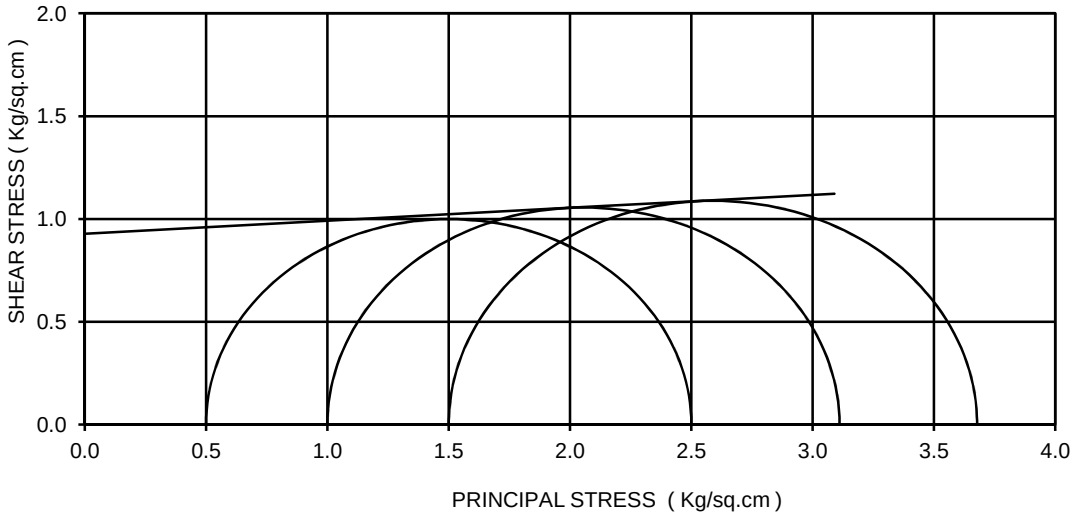


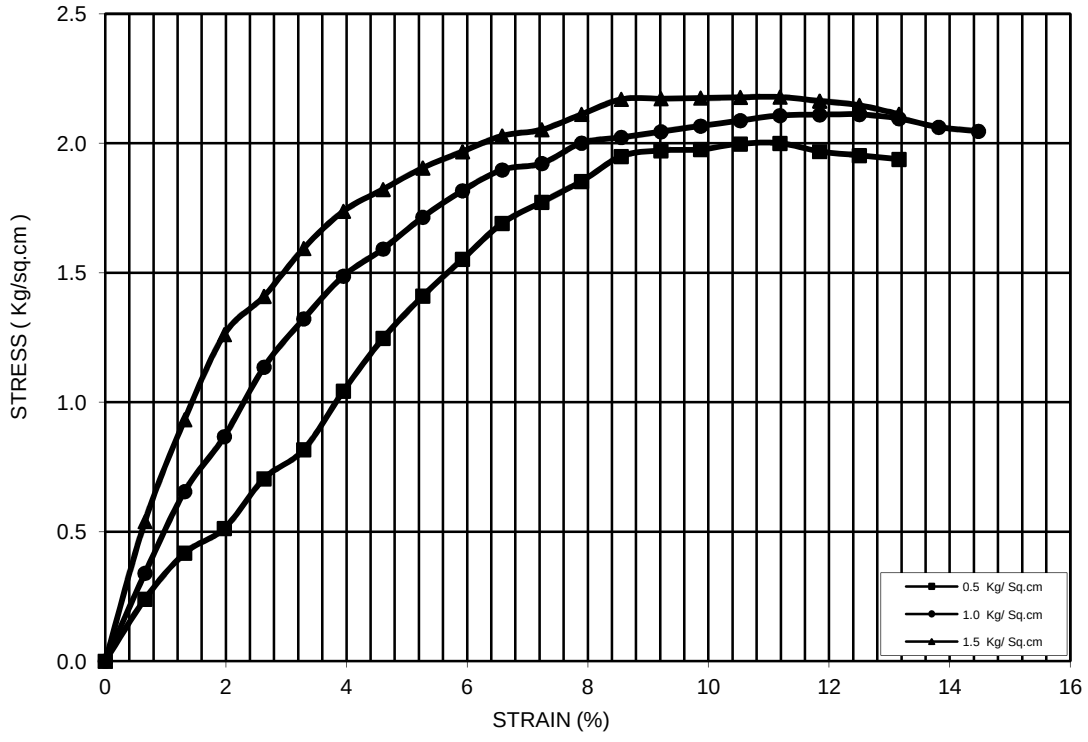
Ch. 58+497
BORE HOLE NO: BH-P2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



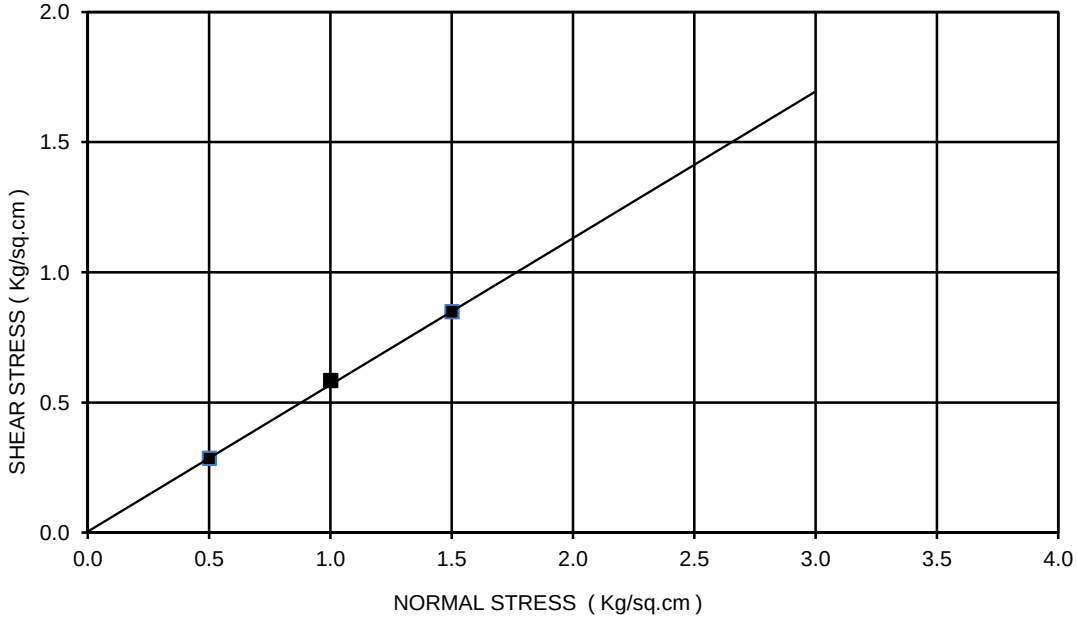


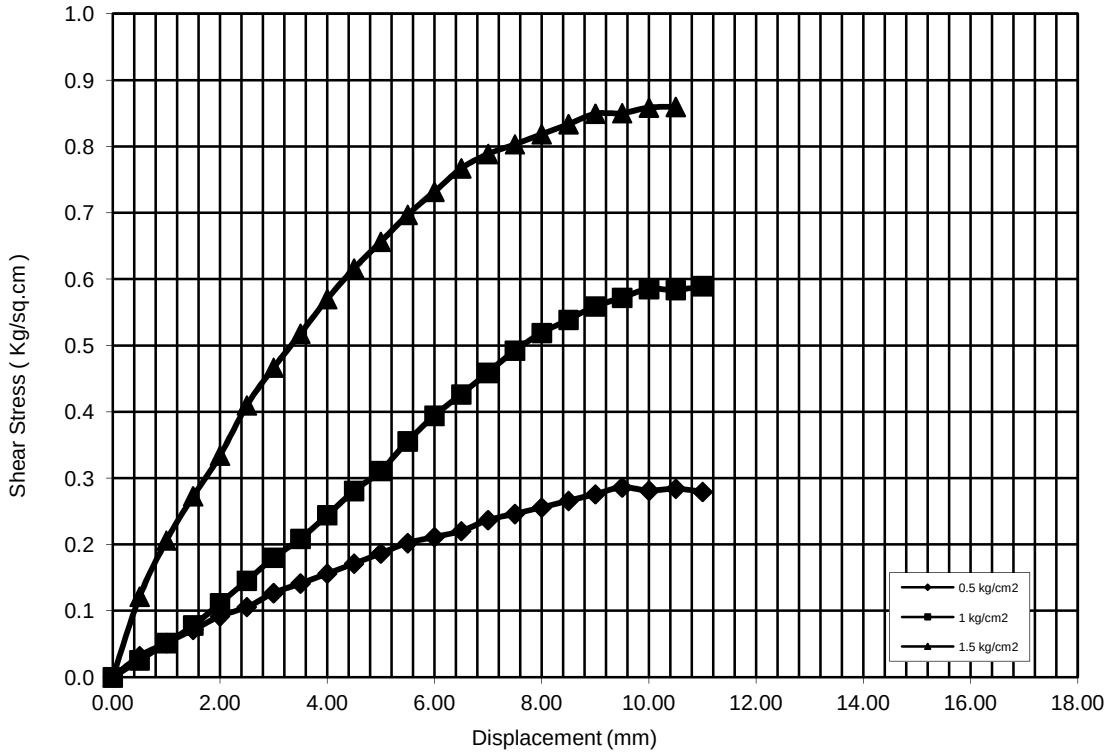
Ch. 58+497
BORE HOLE NO: BH-P2
SAMPLE NO.: UDS-8
DEPTH: 28.00 m
COHESION(C)= 2.65 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



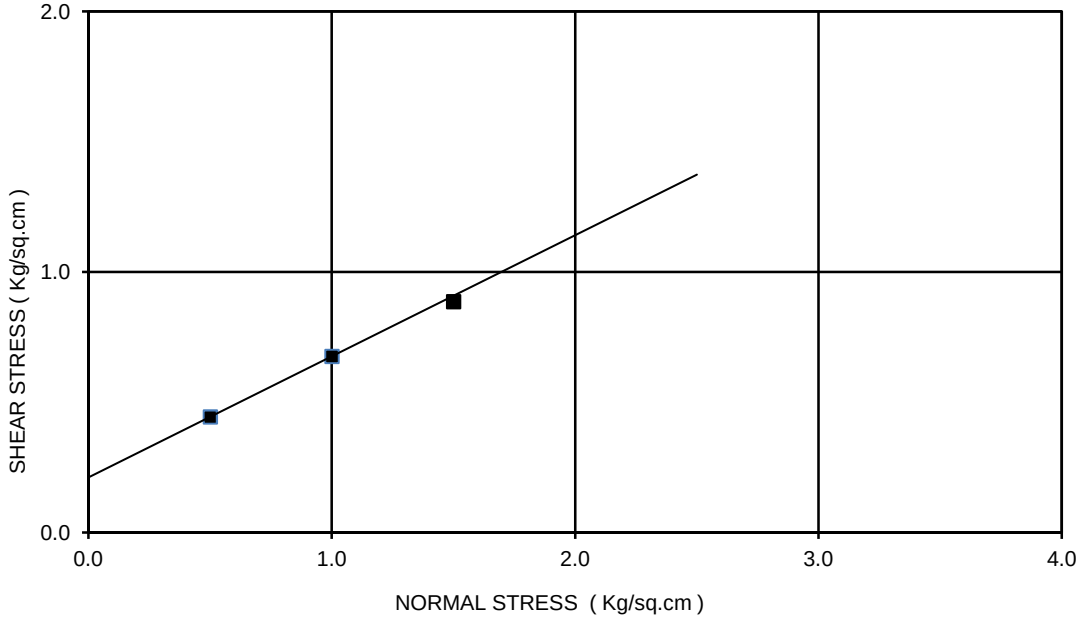


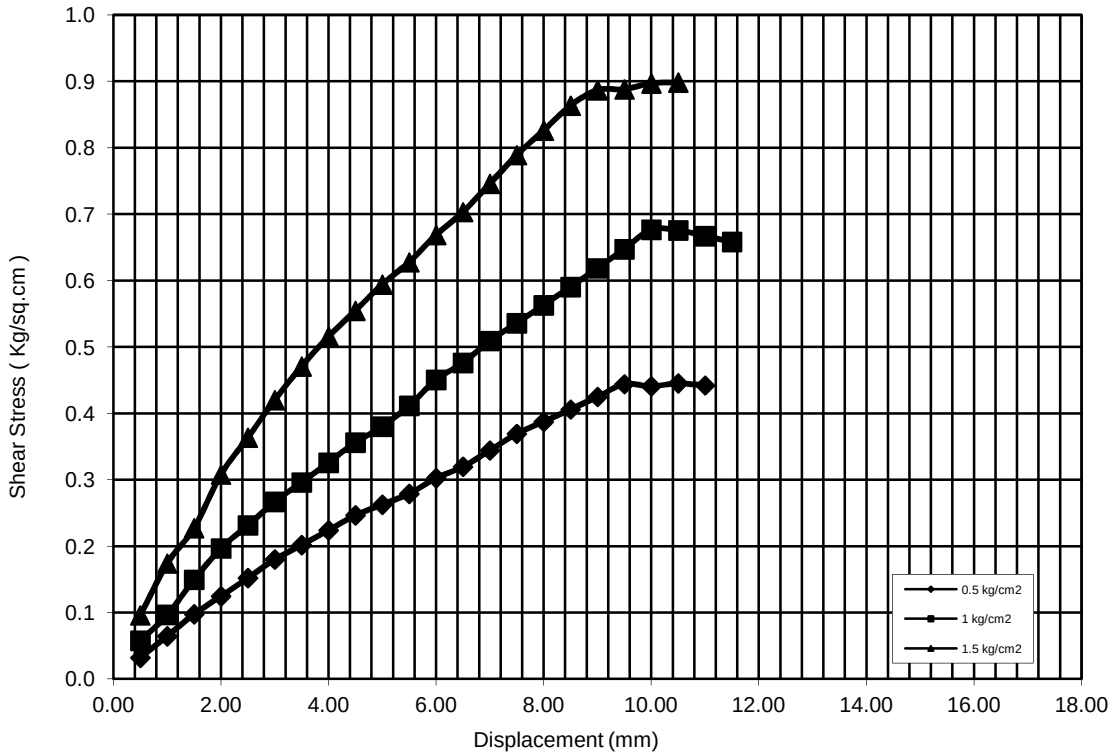
Ch. 58+497
BORE HOLE NO: BH-P3
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



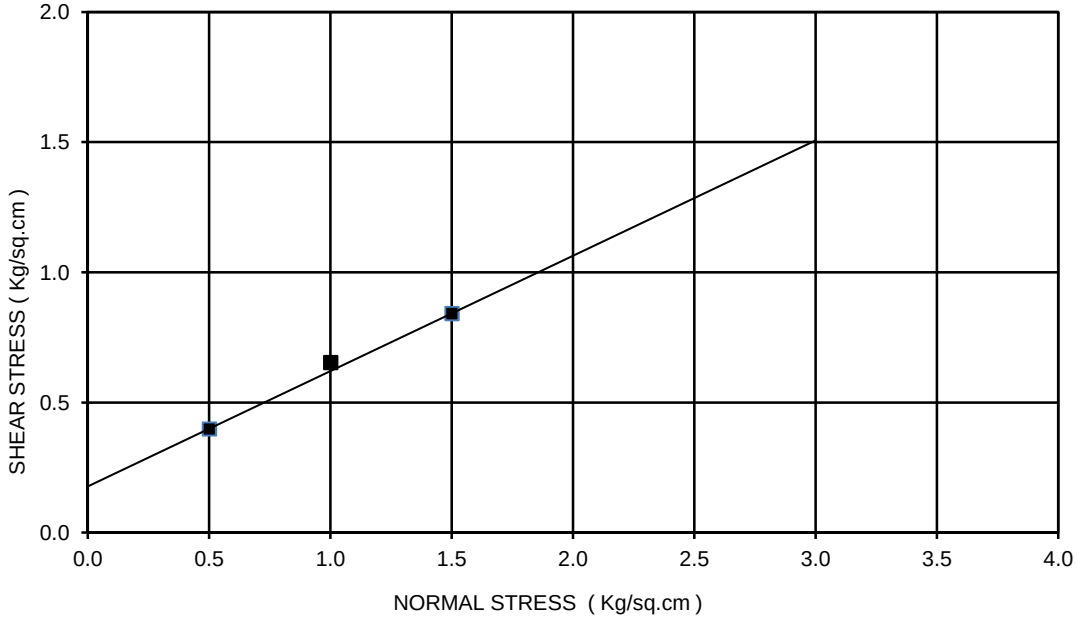


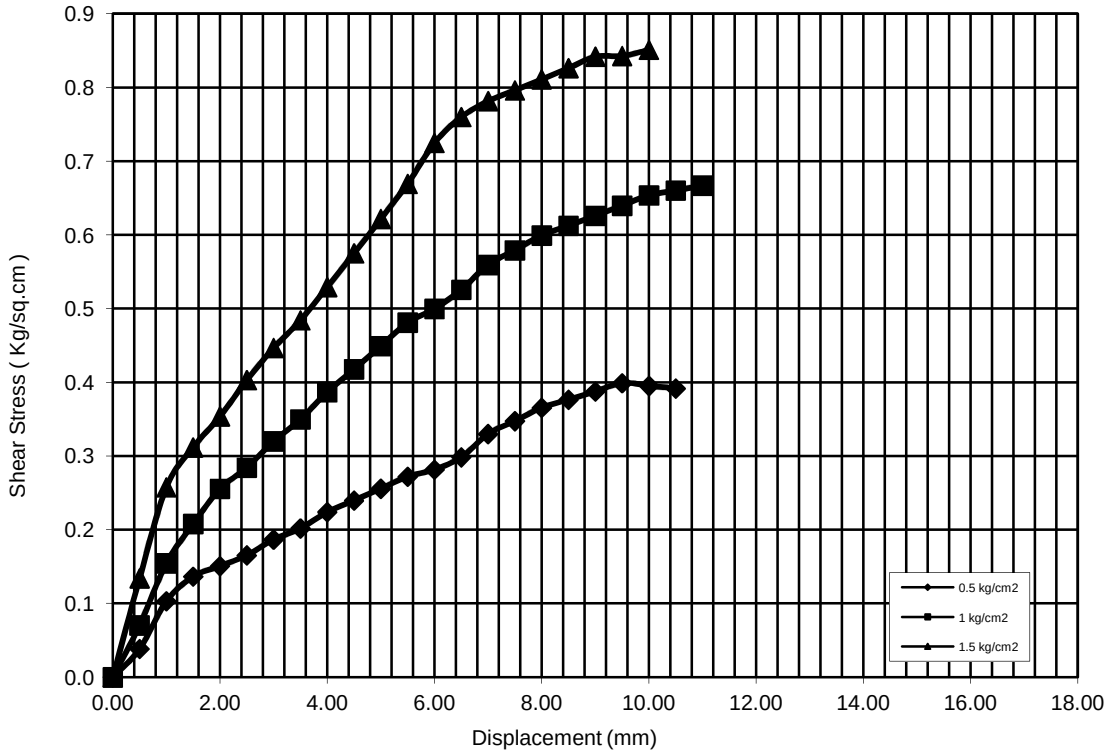
Ch. 58+497
BORE HOLE NO: BH-P3
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



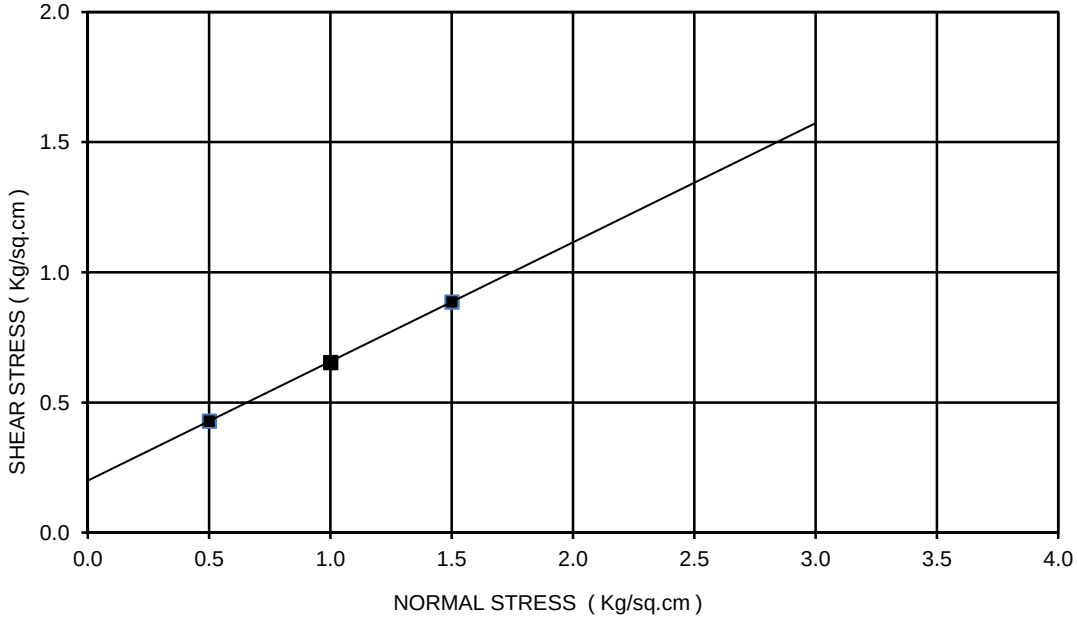


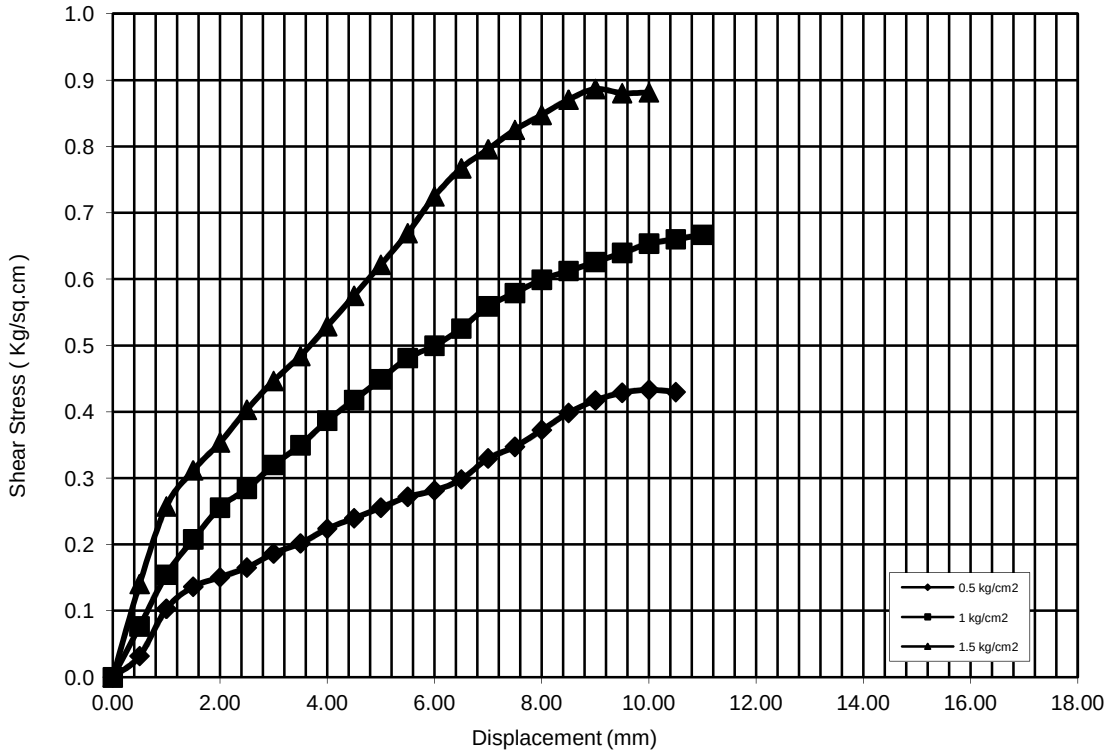
Ch. 58+497
BORE HOLE NO: BH-P4
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



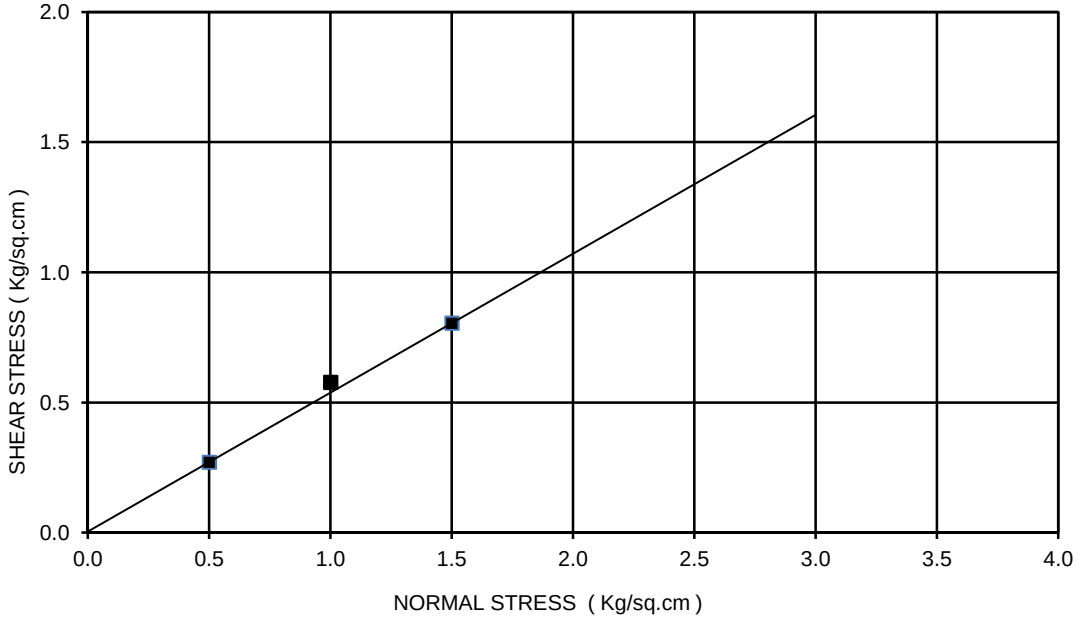


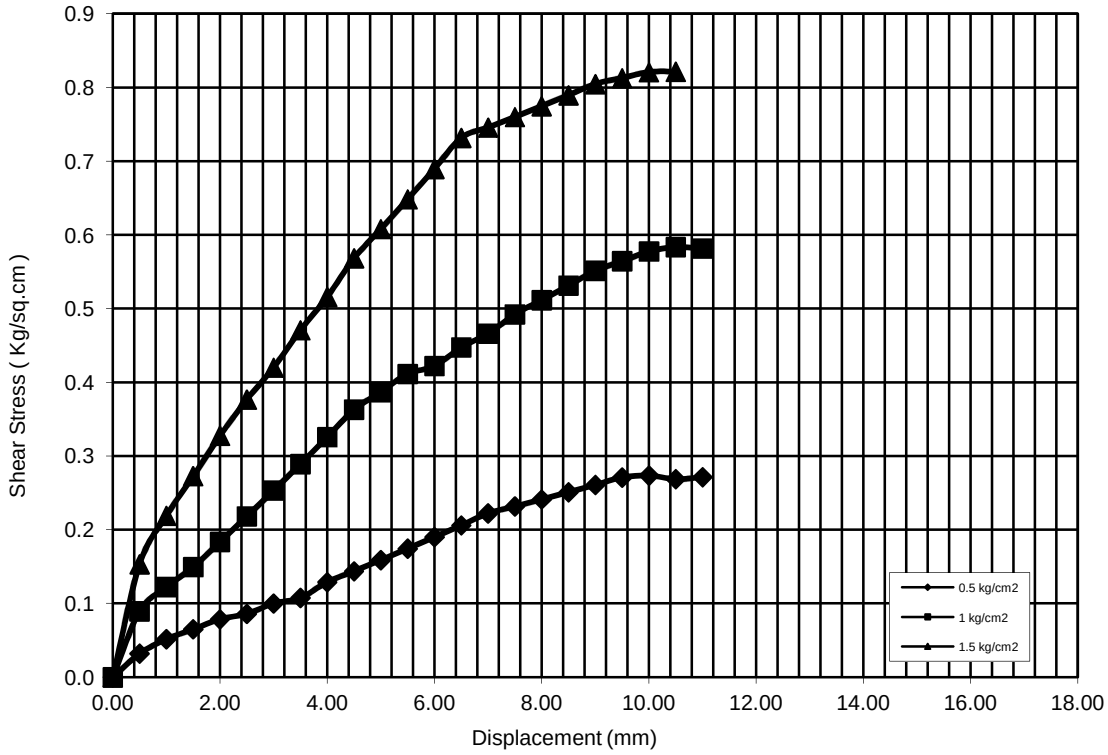
Ch.58+497
BORE HOLE NO: BH-P4
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



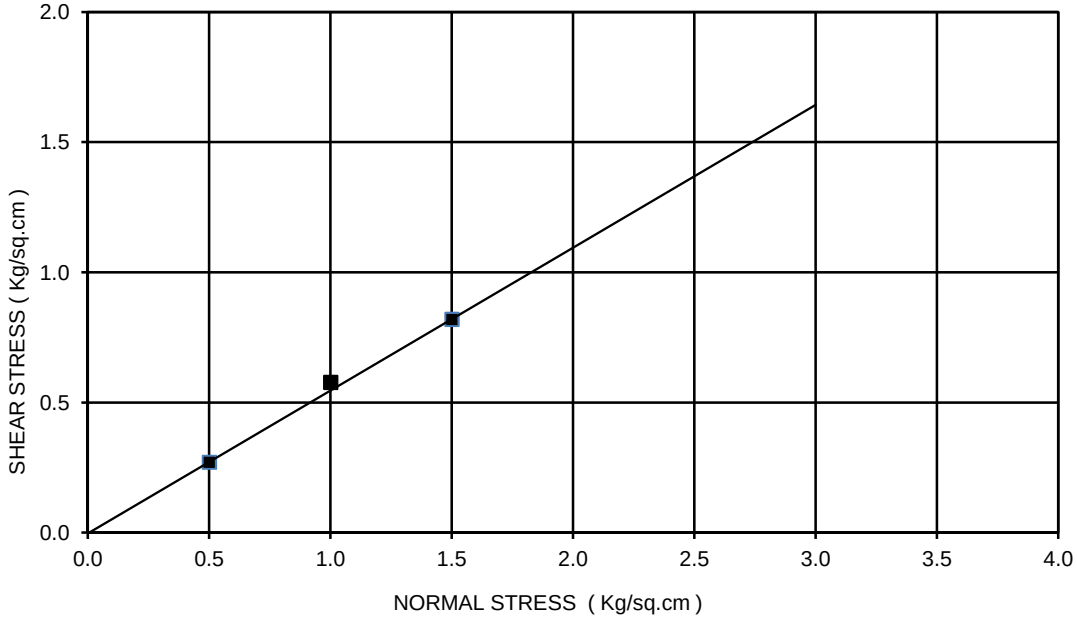


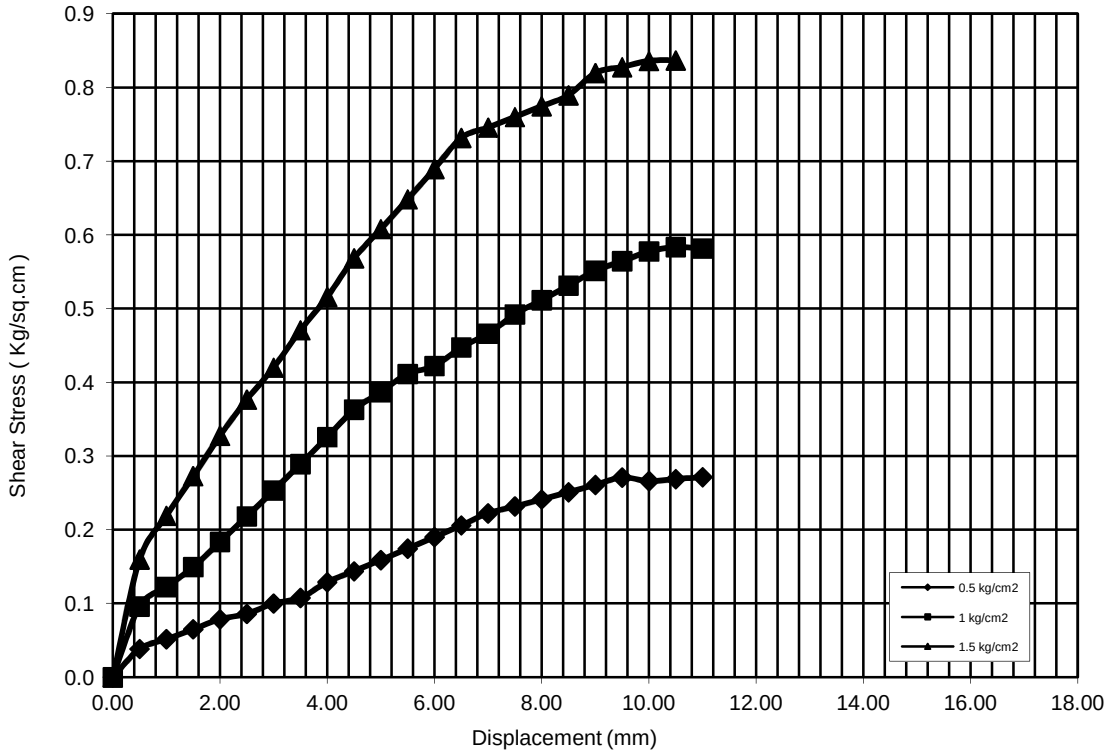
Ch. 58+497
BORE HOLE NO: BH-P5
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



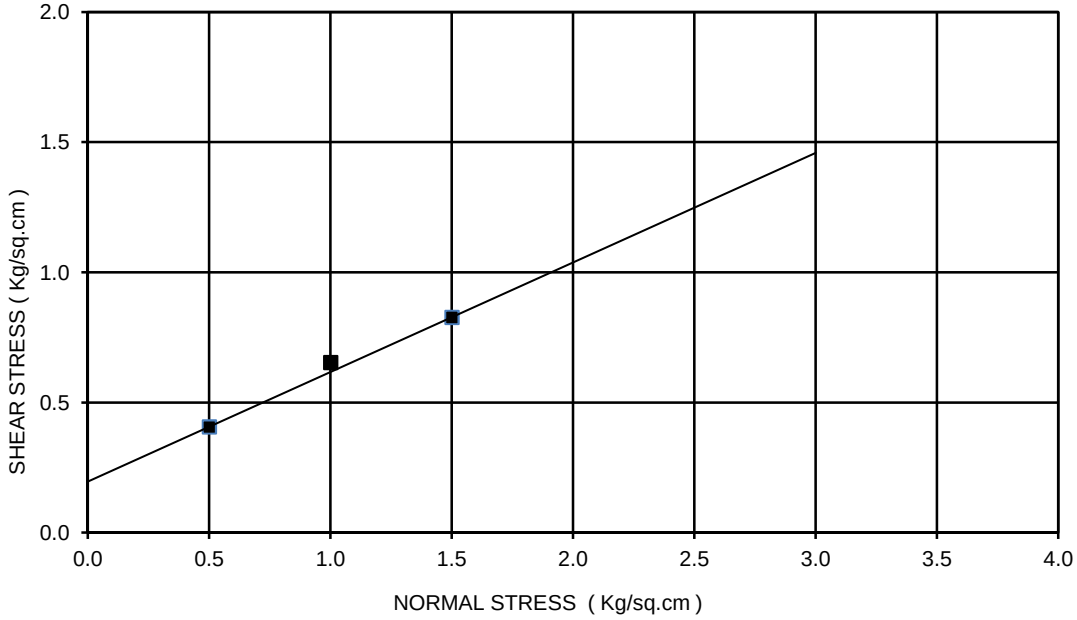


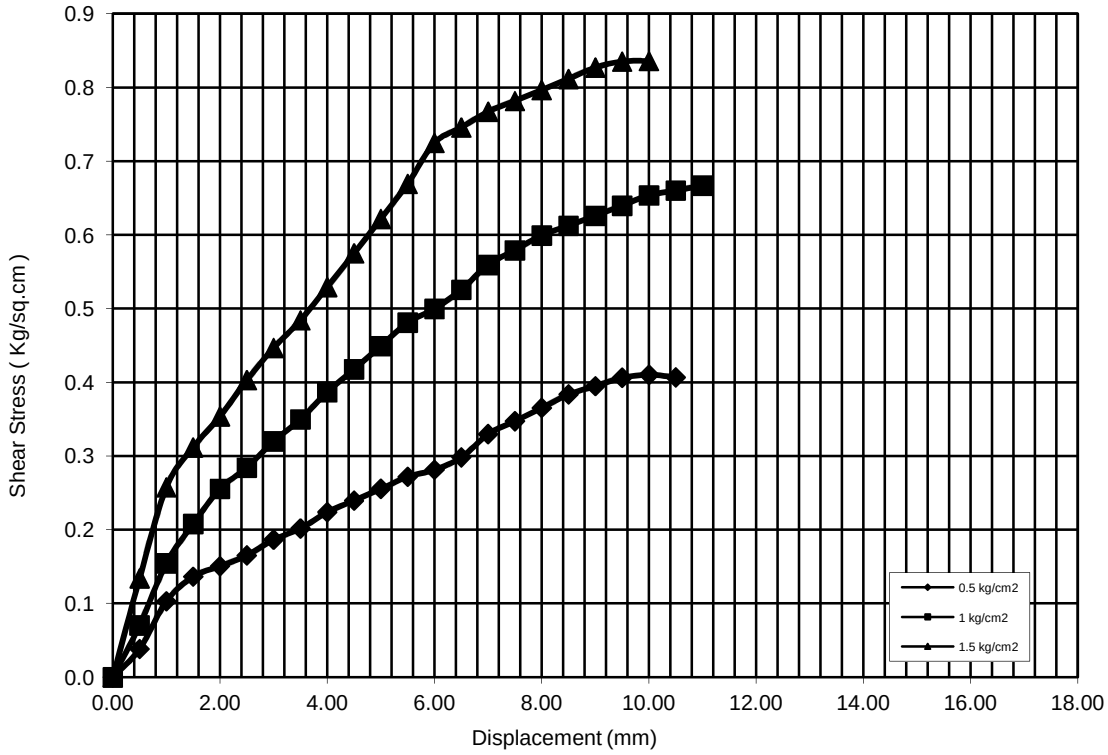
Ch. 58+497
BORE HOLE NO: BH-P5
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



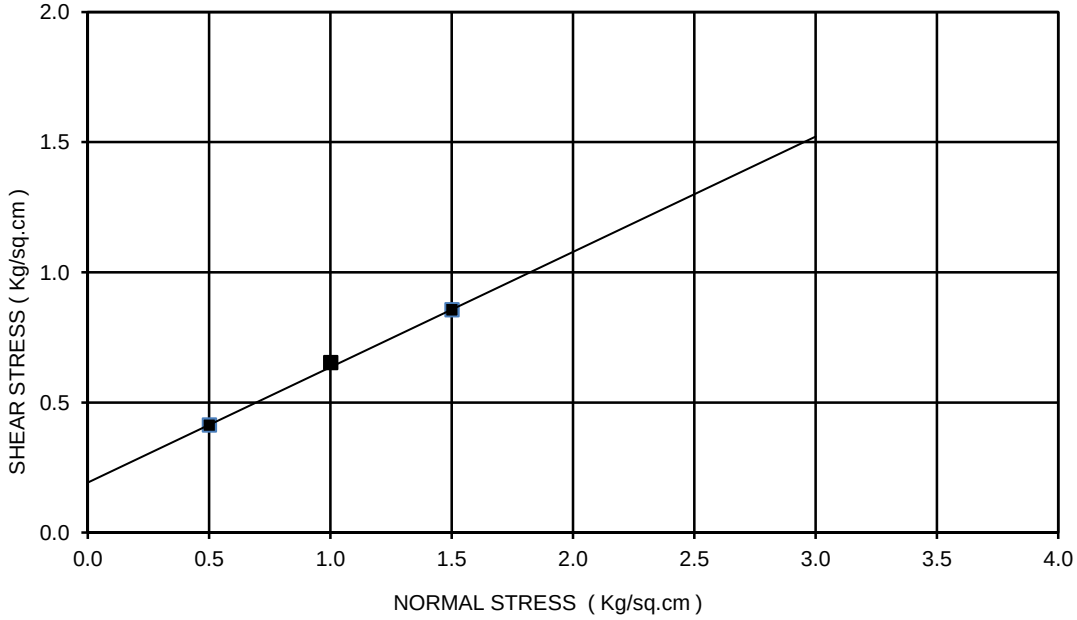


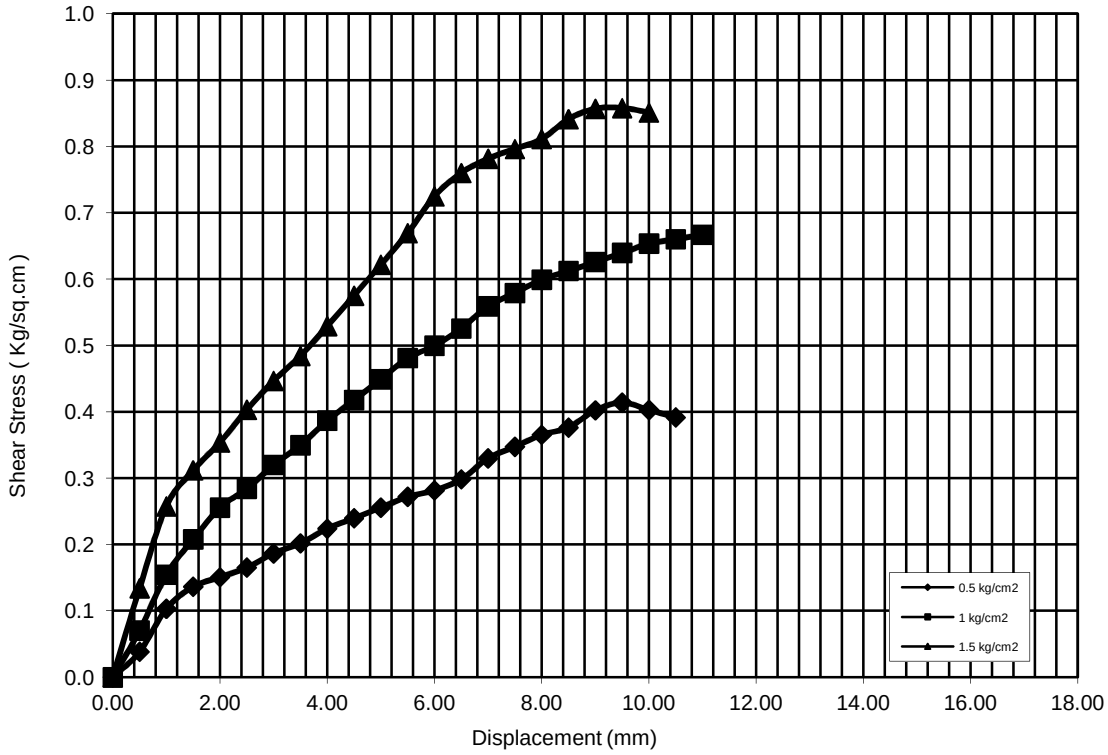
Ch. 58+497
BORE HOLE NO: BH-P6
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



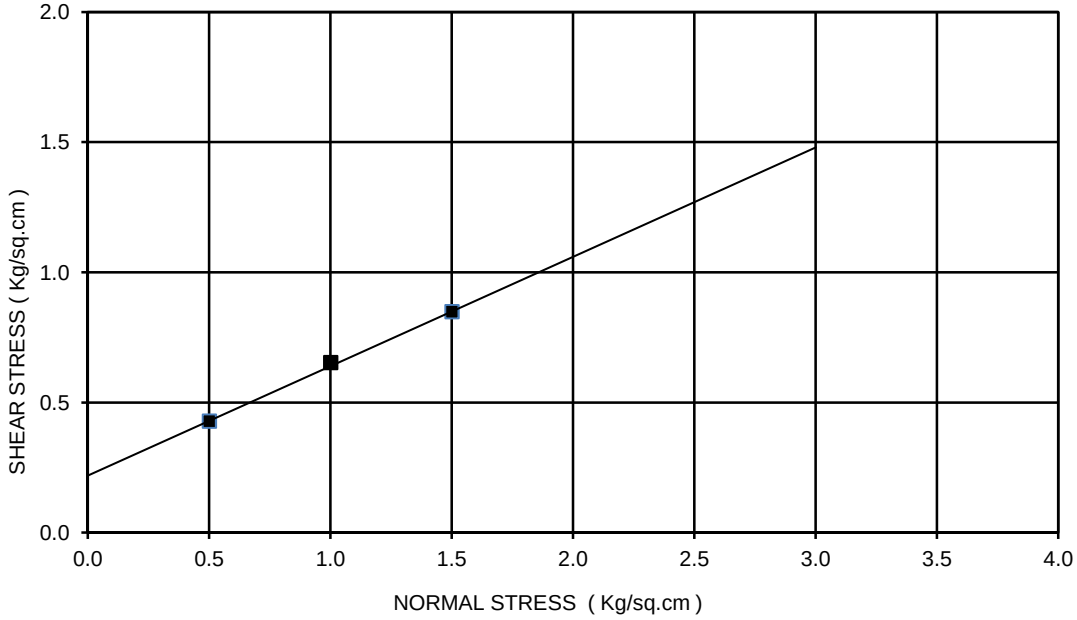


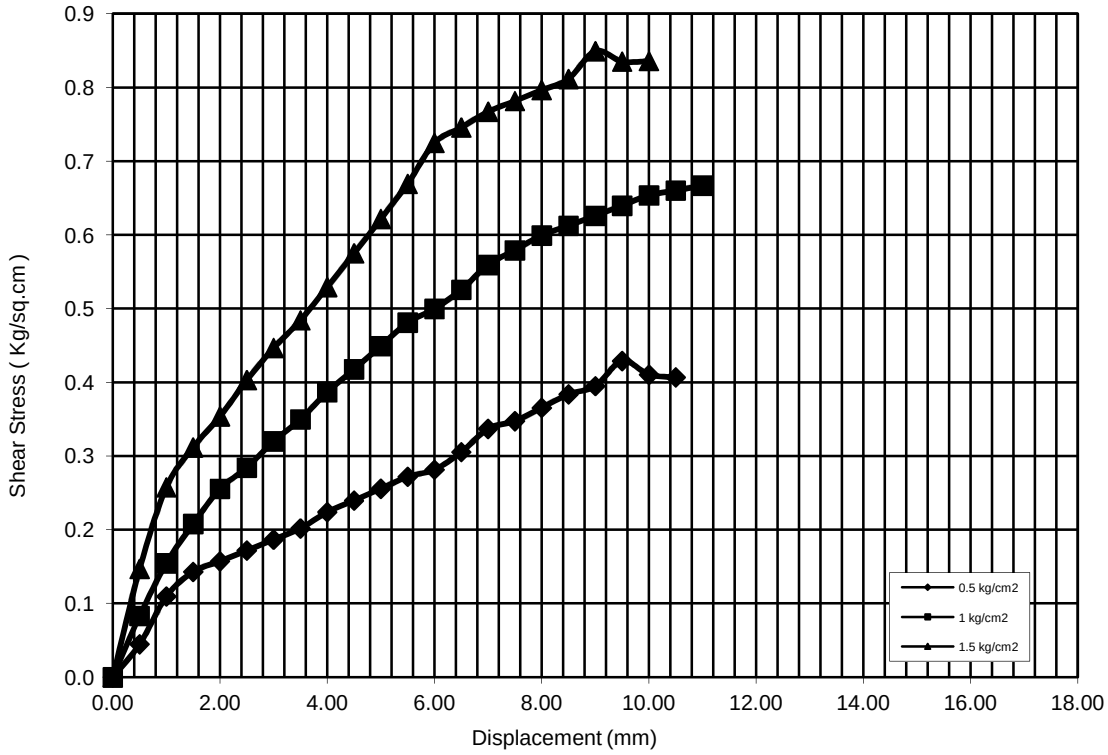
Ch. 58+497
BORE HOLE NO: BH-P6
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



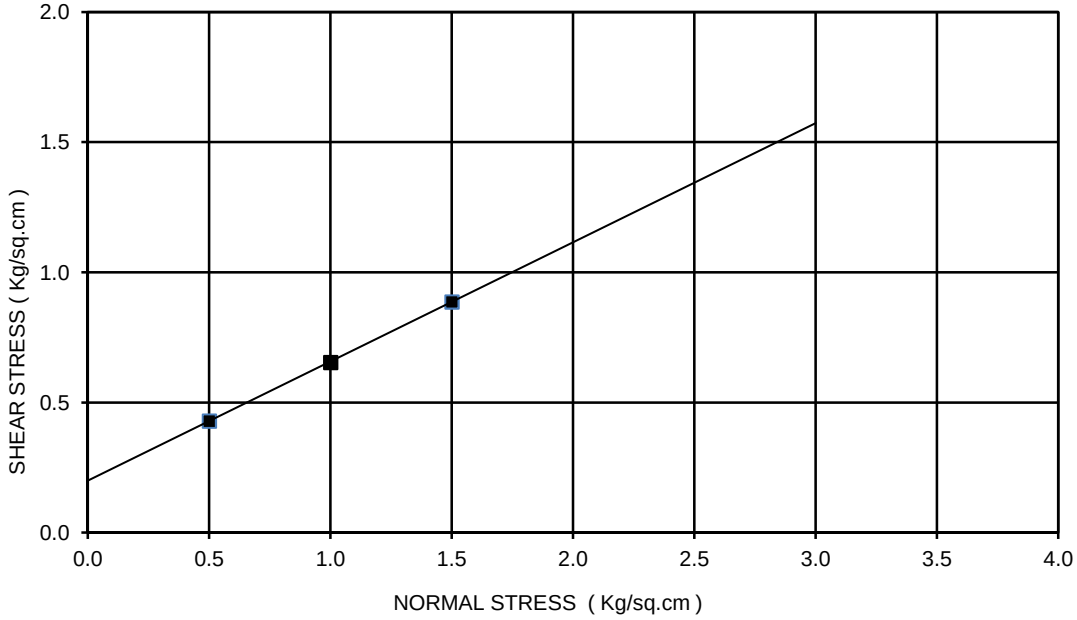


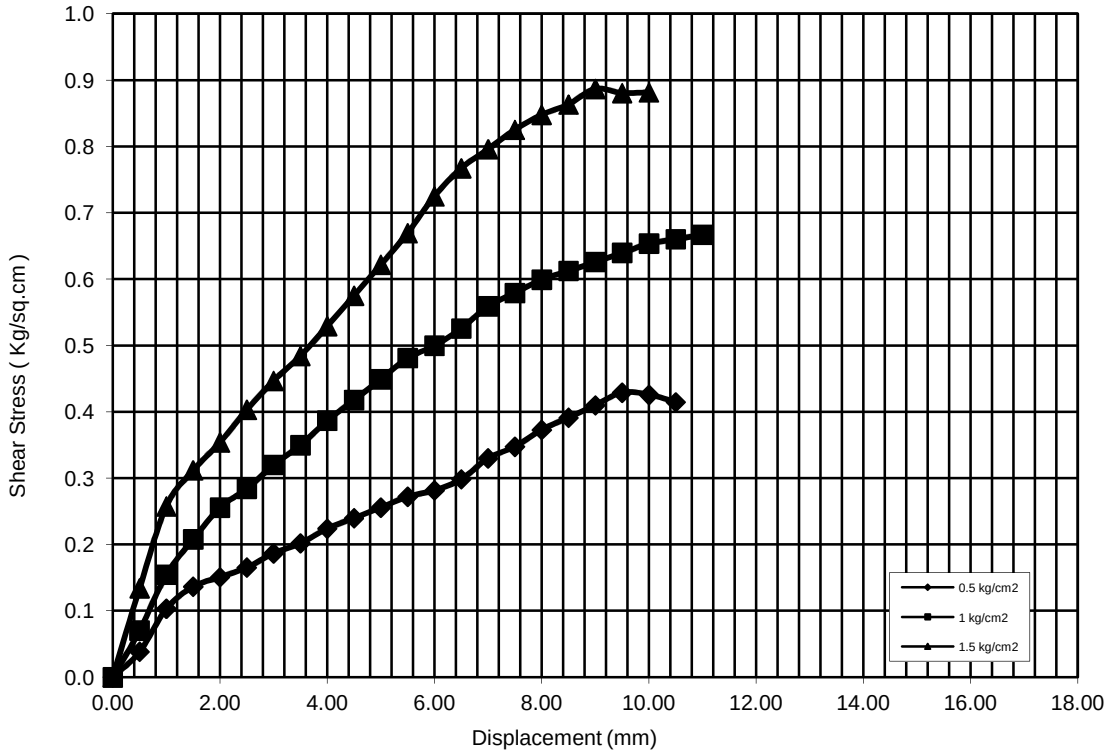
Ch. 58+497
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



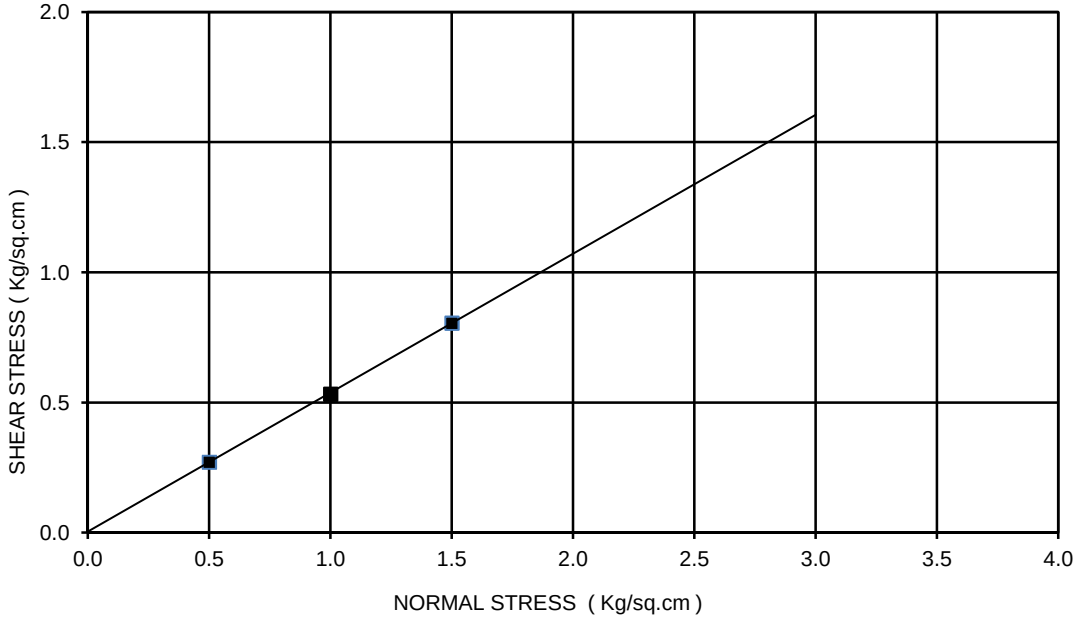


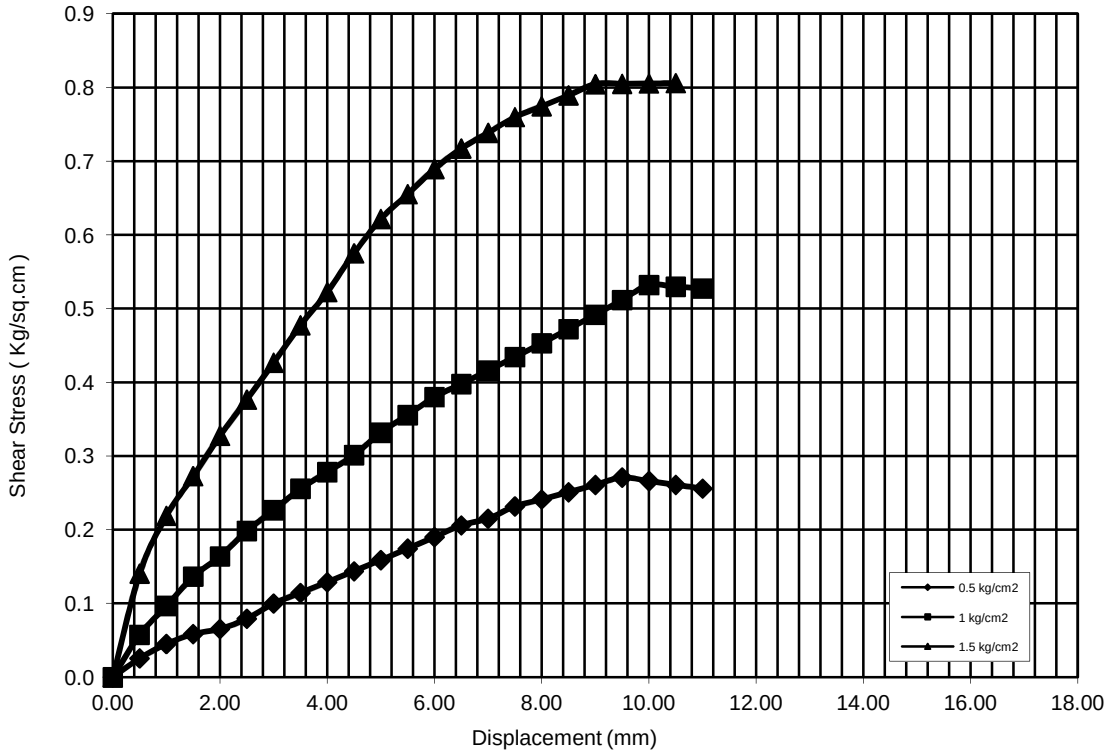
Ch. 58+497
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



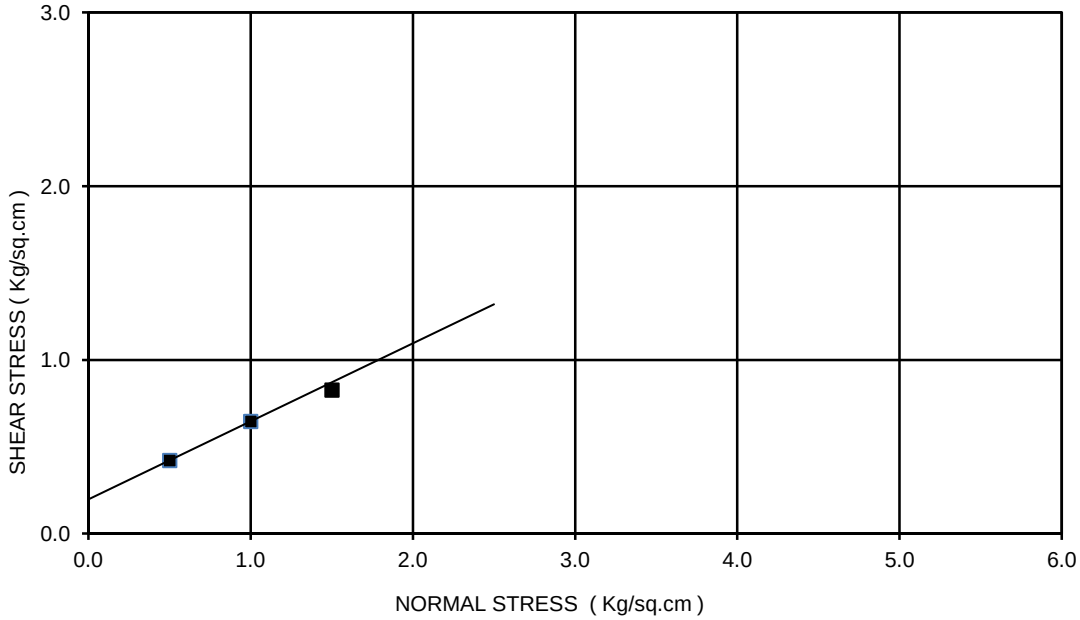


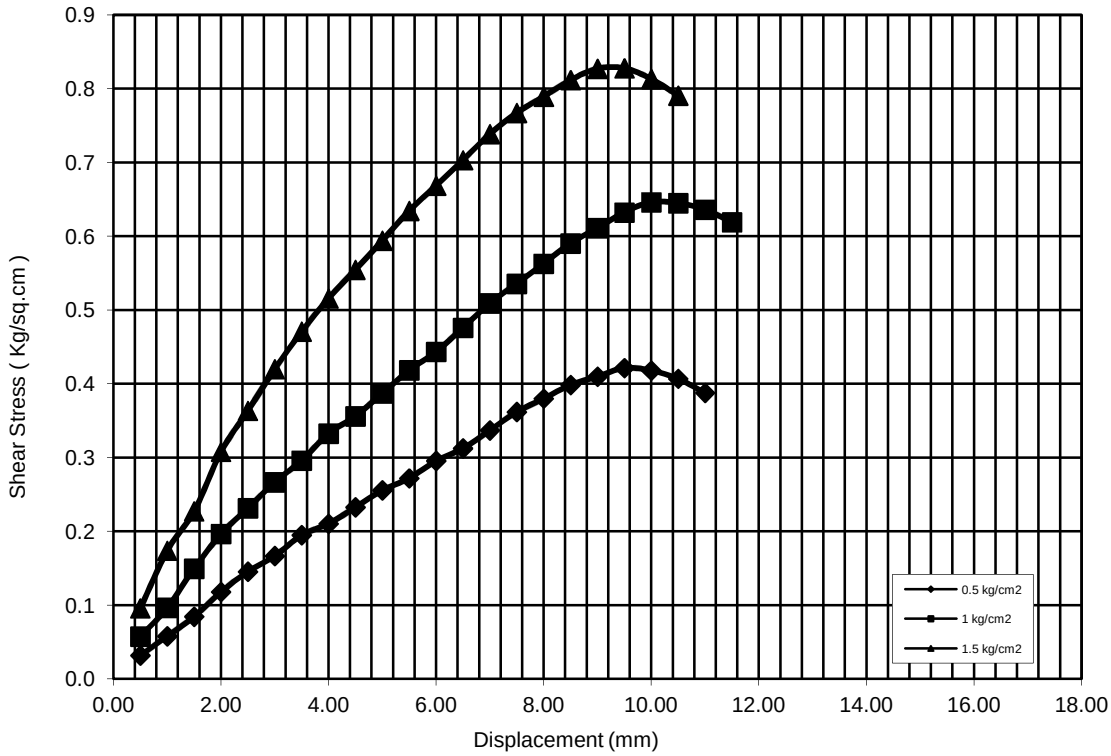
Ch. 58+837
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 28 deg
TYPE OF THE TEST: DST



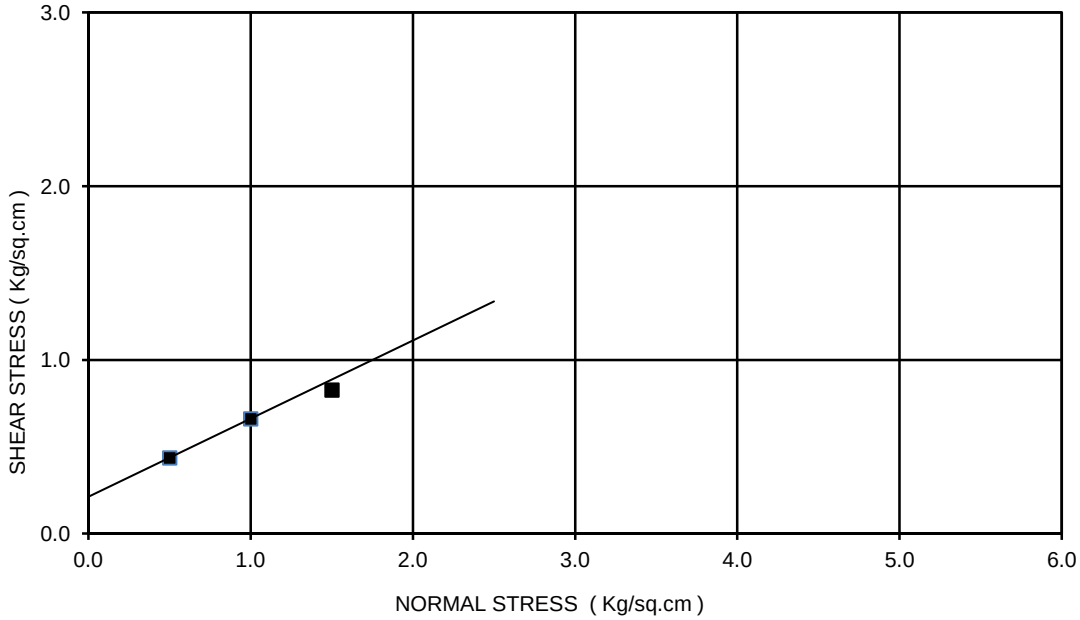


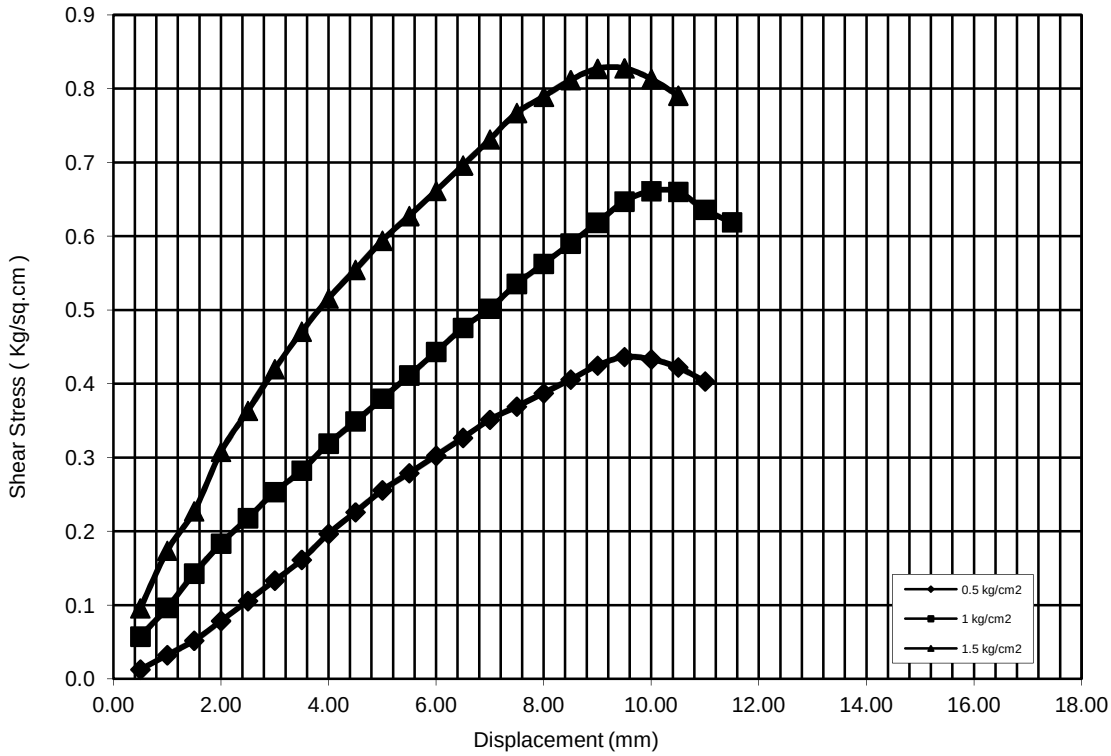
Ch. 59+071
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



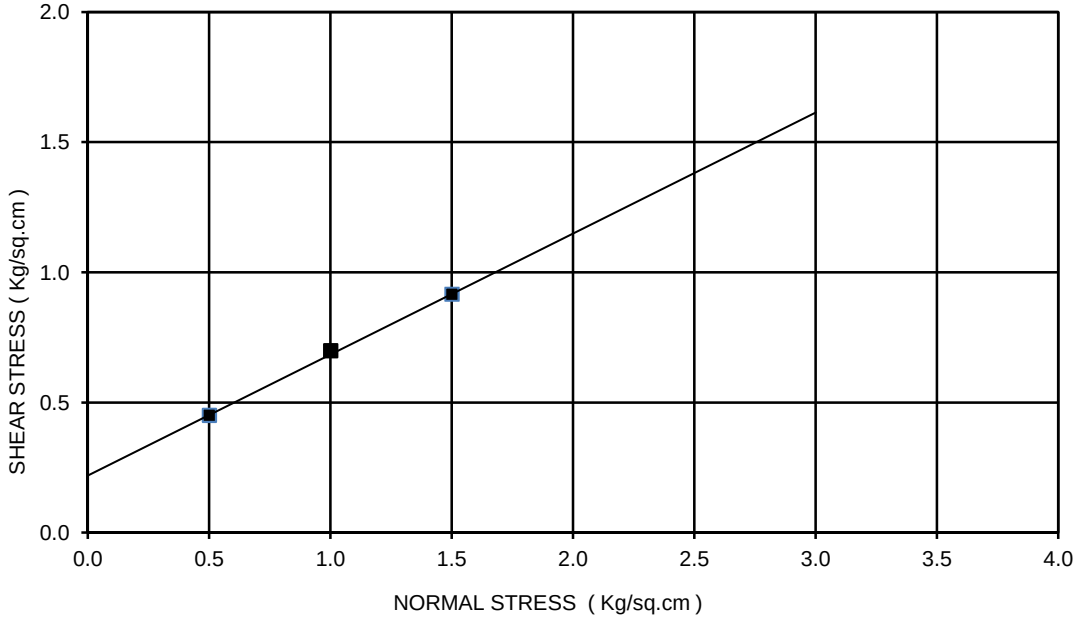


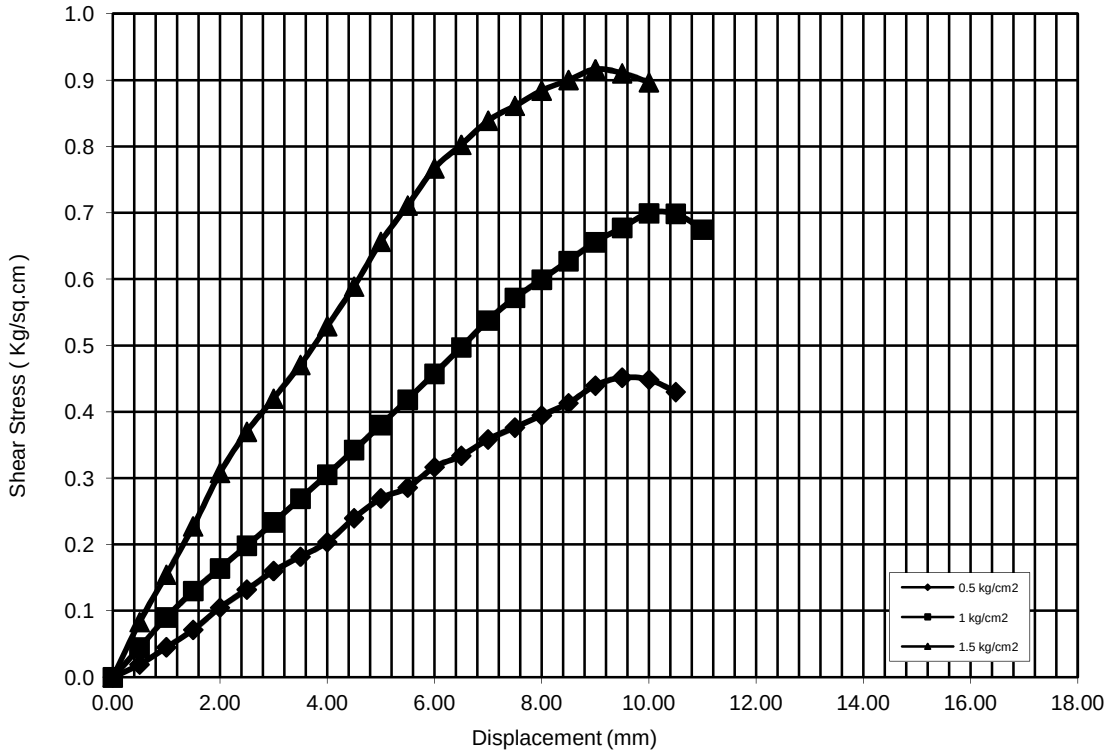
Ch. 59+206
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



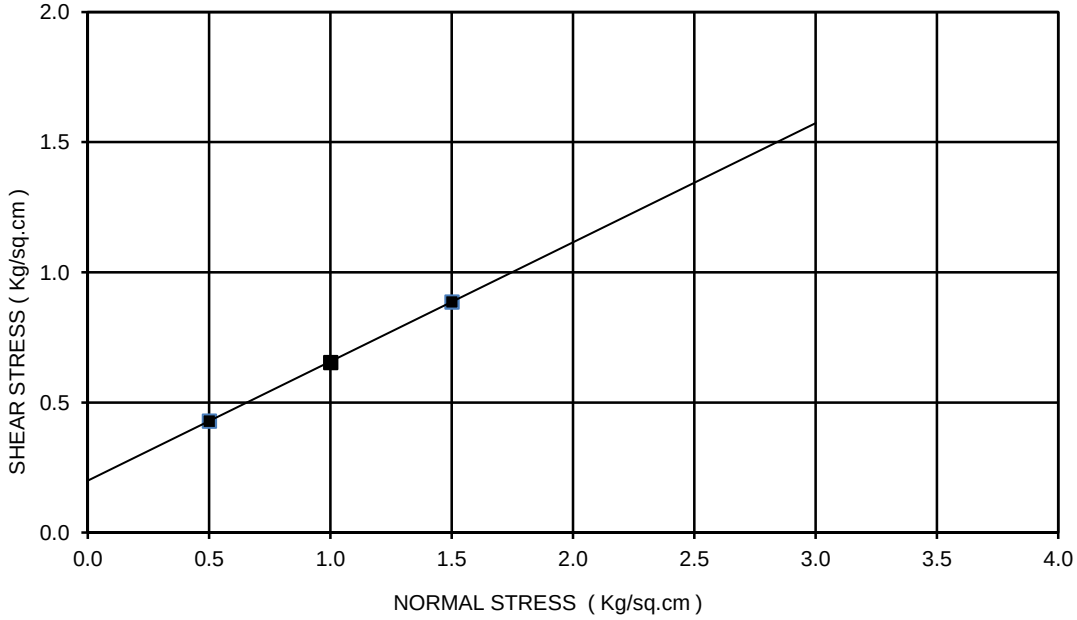


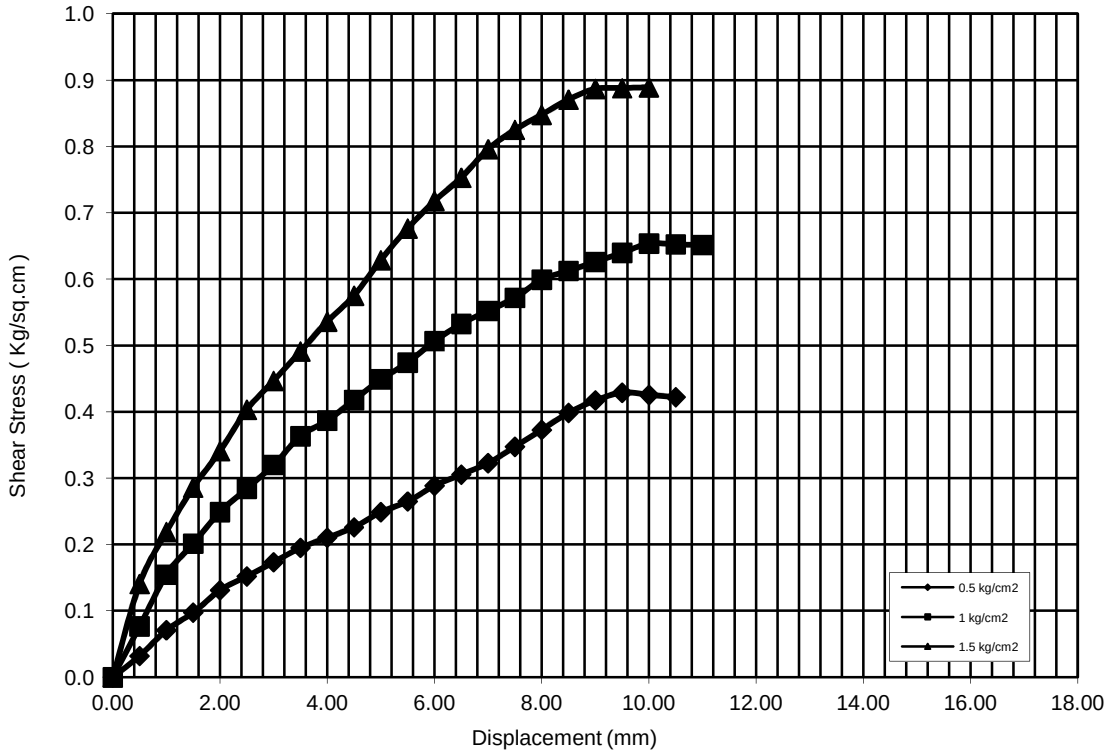
Ch. 59+206
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



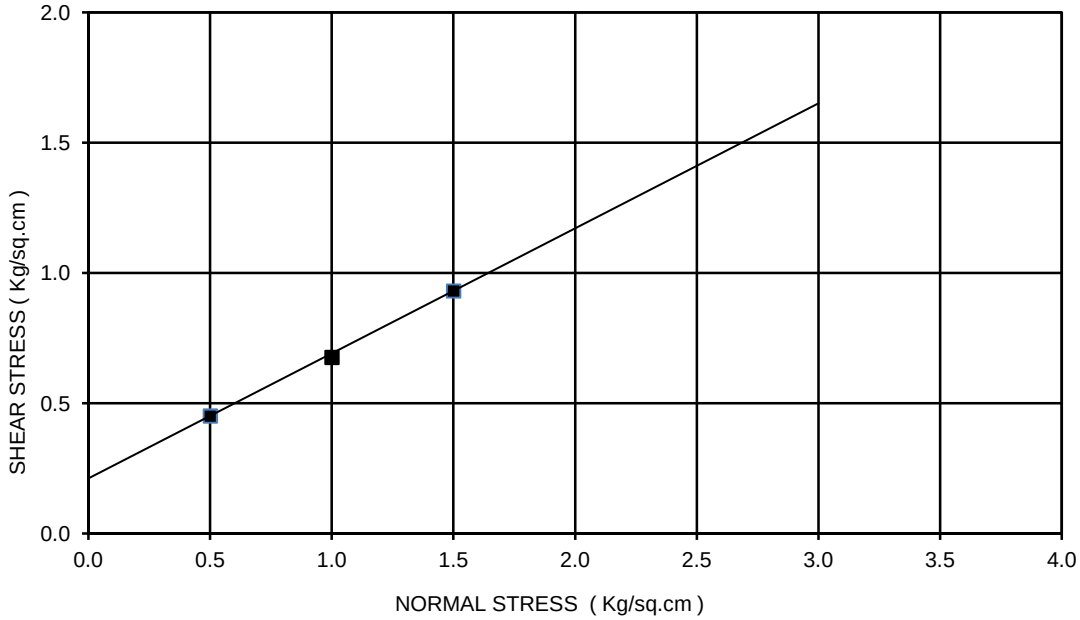


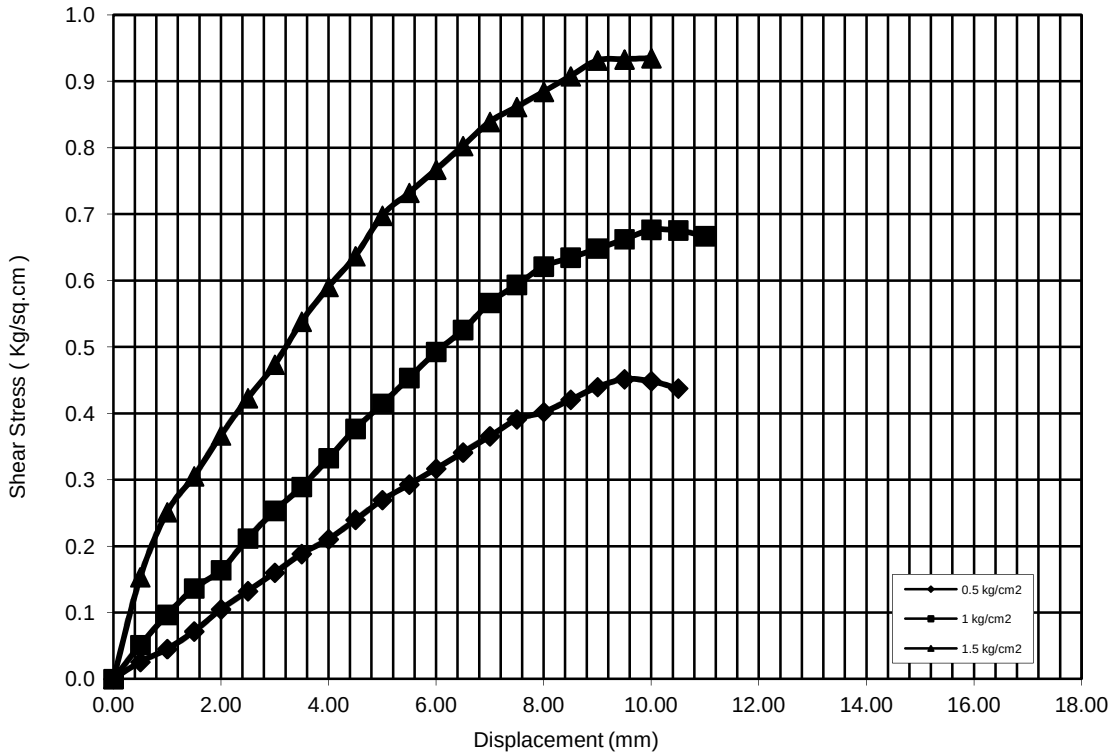
Ch. 59+270
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST

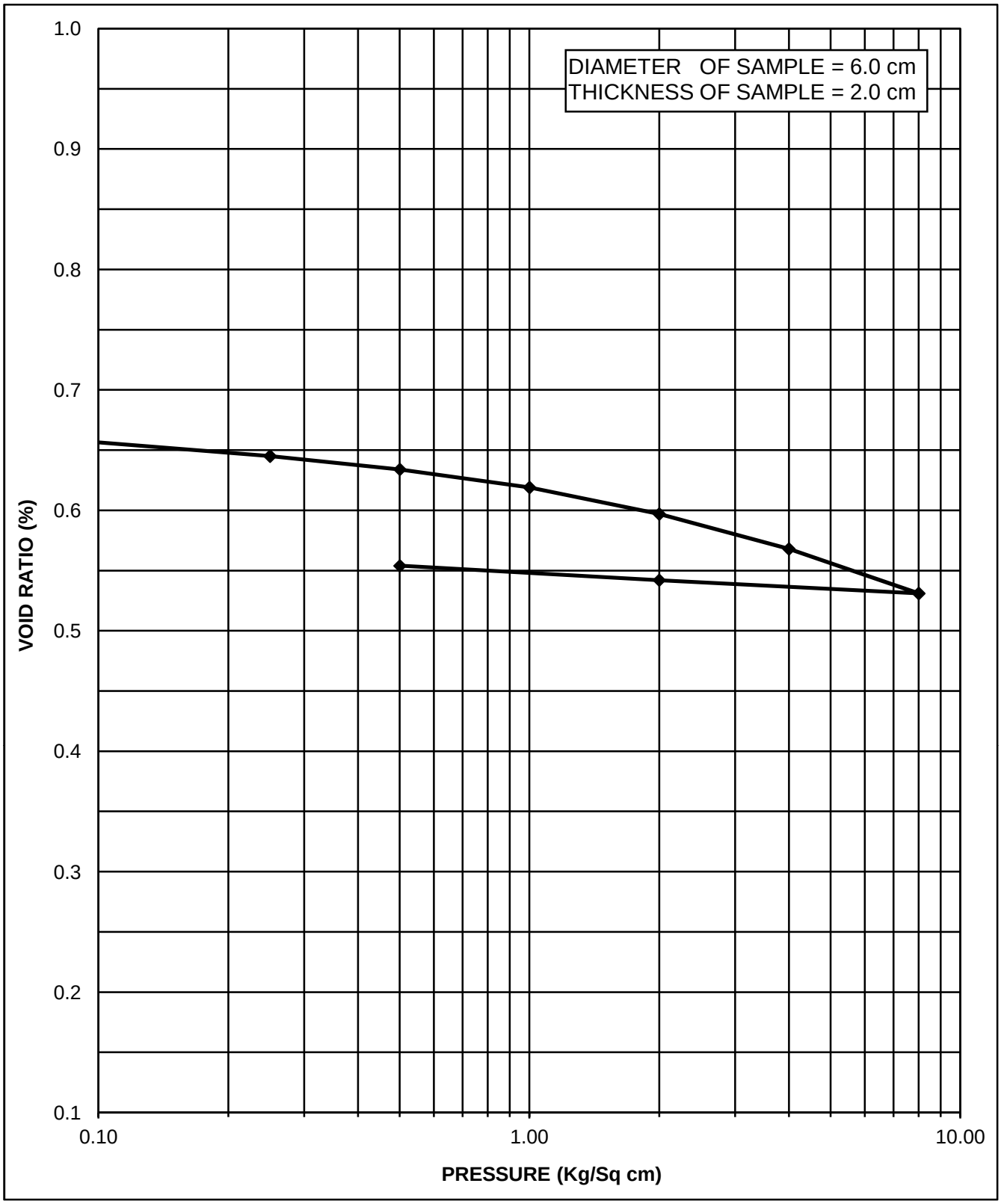




Ch. 59+270
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST







CHAINAGE:-58+497

BORE HOLE NO. = BH-P1

SAMPLE NO. = UDS-3

DEPTH = 7.00 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 15.10 %

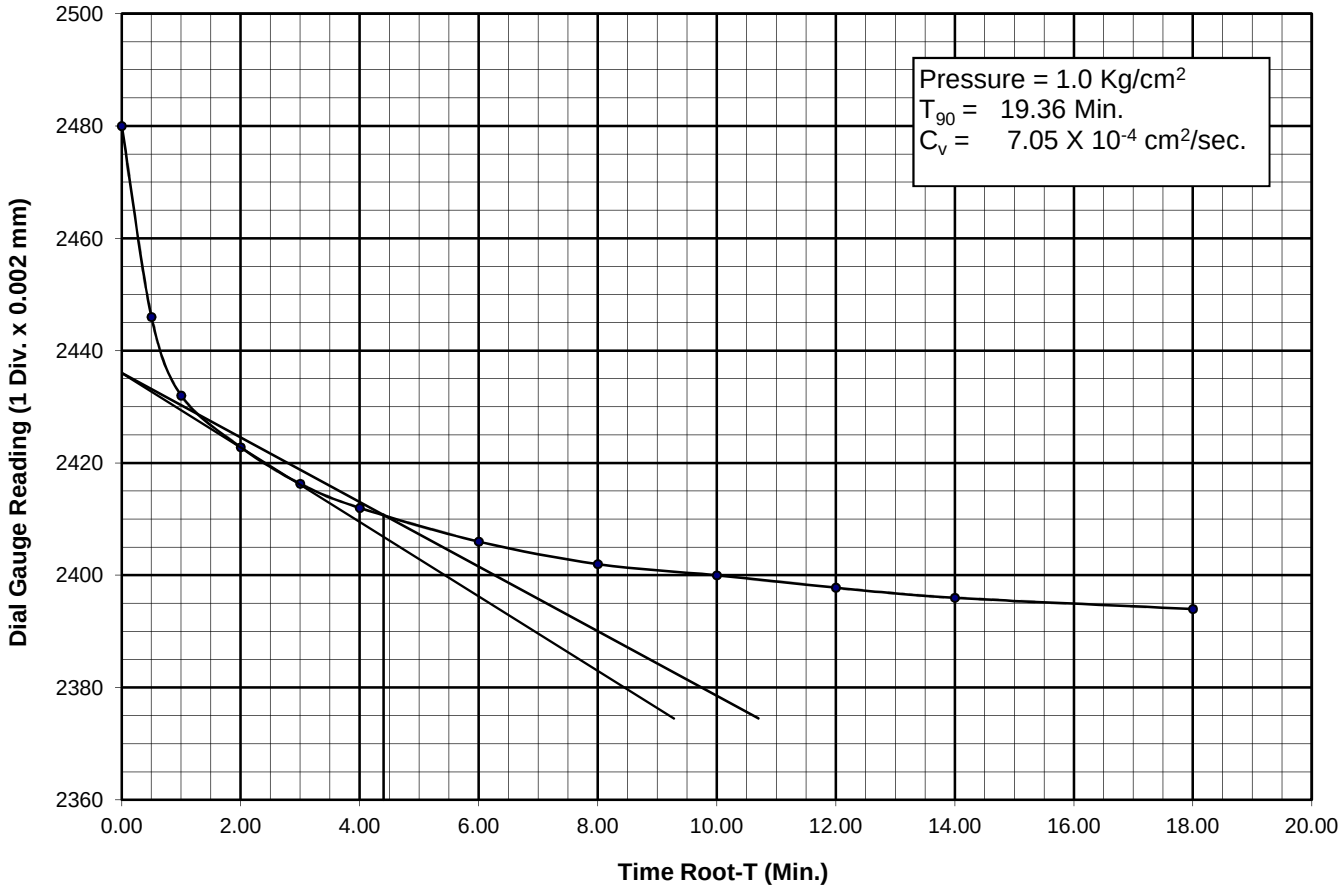
DRY DENSITY = 1.62 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESSION INDEX (C_c) = 0.123

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE	=	58+497
BORE HOLE NO.	=	BH-P1
SAMPLE NO.	=	UDS-3
DEPTH	=	7.00 M



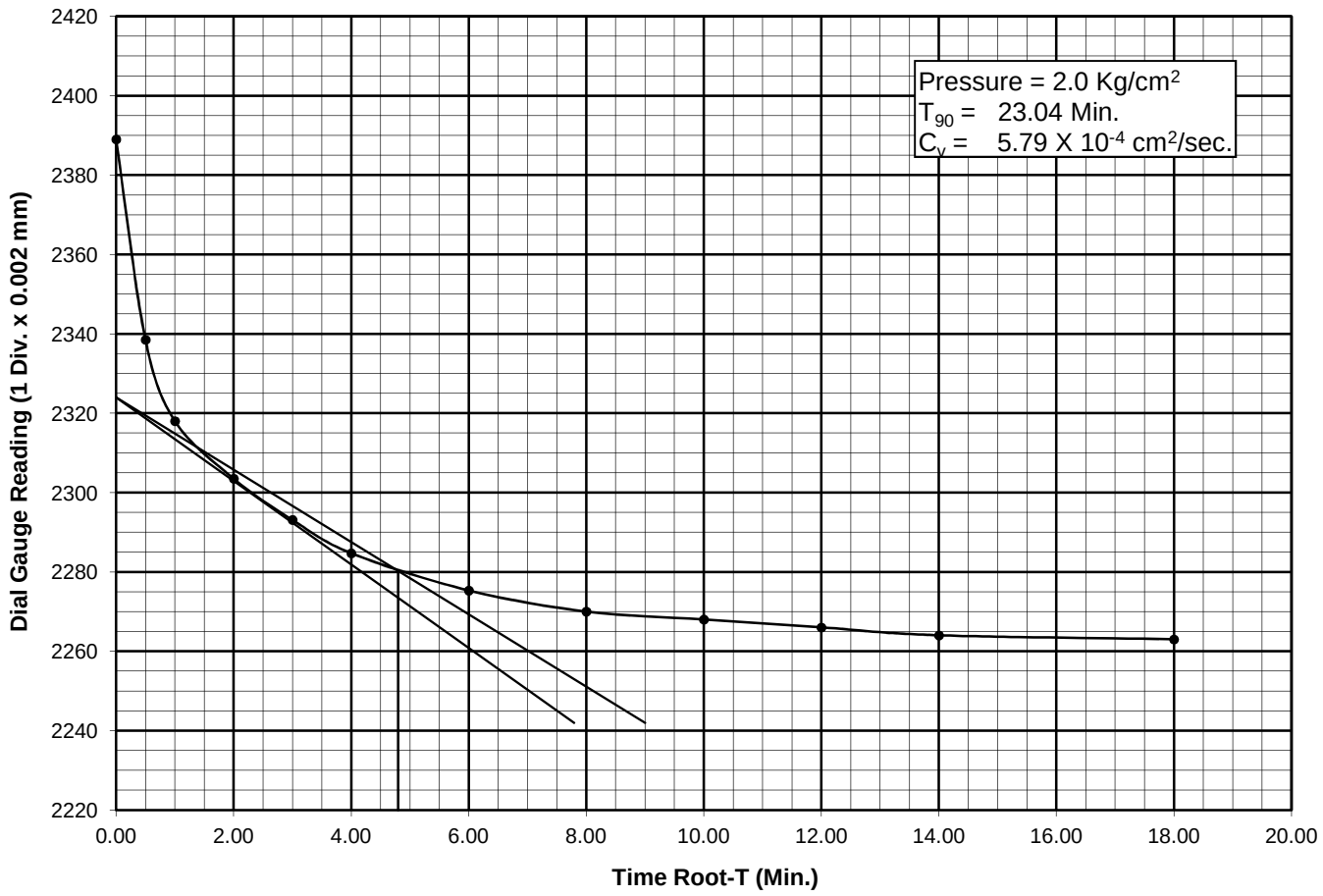
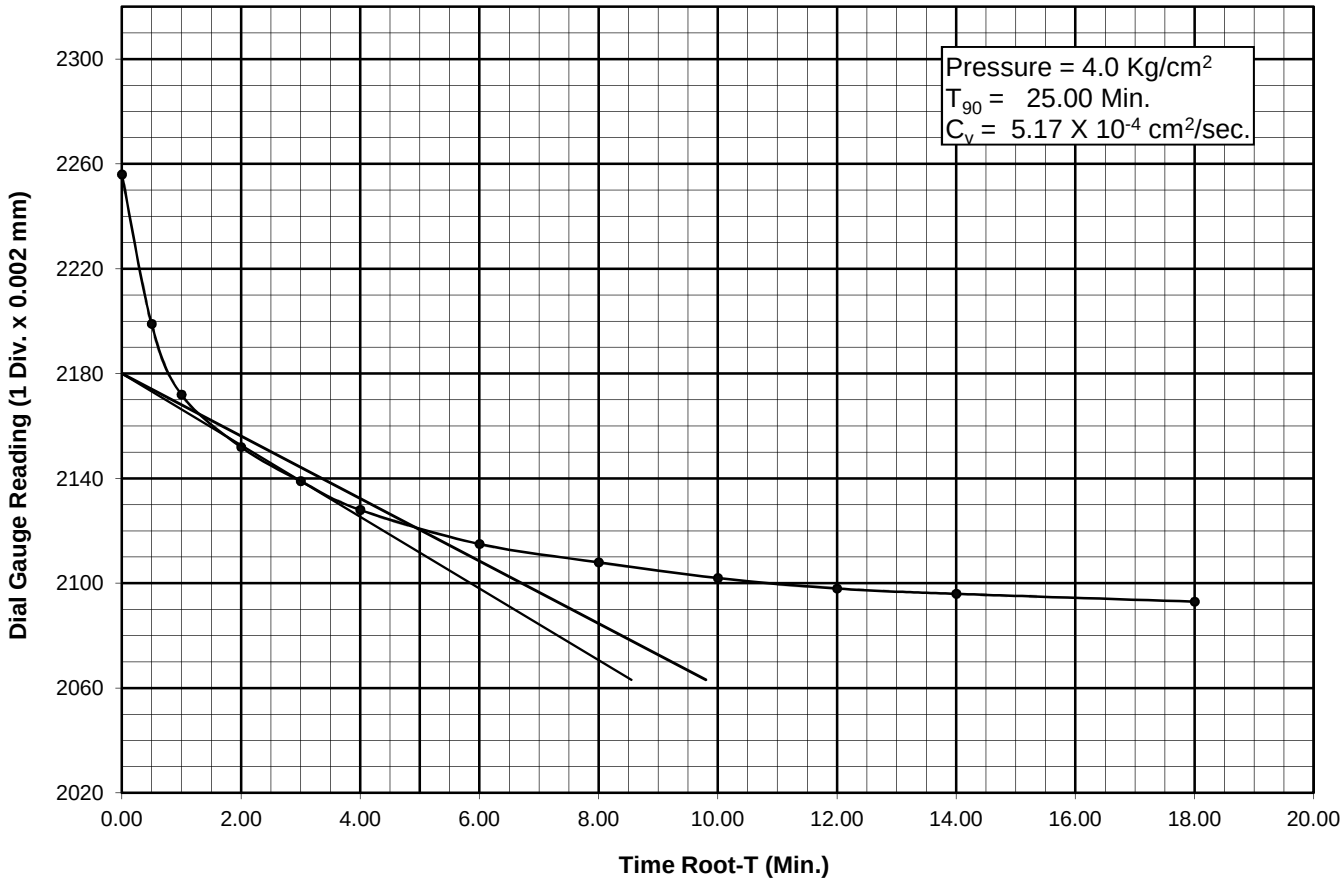


Figure No. -

CHAINAGE	=	58+497
BORE HOLE NO.	=	BH-P1
SAMPLE NO.	=	UDS-3
DEPTH	=	7.00 M



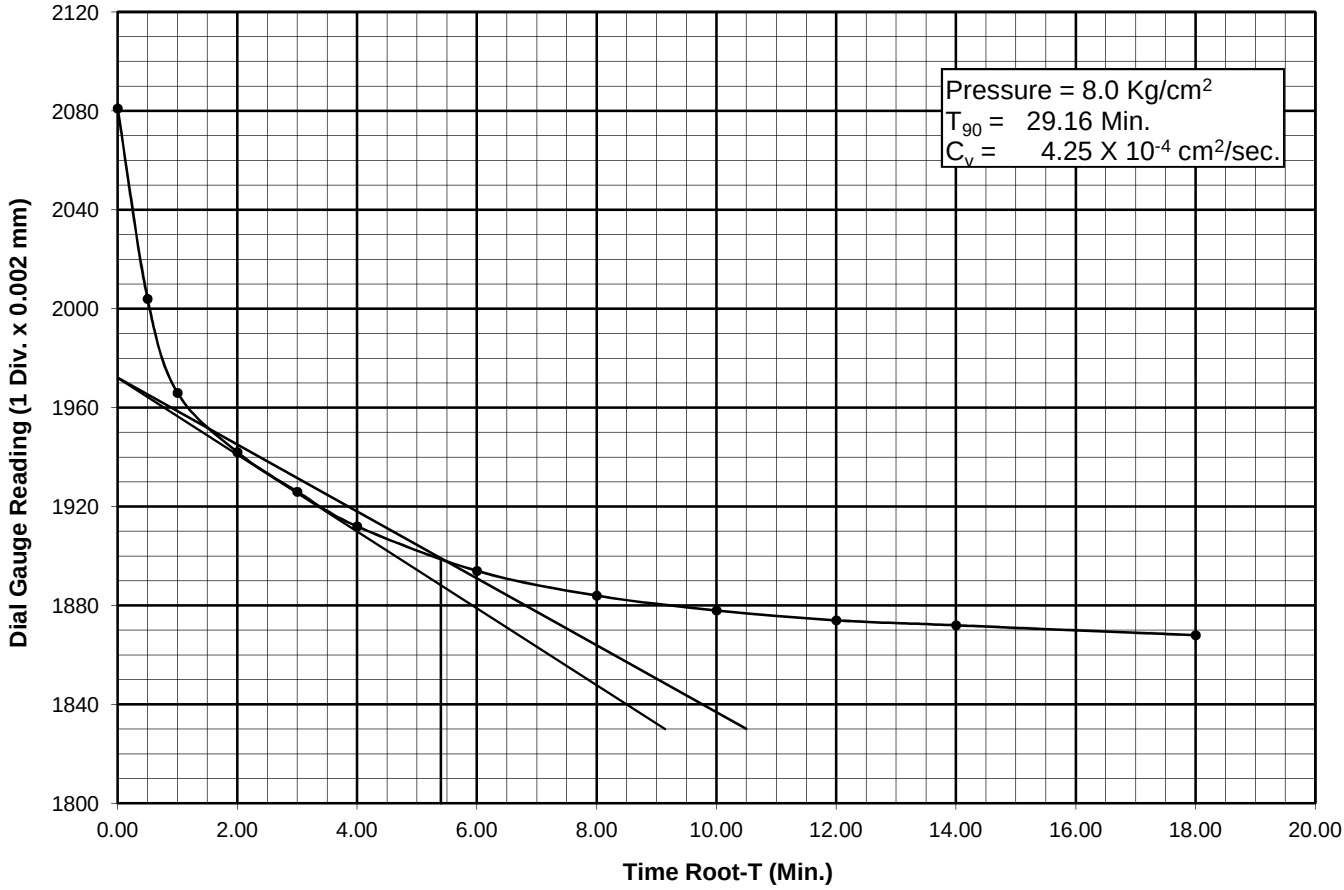
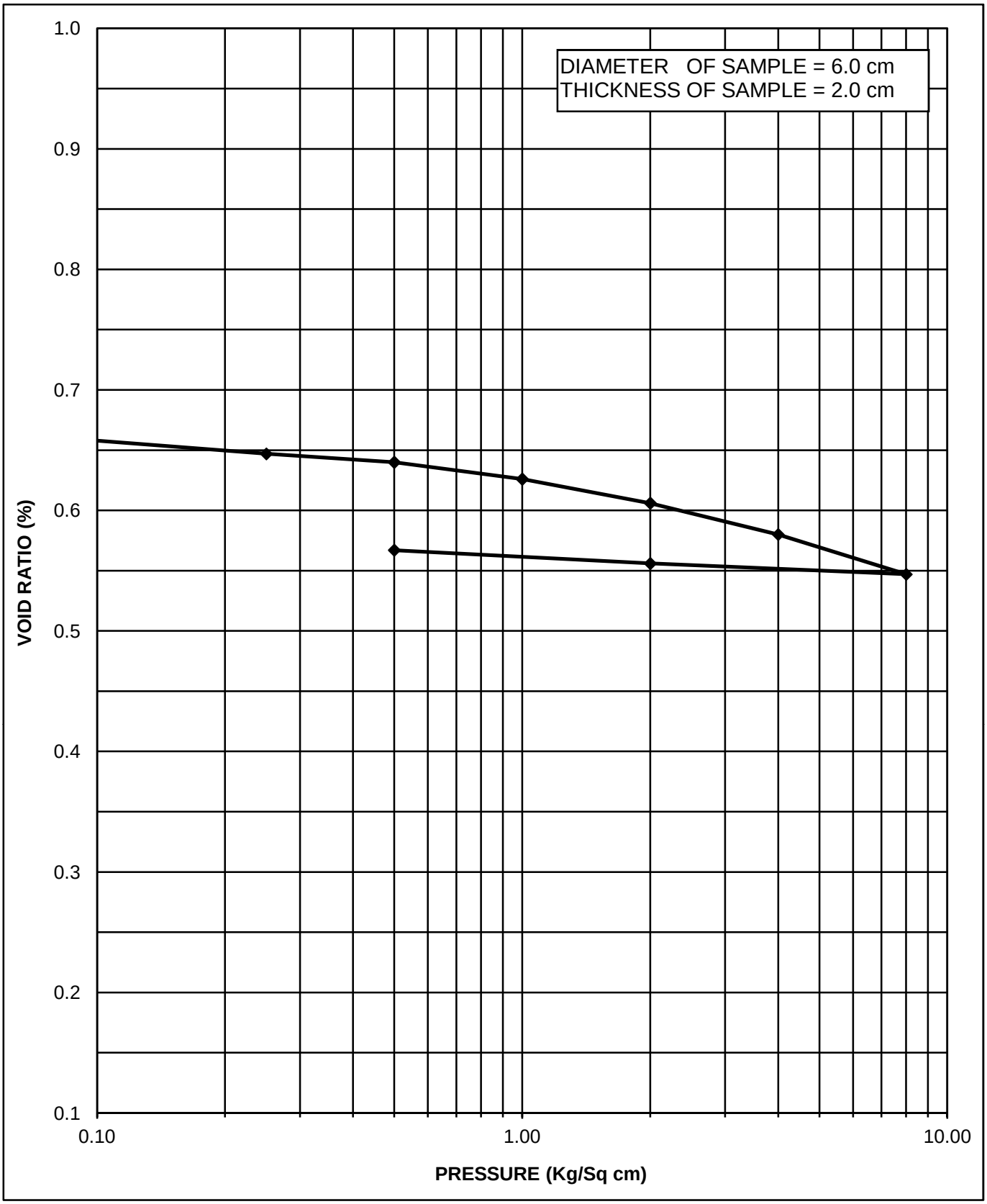


Figure No. -



CHAINAGE = 58+497

BORE HOLE NO. = BH-P6

SAMPLE NO. = UDS-4

DEPTH = 10.00 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 17.48 %

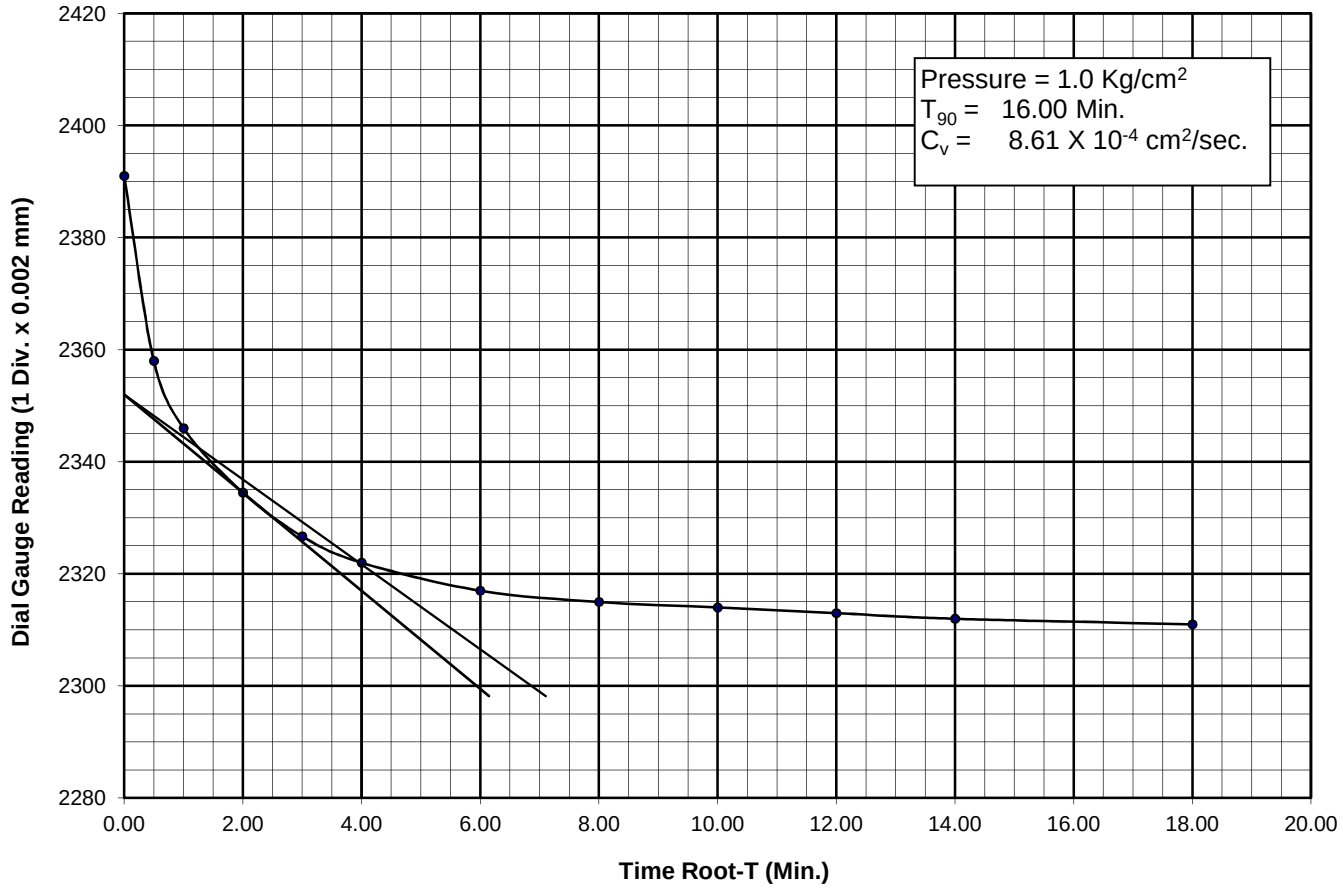
DRY DENSITY = 1.62 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESSION INDEX (C_c) = 0.110

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE	=	58+497
BORE HOLE NO.	=	BH-P6
SAMPLE NO.	=	UDS-4
DEPTH	=	10.00 M



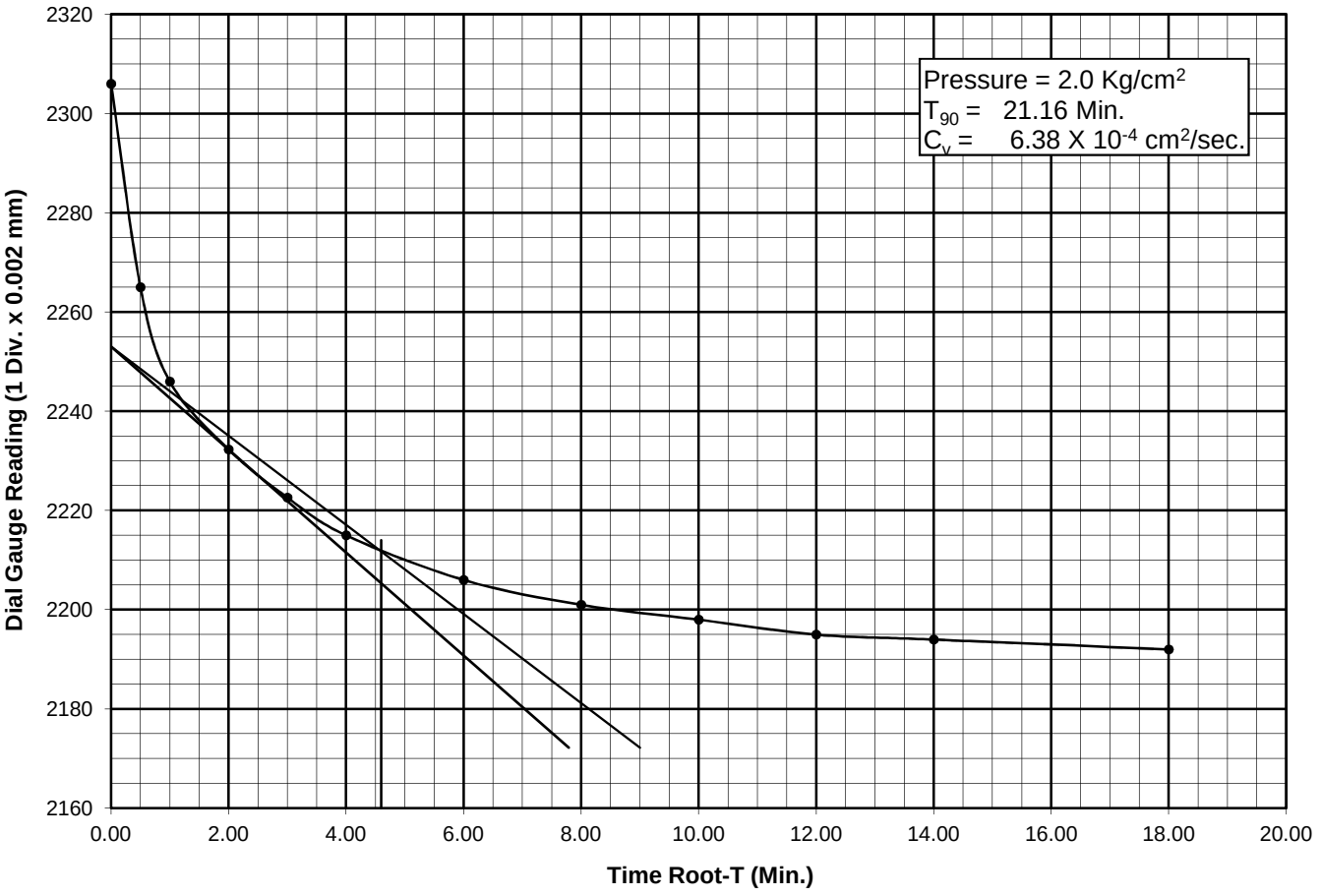
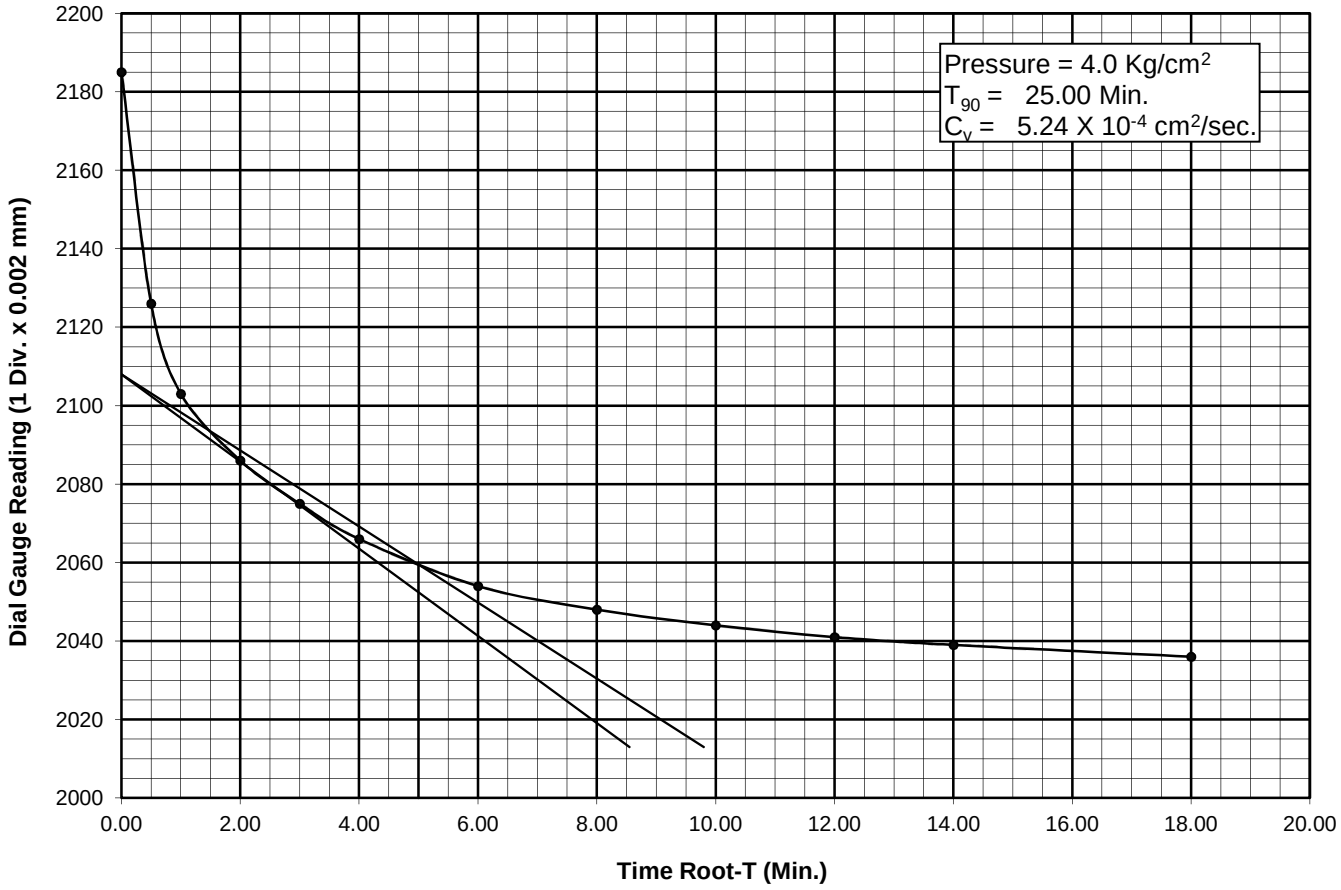


Figure No. -

CHAINAGE	=	58+497
BORE HOLE NO.	=	BH-P6
SAMPLE NO.	=	UDS-4
DEPTH	=	10.00 M



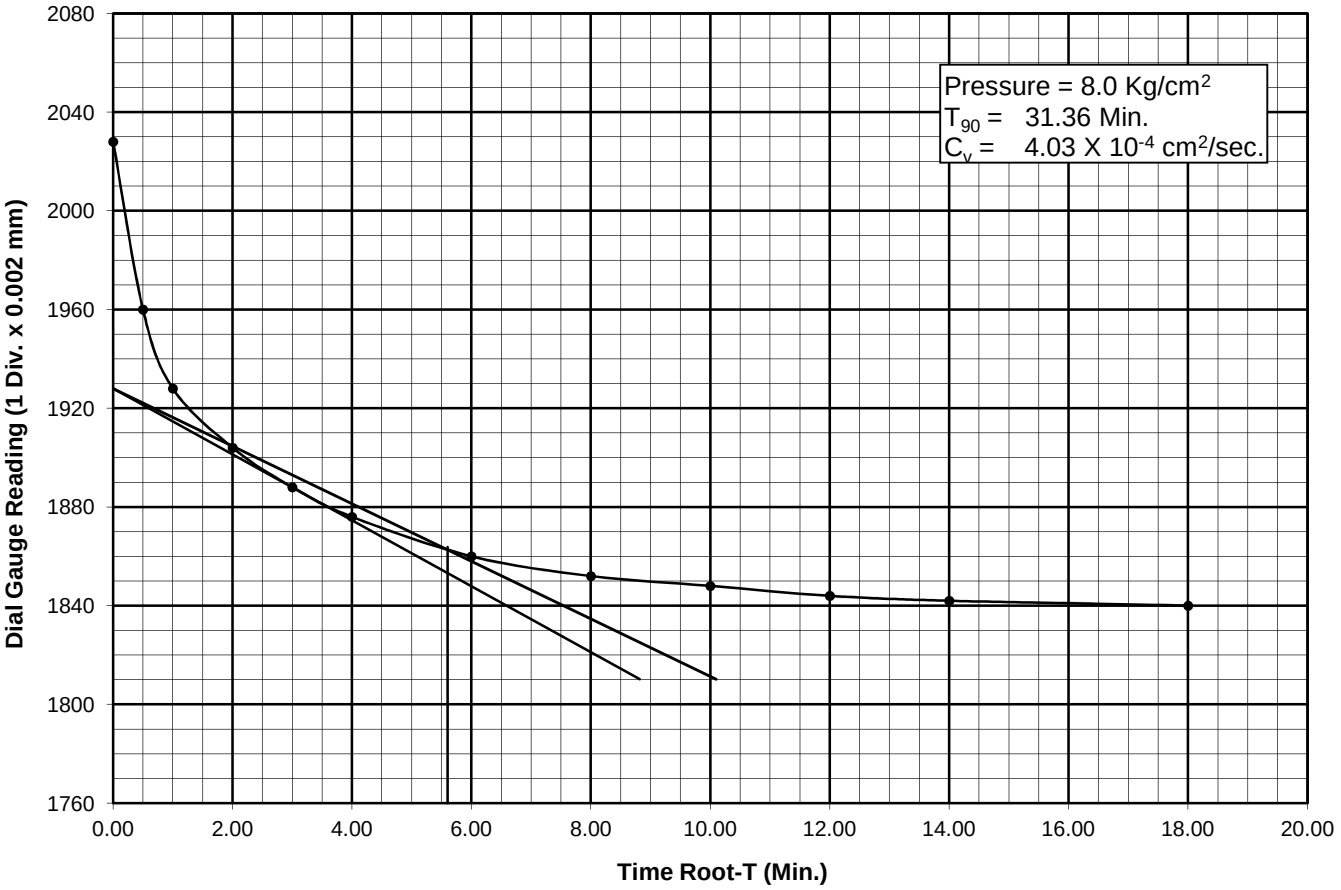


Figure No. -

APPENDIX – C
(ANALYSIS & RECOMENDATION)

Appendix No.	ITEMS
C-1	SAMPLE CALCULATIONS FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR SHALLOW FOUNDATION
C-2	SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN COMPRESSION & UPLIFT
C-3	SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN LATERAL

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- 53+107

BH NO. :- BH-CL

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	24.00
Cohesion (c in t/m^2)	2.10
Void ratio (e), e = (G.γ_w/γ_d)-1	0.71
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.74
Depth of water table(m)	15.00
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	1.00	6.20
2	1.50	6.20
3	2.00	6.20

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	24.00	ϕ'	16.61
N_c	19.32	N'_c	12.06
N_q	9.60	N'_q	4.60
N_γ	9.44	N'_γ	3.34

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	6.20	1.30	1.20	0.80
2	6.20	1.30	1.20	0.80
3	6.20	1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.00	6.20	1.05	1.02	1.02
2	1.50	6.20	1.07	1.04	1.04
3	2.00	6.20	1.10	1.05	1.05
			#VALUE!	#VALUE!	#VALUE!
			#VALUE!	#VALUE!	#VALUE!
			#VALUE!	#VALUE!	#VALUE!

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha/90)^2$	$i_q = (1-\alpha/90)^2$	$i_\gamma = (1-\alpha/\phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.00	6.20	2.26	1.00
2	1.50	6.20	2.18	1.00
3	2.00	6.20	2.10	1.00
			#VALUE!	#VALUE!
			#VALUE!	#VALUE!
			#VALUE!	#VALUE!

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	1.00	6.20	46.27	18.22	23.87
2	1.50	6.20	50.82	20.10	26.30
3	2.00	6.20	55.46	22.03	28.77
					#VALUE!
					#VALUE!
					#VALUE!

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976																BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Water Table Correction Factor	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	5.25	4.25				4.25	6.20	6.200	1.840	21	1.00	14.90	19.33	19.33			
Layer 2		5.25	10.30	5.05				5.05	12.975	12.975	0.420	43	1.00			6.58			
	1.00				1.84	6.20	6.20										0.97	1.00	25.00
Layer 1		1.50	5.25	3.75				3.75	6.20	6.200	1.957	21	1.00	14.90	18.78	18.78			
Layer 2		5.25	10.50	5.25				5.25	12.575	12.575	0.476	43	1.00			7.75			
Layer 3		10.50	10.80	0.30				0.30	15.200	15.200	0.326	38		7.50	0.06	0.06			
	1.50				1.96	6.20	6.20										0.94	1.00	25.00
Layer 1		2.00	5.25	3.25				3.25	6.20	6.200	2.110	21	1.00	14.90	18.13	18.13			
Layer 2		5.25	10.50	5.25				5.25	12.075	12.075	0.556	43	1.00			9.06			
Layer 3		10.50	11.30	0.80				0.80	14.700	14.700	0.375	38	1.00	7.50	0.20	0.20			
	2.00				2.11	6.20	6.20										0.91	1.00	25.00

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.72	200	0.17											
1.00		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								314.29		60.14	
1.00		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								314.29		140.90	
1.00		13.00	15.00	1.12	4	1.00	0.40	1.85	200	2.46								314.29		38.68	
1.00		15.00	16.00	1.12	4	1.00	0.40	1.85	100	2.65								314.29		19.75	
1.00		16.00	18.00	0.21	30	1.00	1.00	1.87	200	2.65								314.29		109.40	
1.00		18.00	24.00	0.21	30	1.00	1.00	0.87	600	2.65	2.65	0.84	0.23	29	9	17.93	19.34	314.29	7857.14	328.20	395.97
																				697.07	395.97

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (697.07 + 395.97) / 2.5 Qa,uplift = 697.07 / 3 + 43.2

Qa,comp.= 437.22 T Qa,uplift = 275.55 T

Say **Qa,comp.= 437.00 T** **Qa,uplift = 275.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.72	200	0.17											
1.00		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								314.29		60.14	
1.00		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								314.29		140.90	
1.00		13.00	15.00	1.12	4	1.00	0.40	1.85	200	2.46								314.29		38.68	
1.00		15.00	16.00	1.12	4	1.00	0.40	1.85	100	2.65								314.29		19.75	
1.00		16.00	18.00	0.21	30	1.00	1.00	1.87	200	2.65								314.29		109.40	
1.00		18.00	25.00	0.21	30	1.00	1.00	0.87	700	2.65								314.29		382.90	
1.00		25.00	26.00	0.23	29	1.00	1.00	0.84	100	2.65	2.65	0.84	0.23	29	9	17.93	19.34	314.29	7857.14	53.41	395.97
																				805.18	395.97

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (805.18 + 395.97) / 2.5 Qa,uplift = 805.18 / 3 + 47.12

Qa,comp.= 480.46 T Qa,uplift = 315.52 T

Say **Qa,comp.= 480.00 T** **Qa,uplift = 315.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.72	200	0.17											
1.00		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								314.29		60.14	
1.00		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								314.29		140.90	
1.00		13.00	15.00	1.12	4	1.00	0.40	1.85	200	2.46								314.29		38.68	
1.00		15.00	16.00	1.12	4	1.00	0.40	1.85	100	2.65								314.29		19.75	
1.00		16.00	18.00	0.21	30	1.00	1.00	1.87	200	2.65								314.29		109.40	
1.00		18.00	25.00	0.21	30	1.00	1.00	0.87	700	2.65								314.29		382.90	
1.00		25.00	28.00	0.23	29	1.00	1.00	0.84	300	2.65	2.65	0.84	0.23	29	9	17.93	19.34	314.29	7857.14	160.23	395.97
																				912.00	395.97

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (912 + 395.97) / 2.5 Qa,uplift = 912 / 3 + 51.05

Qa,comp.= 523.19 T Qa,uplift = 355.05 T

Say **Qa,comp.= 523.00 T** **Qa,uplift = 355.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.72	200	0.17											
1.00		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								314.29		60.14	
1.00		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								314.29		140.90	
1.00		13.00	15.00	1.12	4	1.00	0.40	1.85	200	2.46								314.29		38.68	
1.00		15.00	16.00	1.12	4	1.00	0.40	1.85	100	2.65								314.29		19.75	
1.00		16.00	18.00	0.21	30	1.00	1.00	1.87	200	2.65								314.29		109.40	
1.00		18.00	25.00	0.21	30	1.00	1.00	0.87	700	2.65								314.29		382.90	
1.00		25.00	30.00	0.23	29	1.00	1.00	0.84	500	2.65	2.65	0.84	0.23	29	9	17.93	19.34	314.29	7857.14	267.05	395.97
																				1018.82	395.97

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1018.82 + 395.97) / 2.5 Qa,uplift = 1018.82 / 3 + 54.98

Qa,comp.= 565.92 T Qa,uplift = 394.58 T

Say **Qa,comp.= 565.00 T** **Qa,uplift = 394.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.72	200	0.17											
1.20		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								377.14		72.17	
1.20		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								377.14		169.09	
1.20		13.00	16.00	1.12	4	1.00	0.40	1.85	300	2.56								377.14		70.35	
1.20		16.00	18.00	0.21	30	1.00	1.00	1.87	200	3.02								377.14		147.49	
1.20		18.00	24.00	0.21	30	1.00	1.00	0.87	600	3.21	3.21	0.84	0.23	29	9	17.93	19.34	377.14	11314.29	466.90	685.44
																				925.99	685.44

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (925.99 + 685.44) / 2.5 Qa,uplift = 925.99 / 3 + 62.2

Qa,comp.= 644.57 T Qa,uplift = 370.87 T

Say **Qa,comp.= 644.00 T** **Qa,uplift = 370.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.72	200	0.17											
1.20		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								377.14		72.17	
1.20		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								377.14		169.09	
1.20		13.00	16.00	1.12	4	1.00	0.40	1.85	300	2.56								377.14		70.35	
1.20		16.00	18.00	0.21	30	1.00	1.00	1.87	200	3.02								377.14		147.49	
1.20		18.00	25.00	0.21	30	1.00	1.00	0.87	700	3.21								377.14		544.71	
1.20		25.00	26.00	0.23	29	1.00	1.00	0.84	100	3.21	3.21	0.84	0.23	29	9	17.93	19.34	377.14	11314.29	75.78	685.44
																				1079.59	685.44

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1079.59 + 685.44) / 2.5 Qa,uplift = 1079.59 / 3 + 67.86

Qa,comp.= 706.01 T Qa,uplift = 427.72 T

Say **Qa,comp.= 706.00 T** **Qa,uplift = 427.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.72	200	0.17											
1.20		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								377.14		72.17	
1.20		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								377.14		169.09	
1.20		13.00	16.00	1.12	4	1.00	0.40	1.85	300	2.56								377.14		70.35	
1.20		16.00	18.00	0.21	30	1.00	1.00	1.87	200	3.02								377.14		147.49	
1.20		18.00	25.00	0.21	30	1.00	1.00	0.87	700	3.21								377.14		544.71	
1.20		25.00	28.00	0.23	29	1.00	1.00	0.84	300	3.21	3.21	0.84	0.23	29	9	17.93	19.34	377.14	11314.29	227.34	685.44
																				1231.15	685.44

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1231.15 + 685.44) / 2.5 Qa,uplift = 1231.15 / 3 + 73.51

Qa,comp.= 766.64 T Qa,uplift = 483.90 T

Say **Qa,comp.= 766.00 T** **Qa,uplift = 483.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.72	200	0.17											
1.20		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								377.14		72.17	
1.20		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								377.14		169.09	
1.20		13.00	16.00	1.12	4	1.00	0.40	1.85	300	2.56								377.14		70.35	
1.20		16.00	18.00	0.21	30	1.00	1.00	1.87	200	3.02								377.14		147.49	
1.20		18.00	25.00	0.21	30	1.00	1.00	0.87	700	3.21								377.14		544.71	
1.20		25.00	30.00	0.23	29	1.00	1.00	0.84	500	3.21	3.21	0.84	0.23	29	9	17.93	19.34	377.14	11314.29	378.90	685.44
																				1382.71	685.44

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1382.71 + 685.44) / 2.5 Qa,uplift = 1382.71 / 3 + 79.17

Qa,comp.= 827.26 T Qa,uplift = 540.07 T

Say **Qa,comp.= 827.00 T** **Qa,uplift = 540.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

Lateral Load capacity of Pile

BH-A1

52+518

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 24.000 m **Fck = 35.0 N/mm^2** **D = 100 cm**

Bed level	**0.0 m**
Pile cap bottom level	**-2.0 m**
Max. of Liquefaction & Scour Depth	**-2.0 m**

E = Young's Modulus of Pile (Kg/cm^2) = $5000\sqrt{F_{ck}}$ N/mm^2 = 295803.99 Kg/cm^2

I = Moment of Inertia (cm^2) = $\pi xD^4/64$ = 4908738.5 cm^4

K_1 = Constant for Sandy / Normally Consolidated Clay (Kg/cm^3) = **0.490**

T, Relative stiffness factor in Sand $T = \sqrt[5]{\frac{EI}{K_1}}$ = **312.1** cm

For Long Pile If $L_e > 4T$

L1 = = **0.000** cm

$\frac{L_1}{T}$ = 0.00

For Fixed Head Pile

$\frac{L_f}{T}$ = **2.219** From Fig. 4

Lf = 692.65 cm

Equivalent length of cantilever L= $L1+L_F$: 0.00 + 692.64846 = **692.65** cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection .5 cm Q = 26217.22 Kg

= **26.22 T**

Lateral Load capacity of Pile

BH-A1

52+518

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 24.000 m **Fck = 35.0 N/mm^2** **D = 120 cm**

Bed level	**0.0 m**
Pile cap bottom level	**-2.0 m**
Max. of Liquefaction & Scour Depth	**-2.0 m**

E = Young's Modulus of Pile (Kg/cm^2) = $5000\sqrt{F_{ck}}$ N/mm^2 = 295803.99 Kg/cm^2

I = Moment of Inertia (cm^2) = $\pi xD^4/64$ = 10178760.2 cm^4

K_1 = Constant for Sandy / Normally Consolidated Clay (Kg/cm^3) = **0.490**

T, Relative stiffness factor in Sand $T = \sqrt[5]{\frac{EI}{K_1}}$ = **361.2** cm

For Long Pile If $L_e > 4T$

L1 = = **0.000** cm

$\frac{L_1}{T}$ = 0.00

For Fixed Head Pile

$\frac{L_f}{T}$ = **2.219** From Fig. 4

Lf = 801.42 cm

Equivalent length of cantilever L= $L1+L_F$: 0.00 + 801.41574 = **801.42** cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection .5 cm Q = 35097.53 Kg

= **35.10 T**

Section VII: Employer's Requirements

Section VII-12: Appendices

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APPENDIX 1
DRAWING LIST

1. GENERAL

The Tender Documents contains a set of reference/Tender drawings that are applicable to the Contract Works. The Tenderer shall incorporate into the Tender only those drawings from that set which amplify aspects of the Contractor's Technical Proposals. General information drawings will not be included in the Contract. The dimensions mentioned in the tender drawings are indicative and may vary as per the design of the Contractor.

(The soft copy of alignment drawing in AutoCAD Format may be collected for reference only from the office of CPM, HRIDC). The AutoCAD files are for reference purpose only and for the purpose of better understanding of the project and shall not be a part of tender documents and is therefore subject to change of details including levels, finishes etc. No claims whatsoever on account of the AutoCAD files, provided to Tenderer at this stage, shall ever be entertained at any stage.

The List of Drawings issued with the Tender documents is stated in Part-2 Employer's Requirements - Tender Drawings and Documents.

APPENDIX – 2

CONTRACT KEY DATES AND COMPLETION DATE

Key Dates	Weeks from		Description of Stage	Delay Damage for non-achieving the key dates
	LOA	Commencement Date		
Key Date 1	4		Submission of Initial Works Programme with all activities for entire work.	
Key Date 2	10		Preliminary Design & GAD of bridges.	
Key Date 3	10		Submission of Detailed Works Programme incorporating all comments of Engineer, if any, including 2 weeks for review by Engineer.	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 4		6	Submission of preliminary design for S&T, preliminary design for OHE work for Part-1and preliminary design for General Services work for Manesar Station/Yard area Including Manesar Sub- station (11kV/0.44kV)	
Key Date 5		10	Submission of Definitive Design & GFC for civil structures. Submission of final design for phase-1 S&T	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 6		11	Submission of Final design for OHE work for Part-1, preliminary design for Switching Post (SP/SSP) for Part-1, Final design for General Services work for Manesar Station/Yard Area including Manesar Sub- station (11kV/0.44kV)	
Key Date 7		15	Submission of Final design for Switching Post (SP/SSP) for Part-1 and supply of all General Services Material for Manesar Station/ Yard Area including Manesar Sub- station (11kV/0.44kV)	

Key Date 8		18	Supply of all signalling and telecom materials and equipments for phase-1.	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 9		19	Supply of all Switching post Material for Part-1 and submission of preliminary design for OHE and General services work for Part-2	
Key Date 10		21	Installation of 1st 500m of precast retaining wall.	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 11		22	Completion of Foundation work for Part-1, Supply of all type of Steel material (Mast and Portals Components) for Part-1,	
Key Date 12		24	Supply of Contact and Catenary wire only for Part-1, Submission of Final design for OHE work for Part-2, Submission of Preliminary design for Switching Post (SP/SSP) for Part-2, Submission of Final design for General Services work for Part-2	
Key Date 13		25	Submission of final design for phase-2 S&T	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 14		26	Completion of steel Erection (Mast & Portal) & grouting with painting of location numbers for Part-1, Erection of all Switching post Material for Part-1	
Key Date 15		27	Completion of substructure of major bridge no. 147.	
Key Date 16		28	Submission of Final design for Switching Post (SP/SSP) for Part-2,	

			Supply of all General Services Material for Part-2	
*Key Date 17		30	Completion of Signalling and Telecom indoor and outdoor works at Patli Station of IR phase-1 including Signalling /Telecom alteration/modification works at Patli Completion of platform at Sultanpur	
Key Date 18		31	Completion of Cantilever, Guy rod and anti-creep assembly etc. (Completion of pre-wiring activity) for Part-1, Submission of Preliminary design for SCADA work for Part-2	
%Key Date 19		32	Completion of S&T works for providing single line connectivity to Patli station of IR including Signalling/Telecom alteration/modification works at Patli Station Phase-1 works including testing & commissioning of S&T works at Patli Phase 1 and Manesar Stations only Line no. 1	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 20		33	Supply of all Switching post Material for Part-2	
Key Date 21		34	Completion of wiring along erection of balance weight, dropping & clipping including antitheft Charging for Part-1, Completion of Foundation work for Part-2, Supply of all type of Steel material (Mast and Portals Components) for Part-2, Submission of Final design for SCADA work for Part-2	

Key Date 22		35	Commissioning of all OHE work for Part-1, Commissioning of Switching Posts for Part-1	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 23		36	Supply of all signalling and telecom materials and equipments for phase-2.	
Key Date 24		37	Supply of Contact and Catenary wire only for Part-2	
Key Date 25		38	Completion of steel Erection (Mast & Portal) & grouting with painting of location numbers for Part-2, Erection of all Switching post Material for Part-2, Supply of all SCADA Material	
Key Date 26		39	Completion of RCC box barrel of sub-way at New Patli station	
Key Date 27		40	Erection and commissioning of all general services material for Manesar Station/ Yard Area including Manesar Sub- station (11kV/0.44kV), Erection and Testing of all SCADA Material	
Key Date 28		42	Completion of superstructure of major Br No. 147 including placement on bearings, .	
Key Date 29		43	Completion of Cantilever, Guy rod and anti-creep assembly etc (Completion of pre-wiring activity) for Part-2	
Key Date 30		44	Completion of Sultanpur station building and platform including finishing, plumbing etc. in all respect.	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 31		45	Completion of earthwork including blanketing on New Patli (Ch -0.660) to Patli connectivity line	

£Key Date 32		46	Completion of Signalling and Telecom indoor and outdoor works at Manesar Station	
Key Date 33		47	Completion of earthwork including blanketing on New Patli (Ch – 1.280 Km) to Sultanpur connectivity line.	
Key Date 34		48	Completion of wiring along erection of balance weight, dropping & clipping including antitheft Charging for Part-2	
Key Date 35		49	Commissioning of all OHE work for Part-2, Commissioning of all Switching post Material for Part-2 Commissioning of SCADA	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 36		50	Completion of major bridge No 136.	
Key Date 37		51	Completion of end platform at New Patli station.	
#Key Date 38		52	Completion of Signalling and Telecom indoor and outdoor works at New Patli Station.	
@Key Date 39		54	Completion of Signalling and Telecom indoor and outdoor works at Sultanpur Station of IR.	
Key Date 40		56	Completion of island platform at New Patli station	
$Key Date 41		58	Completion of Signalling and Telecom indoor and outdoor works at Patli Station of IR Phase-2 including Signalling / Telecom alteration/modification works at Patli.	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 42		60	Completion of earthwork including blanketing Ch. 55.6 to 61.5 on main line	
Key Date 43		61	Erection and commissioning of all general services material for Part-2	

Key Date 44		62	Completion of New Patli station including finishing, plumbing etc. in all respect.	
Key Date 45		63	Completion of S&T works for providing single line connectivity from New Patli to Patli station of IR Phase-2 and from New Patli to Sultanpur station of IR and entire S&T work of including Signalling and Telecom works at New Patli, Manesar, Patli (Phase-2) and Sultanpur including signalling/telcom alteration /modification works at Patli, Faruq Nagar and Garhi Harsuru Stations of IR and entire Phase-2 works including testing and commissioning.	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 46		74	Trial run for complete section	0.01% of the fixed lump, sum price quoted in schedule 'A' per week of delay for the key date.
Key Date 47		78	Completion of the Works in all respects	

Note-

1. The S&T Phase 1 work includes Completion including Commissioning of S&T works in Manesar Station only Line no. 1 (Including)-Patli Station (Including) of IR single line connectivity.

2. The S&T Phase 2 work includes Completion including Commissioning of balance S&T works covered under scope of C2 Package.

3. Electrical Part 1 work includes Electrification work of Manesar Station/Yard, Manesar to New Patli block section, Patli to New Patli connectivity, Manesar Switching Posts (2 Nos SSP) and General Services work for Manesar Station Building /Yard area.

4. Electrical Part 2 work includes Electrification work of New Patli Station/ Yard, Sultanpur Station/yard, New Patli to Sultanpur block section, New Patli to Manesar block section, New Patli & Sultanpur switching Posts (2 Nos SSP & 01 No SP respectively), General Services work for New Patli, Sultanpur Station Building /Yard area and SCADA work at Sultanpur SP.

5. * Key date 17 is based on the condition that track works at Patli Station Phase 1 shall be completed for S&T works by 31.3.2023.

6. % Key date 19 is based on the condition that Earth work in Patli-Manesar for Single line connectivity (Priority Section) is completed by 10.3.2023.

7. £ Key date 32 is based on the condition that Manesar S&T rooms shall be made available for S&T works by 28.2.2023 and track works at Manesar shall be completed by 30.6.2023.

8. # Key date 38 is based on the condition that track works at New Patli shall be completed for S&T works by 15.10.2023.

9. @ Key date 39 is based on the condition that track works at Sultanpur shall be completed for S&T works by 15.09.2023.

10. $ Key date 41 is based on the condition that track works at Patli IR Phase 2 shall be completed for S&T works by 31.10.2023.

APPENDIX 3
WORKS AREAS

3. WORK AREA (WITHIN ROW) ACCESS DATES

3.1 General

"Works Areas" means the areas of the Site within the Right of Way and any additional areas which may be obtained by the Contractor and agreed by the Engineer as additional working area.

a) The dates on which Work Areas (within ROW) are available to the Contractor for the commencement of the Works are defined as Work Area Access Dates (AD).

b) The Work Area Access Dates that apply to this Contract are stated in terms of days after the Commencement Date of the Works.

c) Where Work Areas are to be made available to the Contractor, they shall be available within the specified day. Where Work Areas are to be vacated, they shall be released not later than midnight on the specified day.

3.2 Work Area Access Schedule

The access to and possession of Works Area (within ROW) shall be made available as per Part A Contract Data of Particular Conditions of the Contract (PCC).

APPENDIX 4

PROJECT CALENDAR

4. GENERAL

4.1. For the Project, the Contractor shall adopt 7 days a week calendar, identical calendar for the purpose of programming and Execution of Works. Official documents shall be transacted during 5 days week - Monday through Friday, except for National (Govt. of India) Holidays.

4.2. The Project Weeks shall be commenced on a Monday. A day shall be deemed to commence at 0001 hour on the morning of the day in question. Where reference is made to the completion of an activity by a particular week, this shall mean by midnight on the Sunday of that week. Requirements for the computation of Key Date are given in Appendix 2 to the Employer's Requirements.

4.3. A 7-day week calendar shall be adopted for various (Work) programme schedules for scheduling purposes. For Project purposes, the presentation shall be in 'Week"' units.

APPENDIX – 5
INTERFACE, COORDINATION AND COOPERATION WITH OTHER PARTIES

5.1 LIST OF CONTRACT PACKAGES IN HORC

S. No.	Package	Name of Work
1.	C-1	Priority Section - Construction of Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous works in connection with laying of New BG Double Railway line of HORC Project from Km 49.7 to Km 55.6 and its connectivity (new BG single line) from proposed Manesar Station of HORC to existing Patli Railway Station of IR Network
2.	T-1	T-1: Laying of Track and track related works including supply of ballast, special sleepers, switches and crossings track fittings but excluding supply of Rails and line Sleepers in connection with laying of New BG Double Railway Line of HORC project from Km 32.00 to Km 61.5 and its connectivities to IR Network from Manesar to Patli Stations and New Patli to Patli & New Patli to Sultanpur Stations.
3.	Br-1	Fabrication, assembly & launching of 1X76.2 m span Open Web Girder (OWG) each over three lines on NH-352W (Pataudi Road) between Manesar and Patli stations including supplying & fixing of H-beam sleepers in connection with laying of New BG Double Railway Line of HORC project at Km 54.498
4.	C-2	Composite Contract Package in connection with laying of New BG Double Railway Line of HORC project for: (i) Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from Km 55.60 to Km 61.50 and its connectivities to IR network from New Patli to Patli & New Patli to Sultanpur including modifications in Patli and Sultanpur station yards,

		(ii) Design, Supply, Installation, Testing & Commissioning of OHE (1x25 kV) and General Electrical services from Km 49.70 to Km 61.5 and its connectivities to IR network from New Patli to Patli & New Patli to Sultanpur including modifications in Patli and Sultanpur station yards and (iii) Design, Supply, Installation, Testing & Commissioning of Signalling & Telecommunication from Km 49.70 to Km 61.5 and its connectivities to IR network from Manesar to Patli and New Patli to Patli & New Patli to Sultanpur including modifications in Patli and Sultanpur station yards.
5.	C-3	Composite Contract Package of Design and Construction of Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works, 1x25 KV electrification works and Signal & Telecom Works in Connection with laying of New BG Double Railway Line of HORC project from Km 29.20 to Km 49.7
6.	C-4	Composite Contract pacakge for Construction of Tunnel including BLT in tunnel portion but exlcuding supply of rails (from Km 24.87 to Km 29.06) and Earthwork, Bridges, Retaining Walls & other miscellaneous Works, 1x25 KV electrification works, Signal & Telecom Works in connection with laying of New BG Double Railway Line of HORC project from Km 24.87 to Km 29.20 and Km 12.00 to 18.00 Km.
7.	C-5	Composite Contract pacakge for Design and Construction of Viaduct (from Km 21.34 to Km 24.87), Earthwork, Viaduct, Bridges, Retaining Walls & other miscellaneous Works, 1x25 KV electrification works and Signal & Telecom Works in Connection with laying of New BG Double Railway Line of HORC project from km 0.00 to km 12.00 and km 18.00 to km 24.87
8.	C-6	Composite Contract Package of Design and Construction of Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works, 1x25 KV electrification works and Signal & Telecom Works in Connection with laying of New BG Double Railway Line of HORC project from Km 61.5 to Km 125.98 and its connectivities from proposed Badsa station of

		HORC to Existing Sultanpur station on IR Network and proposed Mandothi station to existing Asaudha Station on IR network
9.	T-2	Design, Supply and laying of Track and Track related works in connection with laying of New BG Double Railway Line of HORC project from Km 0.00 to Km 24.87, Km 29.06 to Km 32.00 and from Km 61.50 to Km 125.98 including its connectivities from proposed Badsa station of HORC to existing Sultanpur station on IR Network and proposed Mandothi station to existing Asaudha Station on IR Network.

5.2 GENERAL

5.2.1 This Appendix describes the Contractor's responsibilities with regard to interface management and coordination and includes interfacing with other contractors employed by the Employer (referred to as "Interfacing Contractors" hereinafter), and Interfacing Parties including entities such as local authorities, statutory bodies, public utility companies, private service providers, consultants or contractors whether or not specifically mentioned in the Contract. This responsibility is not limited to a particular number of Interfacing Contractors and Interfacing Parties, and all interfaces as required in the Contract are the sole responsibility of the Contractor.

5.2.2 Interfaces internal to the Contract are the sole responsibility of the Contractor and are not covered by this Appendix.

5.3 RESPONSIBILITIES OF THE CONTRACTOR

5.3.1 So as to ensure that the whole Project including Interfacing Contractors' works as well as the Contractor's Works shall be executed in the most efficient manner in the best interest of the Employer, the Contractor shall:

a) Take the lead in the management of the coordination process with Interfacing Contractors and Interfacing Parties.

b) Accord access to the Site and/or services to any related party in the Contract including members of the Interfacing Contractors, Interfacing Parties and the Engineer/Employer.

c) Not impede the work of the Interfacing Contractors and Interfacing Parties and shall accord them all reasonable opportunities and facilities.

5.3.2 The Contractor shall, in accordance with the Works Requirements, coordinate and integrate the:

a) Contractor's own Works under the Contract with the works of the Interfacing Contractors and Interfacing Parties.

b) Works of the Interfacing Contractors and Interfacing Parties.

5.3.3 The Contractor shall comply with any instruction which the Engineer may give. The Contractor's responsibilities shall neither be mitigated nor in any way affected by virtue of similar responsibilities being placed on the Interfacing Contractors. The Contractor shall be responsible for the detailed coordination of his manufacturing, installation, construction, testing and commissioning activities.

5.3.4 The Contractor shall carefully review any pertinent information made available by the Engineer relating to the nature and programming of all related parties' contracts and use such information in his planning of the Works.

5.3.5 The Contractor shall communicate and exchange information directly with the Interfacing Contractors and Interfacing Parties with a copy to the Engineer for information. Information as necessary to fulfil the Contractor's interface obligations shall be directly requested and obtained from the Interfacing Contractors and Interfacing Parties with a copy to the Engineer for information and receipt acknowledged.

5.3.6 The Contractor shall ensure that the Contractor's requirements, including any design inputs to other packages, are provided to all related parties of the Interfacing Contractors and Interfacing Parties before the cut-off dates as identified in the Interface Management Plan to be developed by the Contractor and consented to by the Engineer.

5.3.7 Where other contracts requiring interface are yet to be awarded, the Contractor shall proceed with coordination activities with the Engineer, until such time as the Interfacing Contractors are employed by the Employer.

5.3.8 The Contractor shall take all reasonable steps to ensure that the Works are integrated with the manufacture, installation, execution and testing of such other works and shall in particular but without limitation to:

a) Comply with any instruction which the Engineer may give for the integration of the Works with the design of any other part of the Project;

b) Consult, liaise and cooperate with those responsible for carrying out such other works, including where necessary, in the preparation of the respective designs and drawings, thepreparation of coordinated programmes, method statements, coordination drawings and specifications together with arrangements of service priorities and zoning to coordinate the priorities of tasks and division of the area together with the items mentionedpreviously; and

5.3.9 Participate in the Integrated Testing and Commissioning of the Works with the Interfacing Contractors and Interfacing Parties and demonstrate to the satisfaction of theEngineer that the Works have been constructed in a manner compatible with the works ofthe Interfacing Contractors and Interfacing Parties.

5.3.10 There shall be a continuous requirement for coordination by the Contractor between Interfacing Contractors/Interfacing Parties.

5.3.11 During the Works the Contractor shall provide within the Site the facilities including, but not limited to, staging, storage and unloading, and temporary storage areas for the temporary use of Interfacing Contractors and/or Interfacing Parties, as may reasonably be required during the construction/installation and commissioning process. Where separate locations need to be provided for each of the Interfacing Contractors and/or Interfacing Parties, prior to construction commencing, specific details shall be coordinated and agreed between the Contractor and the Interfacing Contractors and/or Interfacing Parties.

5.3.12 The Contractor shall attend meetings with Interfacing Contractor and Interfacing Parties (if necessary) and raise/provide correspondence in this regard in accordance with the Works Requirements and/or as instructed by the Engineer. The identity of the Interfacing Contractor(s) and/or Interfacing Parties may not be known before the execution of the Contract but this shall not be a grounds for the Contractor to object to the subsequent appointment of any Interfacing Contractor and/or Interfacing Party.

5.3.13 The Contractor shall in accordance with the requirements of the Contract and instructions of the Engineer coordinate his own Works with the works of Interfacing Contractors and/or Interfacing Parties strictly adhering to the Coordination and Interfacing Programme and shall accord the Interfacing Contractors and/or Interfacing Party's all reasonable opportunities for carrying out their works.

5.3.14 If the Contractor suffers delay by reason of failure caused by any Interfacing Contractor/Interfacing Party to meet the specified installation interfacing and/or coordination completion dates resulting in delay beyond the extent which could be reasonably foreseen by an experienced contractor at the time when the Coordination and Interfacing Programme is formulated and consented by the Engineer, then the Engineer shall take such delay into consideration in determining any extension of time to which the Contractor is entitled under the Contract.

5.3.15 If any act or omission of the Contractor, whether directly or indirectly, results in the delay in execution of the works of an Interfacing Contractor and/or Interfacing Party associated with the execution of the project, the matter shall be settled by the Engineer

5.3.16 All requests for information or clarification, acknowledgement of receipt of information and any official communication between the Contractor and Interfacing Contractors/Interfacing Parties shall be made in writing with a copy to the Engineer for information.

5.3.17 The Contractor shall notify the Engineer in writing of any problems encountered in obtaining necessary information and/or lack of cooperation from an Interfacing Contractor/Interfacing Party. In the event that the Engineer considers that the resolution of an interface is not proceeding satisfactorily, the Engineer shall review the matter and establish a coordinated plan directing the Contractor and the Interfacing Contractors/ Interfacing Parties regarding the required action.

5.3.18 The Contractor shall prepare minutes recording all the matters discussed and agreed at all the meetings.

5.3.19 The Contractor shall ensure that copies of all correspondence, drawings, meeting minutes, programmes, etc. relating to the Contractor's coordination and interfacing meetings with the Interfacing Contractors and Interfacing Parties or the sharing of correspondence, drawings, programmes, etc. are issued to all concerned parties and the Engineer no later than seven days from the date of such meetings and the date of issue of such correspondence, drawings, programmes, etc.

5.3.20 Should it appear to the Engineer that the Three Month Rolling Programme does not conform with the Coordination and Interfacing Programme, the Contractor shall be required to revise all such programmes so as to conform to the approved Contractual Works Programme.

5.4 INTERFACE ADMINISTRATION SYSTEM

5.4.1 The Contractor shall establish an Interface Administration System (the "IAS") and participate in the activities with the Interfacing Contractors and Interfacing Parties. The IAS shall include, but not be limited to, the following provision of:

a) An Interface Manager who shall be responsible for and the authority to resolve interface matters to the satisfaction of the Engineer;

b) The necessary support team for the IAS;

c) Procedures and details for response to, confirmation of and making written agreements with regard to interfaces;

d) Details of the arrangement for attendance at coordination and interface meetings (including those that may be arranged by Interfacing Contractors, Interfacing Parties or the Engineer). The representatives of Contractor, Interfacing Contractors and Interfacing Parties shall be empowered to make agreements on coordination and interfaces. The Contractor shall arrange regular meetings for the Engineer to monitor the status of coordination and interfaces and may arrange special coordination and interface meetingsas may be necessary to resolve specific issues. The Engineer can require the Contractor to arrange a special coordination and interface meetings if necessary. The Contractor may request assistance from the Engineer to arrange coordination and interface meetings on particular subjects;

e) Details to the Engineer of regular status information and/or details of coordination and interfaces including copies of relevant correspondence and material; and

f) Details to the Engineer of access to information for the purpose of conducting audits on interface compliance and for confirming that interface coordination and interface management is proceeding consistently with the requirements of the Contract.

5.4.2 CONSTRUCTION INTERFACE

a) Construction coordination and interface shall be required throughout the duration of the Contract and shall commence from the time of the LOA until the Taking Over of the Works.

b) The Contractor shall coordinate and interface with the Interfacing Contractors and Interfacing Parties to execute the respective construction activities efficiently.

c) The Contractor shall cooperate with Interfacing Contractors and Interfacing Parties on all Site- related matters including but not limited to Site access and occupation, safety, verification of work compatibility and survey control, etc. The Contractor shall advise the Interfacing Contractors and Interfacing Parties in advance when a construction item is ready for site inspection to verify compatibility with the Interfacing Contractors' and Interfacing Parties' needs and shall facilitate access to the Site for the Interfacing Contractors and Interfacing Parties.

d) At or near the completion of the construction of any interface-related element of the Contractor's Work, the Contractor shall:

(1) Advise the Interfacing Contractors and Interfacing Parties that the as-constructed interface-related Works can be inspected and provide the necessary access to the Site and its occupation.

(2) Agree in writing to the Interfacing Contractors and Interfacing Parties, and as consented bythe Engineer, on the adoption of any Interfacing Contractors' and/ or Interfacing Parties' applicable comments on the constructed Works.

e) On advice from the Interfacing Contractor or Interfacing Party that an as-constructed interface- related element is ready for inspection, the Contractor shall:

f) Conduct on-site inspections of the Works elements and give comments in writing to the Interfacing Contractor and/or Interfacing Party.

g) Agree in writing to the Interfacing Contractor or Interfacing Party that the as-constructed Works meet the coordination and/or interface requirements.

h) Prior to applying for a Taking-Over Certificate, the Contractor shall obtain written confirmation from each Interfacing Contractor and each Interfacing Party, that the interface elements meet the requirements of the Interfacing Contractors and Interfacing Parties. If any Interfacing Contractor or Interfacing Party withholds such confirmation, the Engineer shall decide on further action, as requested by the Contractor prior to the issue of a Taking-Over Certificate.

i) Where Contractor's Works are identified as failing to meet the requirements of the Contract and such shall impact the Interfacing Contractors' works or Interfacing Parties' works, the Contractor shall submit the proposed remedial measures to the Engineer for review and shall copy the same to the Interfacing Contractors and/or Interfacing Parties.

j) The Contractor shall coordinate and interface with the Engineer with respect to all construction/installation activities and shall follow the Engineer's instructions for requesting access for such activities.

k) The Contractor shall undertake construction/ installation in accordance with the approved (Contractual) Works Programme.The Contractor shall coordinate and interface with Interfacing Contractors and/or Interfacing Parties for the planning and execution of the testing and commissioning activities.

5.5 INTERFACE DOCUMENTS

5.5.1 Preparation of Interface Documents

The Contractor shall prepare as required the following coordination and interface documents which shall be used to completely define the Contractor's coordination and interface details:

a. Interface Table;

b. Coordination and Interfacing Programme; and

c. Interface Management Plan (IMP).

5.5.2 These coordination and interface documents shall be submitted for review by the Engineer in order to obtain the Engineer's Approval. For all subsequent updates, these documents shall be submitted to the Engineer for information, review and comment. A summary of principal issues with suitable solutions shall be included in each Monthly Progress Report.

5.6 INTERFACE TABLE FOR SUPPLY AND INSTALLATION ITEMS

5.6.1 The Interface Table shall include at least (but without limitation) the items related with the Contractor's Contract described in Appendix5 B . The Interface Table, which describes the relationships between the Contractor and Interfacing Contractors and/or the Interfacing Parties and their roles and responsibilities, shall be submitted to the Engineer for consideration after further development of Interface Table.

5.6.2 The Interface Table shall indicate the demarcation of scope of responsibilities between the Contractor and the Interfacing Contractors and the Interfacing Parties.

5.6.3 Within sixty (60) days of notification from the Engineer of the identity of each Interfacing Contractor, the Contractor shall develop and submit to the Engineer an Interface Table that is mutually acceptable to both the Contractor and the Interfacing Contractors and Interfacing Parties.

5.7 COORDINATION AND INTERFACING PROGRAMME

5.7.1 The Contractor shall prepare and submit a Coordination and Interfacing Programme to the Engineer in accordance with the Works Requirements and/or as instructed by the Engineer as detailed below.

5.7.2 The Coordination and Interfacing Programme shall be submitted to the Engineer for consent within sixty (60) days from the Letter of Acceptance (LOA) to allow for checking and monitoring by the Engineer.

5.7.3 The Coordination and Interfacing Programme shall include detailed activities describing all aspects of the works of Interfacing Contractors and Interfacing Parties to meet all Sections or Milestones given in the Contract and be clearly linked to other programmes such as the (Contractual) Works Programme (or Work Segment Programmes) to streamline the Works and the works of the Interfacing Contractors and Interfacing Parties.

5.7.4 The Coordination and Interfacing Programme shall indicate the physical areas to which the Interfacing Contractors and Interfacing Parties require access, with access dates, durations required and the required degree of completion of the Works prior to the access dates by Interfacing Contractors and Interfacing Parties.

5.7.5 It is the Contractor's responsibility to ensure timely coordination with the Interfacing Contractors and Interfacing Parties to review, revise and finalise his Coordination and Interfacing Programmes so as not to affect the progress of the Works and/or the works of the Interfacing Contractors and Interfacing Parties.

5.7.6 The Contractor shall note that the following conditions apply to the works of the Interfacing Contractors and/or Interfacing Parties:

a) The Interfacing Contractors and/or Interfacing Parties shall not have exclusive access to any part of the Site except with the consent of the Engineer;

b) The Contractor shall take note that concurrent time allocations for certain areas may be given to more than one Interfacing Contractors and or Interfacing Parties. The Contractor

shall coordinate the Works in such areas with the works of the Interfacing Contractors and/or Interfacing Parties and report to the Engineer for his review and consent;

c) The absence of a Coordination and Interfacing Programme date or construction/ installation period for the Interfacing Contractors and/or Interfacing Partiesin a specific area shall not prejudice the right of the Engineer to establish a reasonable Coordination and Interfacing Programme date or construction/installation period for thatarea;

d) The Contractor and the Interfacing Contractors shall comply with the Sections or Milestones and other successive activities specified in the Coordination and Interfacing Programme

5.8 INTERFACE MANAGEMENT PLAN (IMP)

5.8.1 The Contractor shall develop and submit to the Engineer, within sixty (60) days from the LOA, an IMP for all interface issues that may arise during the construction, testing and commissioning of the Works, in consultation with the Interfacing Contractors / Interfacing Parties and the Engineer. The IMP shall allow adequate time periods for each of the Interfacing Contractors/ Interfacing Parties and the Contractor to install their Plant, equipment and Materials in the designated areas.

5.8.2 The IMP shall:

a) Identify all the systems and sub-systems and facilities with interfacing requirements;

b) Define as far as possible the authority and responsibility of the contractor's, theInterfacing Contractor's and interfacing party's involved in interface management and development;

c) Identify the information to be exchanged, together with the management and technical skills required for the associated development of the works, at each phase of the contractor's and Interfacing Contractor's and Interfacing Parties' project life-cycles;

d) Address the Contractual Works Programme (or Work Segment Programmes) of the Contract to meet the Contractor's sections or Milestones and the Interfacing Contractors' sections or milestones and highlight any programme risks requiring the Engineer's attention;

e) Include relevant consideration of the requirements of " Environment Social Health and Safety Manual" as described in Appendix 13;

f) Address the supply, installation, testing and commissioning programmes of the Contractto meet Interfacing Contractors' Sections or Milestones, and highlight any programme risks requiring management attention; and

g) Indicate dates for commencement and completion of each principal activity by the Contractor and those of the Interfacing Contractors and Interfacing Parties, including delivery and installation of Plant, equipment and Materials.

5.8.3 After the Engineer reviews and issues approval to the IMP, the Contractor shall execute the Works accordingly.

5.8.4 The Contractor shall raise and apprise the Engineer immediately of any difficulty in developing a mutually acceptable IMP.

5.8.5 Employer's / Engineer's Input

a) The Employer or Engineer or both will coordinate the activities of the Contractor with reference to interfacing with third parties during all the phases of the Contract.

b) The Employer or Engineer, within the scope of the relevant Contract provisions, may assist the Contractor in the following fields:

(1) Coordination and interface with state and local authorities for the timely receipt of required permits, certificates and approvals related to the construction process;

(2) Coordination and interface with state and local authorities for the implementation of acquisition procedures for any additional land areas that may be required by the Contractor; and

(3) Any other fields or activities related to the Contract as may be required for the purposes of facilitating the Contractor's performance.

c) The Engineer shall conduct a coordination and interface meeting with the interfacing parties every fortnight with the Contractor which may be attended by the Employer. The primary objective of the meeting will be to review progress of the coordination and interface activities.

d) The support and assistance of the Employer and/or the Engineer shall not release the Contractor of any of his obligations under this Contract.

5.9 DETAILED INTERFACE DESCRIPTION (DID)

5.9.1 The DID is the document that provides a clear technical description of each of interface in the Interface Table.

5.9.2 Any revision to the DID shall be mutually acceptable to both the Interfacing Contractors and Interfacing Parties. Only then shall this be submitted to the Engineer for his review.

5.9.3 DID shall contain the following items:

S. No.	Detailed Interface Description
1	Item number and name of interface in Interface Table
2	Name of the Contractor and Interfacing Contractor/Interfacing Party
3	Confirmation Table of both the Contractor and Interfacing Contractor/Interfacing Party
4	Creation date and modification date
5	Correction history

6	The following items shall be described: physical interface, functional interface, protocols, software and data interface, naming conversion, design constrains, environmental conditions, and drawings
7	Reference Documents

5.10 CONTENTS OF INTERFACE MANAGEMENT PLAN

Interface Management Plan (IMP) should be prepared including necessary contents referring Table 1. The intention of each section is described by the text inside angle brackets.

Table1: Sample Contents of Interface Management Plan

1	Introduction	
	1.1	Purpose of Document <Describe the methodology to be adopted by the Contractor in managing all interface issues >
	1.2	Overview <Project overview of the Contractor and the Interfacing Contractor>
2	Resource Management	
	2.1	Organization and Roles & Responsibilities
	2.2	Resource Requirement <Detailed description of the manpower, tools, logistics shall be included in this section>
3	Interface Requirements	
	3.1	Allocation of Interfacing Requirements <This is an introduction to Section3.2>
	3.2	Interface Description between Contractors <Task Allocation Table (TAT) shall be included in this section>
	3.3	Areas of Concern <Process for managing the interface concern>
4	Process Management	
	4.1	Change of Interfacing Requirement <The process for the management of interface requirement change shall be addressed in this section.>

	4.2	Verification and Validation of Interfacing Requirements <The approach to be adopted by the Contractor to manage verification and validation of interfacing requirements shall be addressed in this section.>
	4.3	Testing and Commissioning on Interfaces <The approach to be adopted by the Contractor for the management of Interface in the Testing and Commissioning stage shall be addressed in this section.>
	4.4	Quality Procedures <All Contractor's internal quality procedures applicable for the interface management shall be listed here.>
	4.5	Systems Assurance Plans <Considered requirement of the Systems Assurance.>
5	Document Management	
	5.1	Reference Documents <All applicable reference documents shall be listed in this section.>
	5.2	Structure of Reference Documents <The Structure of reference documents shall be addressed in this section.>
	5.3	Version Control of Interface Documents <Configuration management of interface documents shall be addressed in this section.>
6	Communication	
	6.1	Terms of Reference of Interface Meetings <The terms of reference of interface meetings shall be addressed here.>
	6.2	Exchange of Information between Contractors <The process for the exchange of information between the pair-wise contractors shall be stated here.>
	6.3	Submission to Employer <The approach to be adopted by the pair-wise contractors on the Submission of the Interface Management Plan to Employer shall be described here.>
	6.4	Request for Employer Attention

		<The criteria and methodology on requesting for Employer attention shall be mentioned here.>
7	Interface Hazard Management	
	7.1	Strategy and Approach
8	Programme	
	8.1	Key Activities <Include schedule of meetings, schedule of exchange of information, etc.>
	8.2	Section and Milestone <Include Design Freeze Dates, Integrated Test Dates, Critical Items dates, etc. Should include reference to appropriate programmes so that any future changes in programme date need not result in resubmission of this plan for approval.>
	8.3	Critical Items/ Critical Paths <This section shall highlight all the critical items and critical paths to the Employer.>

5.11 INTERFACE TABLE

5.11.1 Interface Table between C-1 and C-2

S. No	Interface Items	Requirements
1.	Providing access to site for C-2 Contractor for OHE and S&T works.	C-1 Contractor shall complete the works and provide access to C-2 Contractor.
2.	Cross Section of bank	C-1 Contractor shall provide stepped profile of bank at junction to C-2 Contractor.
3.	Construction of S&T Rooms	Design & Construction of S&T Rooms at Manesar to be shared with C-2 contractor
4.	Provision of cable duct/pit/ cut out in wall	Provision of cable duct/pit/ cut out in wall in S&T Room(s) in Manesar Station Building
5.	Cable passage requirement on Major Bridges	Provision of duct/channel on both sides of track on top of bridges for laying GI pipes/ Troughs/ DWC pipes for cable protection between Manesar and IR station Patli and at Manesar Station

6.	Track/Road/Platform crossing of cables	Provision of route for Track/Road/Platform crossings of S&T Cables at Manesar, and between Manesar & IR station Patli.
7.	Electrical General Services Works	C-1 Contractor shall allow Electrical General Services Works parallel to Civil works at Manesar Station Building/yard.

5.11.2 Interface Table between Br-1 and C-2

S. No	Description	Remarks
1.	Providing access to site for C-2 Contractor for OHE and S&T works.	Br-1 Contractor shall complete the works and provide access to C-2 contractor for OHE and S&T works.

5.11.3 Interface Table between C-2 and T-1

S. No	Description	Remarks
1.	Handing/Taking over of site for laying of track	C-2 Contractor shall complete the work of formation and bridges as per drawings and handover site to T-1 Contractor for laying of track.
2.	Providing access to site for C-2 Contractor for OHE and S&T works.	T-1 Contractor shall complete the works and provide access to C-2 contractor for OHE and S&T works.
3.	Point Machines installation and Installation of Second drive arrangement if any	T-1 Contractor shall make provision of second drive arrangement if any for thick web switches/turnout and install the same and will coordinate/attend Points and Point fittings as required by Signalling system for points machine installation and commissioning at Manesar and IR station Patli as per Indian Railways Signal Engineering Manual. Through packing of points and crossings at Manesar and IR station Patli
4.	Testing of Points	T-1 shall jointly test the points with C-2 Contractor and rectify any track-related defects identified during testing as per IRPWM/IRSEM

5.	Marking centre-line of track, centre line of track rail level and locations of stock joints	T-1 shall provide the centre-line of track, centre line of track rail level and Stock-Joint locations for OHE and S&T works

5.11.4 Interface Table between C-2 and C-3

S. No	Description	Remarks
1.	Interlocking of block section	Configuration & Testing of BPAC and Telephone communication between Dhulawat and Manesar Stations
2.	Telecommunication work	• Configuration & Testing of DTMF Control communication between Dhulawat and Manesar • Configuration & Testing of Emergency communication between Dhulawat and Manesar • Configuration & Testing of IP based exchange telephone between Dhulawat and Manesar • Configuration & Testing of Clock system between Dhulawat and Manesar • Configuration & Testing of OFC communicatioin between Dhulawat and Manesar • Configuration & Testing of Quad communication between Dhulawat and Manesar
3.	Overlap arrangement at interface point	Coordinate with C-3 and C-6 Contractors for overlap arrangement at interface point and provide electrical continuity for OHE works

5.11.5 Interface Table between C-2 and C-6

S. No	Description	Remarks

1.	Cross Section of bank	C-1 Contractor shall provide stepped profile of bank at junction to C-2 Contractor.
2.	Interlocking of block section	Configuration & Testing of Block instrument interlocking and BI Telephone communication between Badsa and New Patli
3.	Interlocking of block section	Configuration & Testing of BPAC and Telephone communication between Badsa and New Patli
4.	Telecommunication work	• C-6 Contractor shall provide VoIP based Train control communication equipment at Manesar IMD/SSC New Delhi and IP phones at other all stations/TSS/SP/SSP/ Other required places. Emergency communication and Voice recording system is also its part. • Existing DTMF Control communication for C-2, C-3, C-4 and C-5 packages shall be changed with the VoIP based Train control communication. • Configuration & Testing of VoIP based Train Control communication including emergency communication from Manesar to all stations/TSS/SSP/SP/ other rquired places. • Configuration & Testing of IP based exchange telephone between Badsa and New Patli • Configuration & Testing of Clock system between Badsa and New Pali • Configuration & Testing of OFC communicatioin between Badsa and New Patli • Configuration & Testing of Quad communication between Badsa and New Patli

5.11.6 Interface Table between C-2 and Maruti siding electrical works Contractor.

S. No	Description	Remarks
1.	Overlap arrangement at interface point	Coordinate with Maruti siding electrical works Contractor for overlap arrangement at interface point and provide electrical continuity for OHE works.

5.12 Interface requirements specified above are by no means exhaustive and it remains the Contractors' responsibilities to develop, update and execute jointly Interface Requirements during design & throughout the execution of Works, to ensure that:

i. all interface issues between the Contracts/Systems are satisfactorily resolved;
ii. design, supply, installation and testing of equipment are fully co-ordinated; and
iii. all equipment and facilities supplied under the Contracts are fully compatible with each other, whilst meeting the requirements of the respective Specifications.

5.13 Interface Requirements with Indian Railway at Patli & Sultanpur

i. Contractor shall liaison with designated authorities in Indian Railway to design Signalling & Telecom arrangement for/interfacing/serving both Indian Railway and HORC. The design so finalised shall be submitted to Engineer for review. The contractor shall execute the so reviewed S&T Arrangement for stations serving both Indian Railway and HORC.
ii. Contractor shall prepare the site plans/equipment layout plan for SER/TER and power supply equipment rooms in coordination with the IR.
iii. Contractor shall also provide additional space at these SER, TER and Power Supply Equipment rooms if required.
iv. Contractor shall liaison with designated authorities in Indian Railway to design Signalling and Telecom plans/Arrangement including approval of SIP/VDU diagram/Selection Table/Interface circuit/Logic circuits etc./Quad cable allocation chart/OFC channeling plan for HORC.
v. Contractor shall liaison with designated authorities in Indian Railway in respect of OHE modification work, SP work, General services work and SCADA work to be undertaken at Sultanpur Station of IR.
vi. Contractor shall liaison with designated authorities in Indian Railway in respect of Electrical feed extension from Patli Station of IR and respective equipment setting at TSS of IR.

APPENDIX 6

PROGRAMME REQUIREMENTS

6. GENERAL

6.1 PURPOSE OF PROGRAMME

6.1.1 There are two primary purposes for the requirement of Programme (Scheduling) information described in this document:

a) Evaluation of tender.

b) Status Reports during Construction

To provide the Engineer with status reports for managing, monitoring and coordinating the awarded contracts during their execution within the overall multi-contract project schedule.

The requirements are organized in two stages. The first stage is a requirement for all Bidders and shall be submitted as part of Bid. The second stage is a requirement of the Employer and describes a series of reports to be submitted by the Contractor to the Engineer during the execution of contract, following the award of contract.

6.1.2 The Tenderer/Contractor shall programme his work at all times to meet the Key Date stated in Appendix 2 to the Employer's Requirements and the specified interface periods for the design and installation of the Works with those of the Interfacing Contractors and shall during the progress of the Works constantly monitor his progress against the programmes described below.

6.1.3 The Tenderer/Contractor shall include in all programmes his work obligations towards shared access, shared Site areas and other coincident or adjacent Works Areas.

6.1.4 The Works Programme, and all more detailed or revised versions, shall be submitted to the Engineer in hard copy as well as soft copy for his consent in accordance with the provisions of the GC.

6.2 METHODOLOGY

6.2.1 The computerized Critical Path Method (CPM) network using the Precedence Diagramming Method (PDM), has been selected by the Employer as the technique for contract management system and in co-coordinating the multi-contract project. This technique shall also be employed by the Tenderer in preparing their Tender submissions and by the Contractor in their Construction Stage submissions.

6.2.2 Unless otherwise agreed by the Engineer, all programmes submitted by the Contractor shall be produced using computerized Critical Path Method (CPM) Networks developed implementing the Precedence Diagramming Method (PDM) with Cost Loaded Charts and Tables.

6.2.3 The Contractor shall implement and use throughout the duration of the Contract, a computerized system to plan, execute, maintain and manage the planning, design, pre-construction, construction, and sub-contracts in executing the CPM scheduling by PDM. The reports, documents and data provided shall be an accurate representation of the current status of the Works and of the work remaining to be accomplished; shall provide a sound basis for identifying problems, deviations from the planned works, and for making decisions; and shall

enable timely preparation of the same for presentation to the Engineer.

6.3 PROGRAMME MANAGEMENT SOFTWARE

6.3.1 CPM programming software used shall be Primavera Project Planning (P6) Program - Ver 21.12 or later. Any other compatible system capable of direct file interchange capability with software program used by the Employer - Primavera (P6), Ver 21.12 or later can be used with Engineer's consent. Scheduling software and relevant instruction manuals, licensed for use in connection with the contract, shall be provided by the Contractor according to the Employer's specifications

6.3.2 The Tenderer may use a system other than Primavera but will be required to demonstrate that full electronic data transfer to Primavera is available and that the various levels of reporting and coding capabilities are at least equivalent to Primavera. Compatibility and comparable performance between Primavera and the Tenderer's proposed system shall be demonstrated in his Tender submission. Should compatibility not be demonstrated to the Employer's satisfaction the Contractor shall utilise Primavera for development, stat using, updating and revision of all the Programmes during the duration of the Contract. Upon the Engineer's consent of a system other than Primavera, the Contractor shall supply the Engineer with an original licensed copy, including manuals and approved training of the software and any subsequent versions thereof at no extra cost.

6.4 POST CONTRACT AWARD

6.4.1 The Contractor shall develop his Tender Programme into the Initial Works Programme including an outline Narrative Statement and submit its more detailed version as per the key dates mentioned in Appendix 2 to the Engineer for approval.

6.4.2 The first Three Month Rolling Programme shall be submitted within thirty (30) days of the date of commencement and all subsequent editions shall accompany the Monthly Progress Report. The Monthly Progress Reports shall also include a Programme Update as described below. These programmes shall subsequently be updated as described below.

6.4.3 The Contractor shall take into account the programmes of Interfacing Contractors while finalizing the Works Programme .It is the Contractor's responsibility to ensure timely co-ordination with the Interfacing Contractors to review, revise and finalise his Work Programme so as not to affect the progress of Works/ and or the works of the Interfacing Contractors. The Detailed Works Programme when approved by the Engineer after incorporating requirement of Interfacing Contractors shall form the Baseline Programme against which actual progress of the Contract shall be reckoned. As the work progresses, it may be necessary to update/ revise the Baseline programme but such updating shall only be carried out with the prior consent of the Engineer or when directed by them.

6.4.4 For Initial & Detailed Work Programme submission, one (1) original and three (3) copies each of the following Programmes and Reports shall be submitted to the Engineer:

a) Programme: Baseline CPM Network

b) Programme: Baseline Milestone based Cost Activity Schedule

c) Baseline Schedule Report

d) Narrative

e) Baseline Physical Progress 'S' curve

f) Baseline Resource Charts

6.4.5 The Engineer shall review and comment on the Contractor's programmes and information submitted under this Clause. The Engineer will confirm his consent or otherwise of the submissions within thirty (30) calendar days.

6.4.6 The Engineer shall require the Contractor to re-submit within thirty (30) calendar days if he is of the opinion that the programmes and information submitted by the Contractor is unlikely to meet the Contract Key Date.

6.4.7 If in the opinion of the Engineer, any of the Contractor's revised programmes or Baseline Schedule Report is not acceptable, it shall be construed as a failure of the Contractor to meet the Contract Key Date.

6.4.8 Notwithstanding the above, the Engineer may at any time during the course of the Contract require the Contractor to reproduce the computer-generated Baseline Schedule Report described above to reflect actual activity dates and generate schedules based upon "what if" statements. The initial computer-generated report after receiving the Engineer's consent will serve as the base against which the contract progress will be measured. Any changes to the Report reflected in subsequent Baseline Schedule Reports shall also require the Engineer's consent.

6.4.9 Failure to include any element of work required for performance of the Contract shall not relieve the Contractor from completing all works required under the Contract to achieve the original or any extended key completion date.

6.5 WORKS PROGRAMME

6.5.1 The Works Programme shall show the Contractor's plan for organising and carrying out whole of the Works.

6.5.2 The Works Programme shall be a computerised Critical Path Method (CPM) network developed using the Precedence Diagramming Method (PDM) and shall be present in bar chart and time-scaled network diagram format to a weekly or monthly time scale.

6.5.3 Tasks in the Works Programme shall be sufficiently detailed to describe activities and events that include, but are not limited to, the following:

a) Key Date,

b) all physical work to be undertaken in the performance of the Contract obligations, including Temporary Works,

c) the requested date for issue of any drawings or information by the Engineer,

d) incorporation of principal aspects of the Design Submission Programme,

e) procurement of major materials and the delivery and/or partial delivery date on-Site of principal items of Contractor's Equipment,

f) any off-site work such as production or pre-fabrication of components,

g) installation of temporary construction facilities,

h) interface periods with Interfacing Contractors or utility undertakings,

i) design, supply and/or construction activities of sub-contractors,

j) any outside influence which will or may affect the Works.

6.5.4 The Works Programme shall show achievement of all Key Date.

6.5.5 Activity descriptions shall be unique, describing discrete elements of work. Any activity creating an imposed time or other constraint shall be fully defined by the Contractor.

6.5.6 The Works Programme shall be organised in a logical work-breakdown-structure including work stages and phases, and shall clearly indicate the critical path(s).

Each activity in the Works Programme shall be coded to indicate:

a) Activity ID and Activity Code.

b) The Engineer may request additional activity coding to the extent available without restraint to the Contractor's utilisation of the programme software. When requested the Contractor shall add the required additional coding to the Programme. The Contractor shall use additional code fields as requested to comply with the requirements and for the use of the Contractor.

6.5.7 Activity duration shall not exceed two (2) weeks, unless otherwise consented to by the Engineer, except non-construction activities such as submittals, submittal reviews, procurement and delivery of materials or equipment and concrete curing. The Contractor shall submit a Programme/Project Calendar cross reference clearly indicating the allowance for holidays.

6.5.8 The Works Programme, in each submission, shall be accompanied by an Activity Report and a Narrative Statement as described below in both electronic and hard copy format (time scale logic diagrams in A1 size, reports in A4 size).

6.5.9 Activity Report shall list all activities, and events in the Works Programme, sorted by activity identification number.

The Activity Report shall include the following for each activity and event:

a) activity identification number and description,

b) duration expressed in Days,

c) early and late start, & early and late finish dates. Planned start and finish dates,

d) calculated total float and free float,

e) predecessor(s) and successor(s), accompanying relationships and lead/lag duration,

f) imposed time or date constraints,

g) calendar.

6.5.10 Narrative Statement

The Narrative shall be a comprehensive statement of the Contractor's plan and approach for the execution of the Works and the achievement of Key Date, handover dates, submission dates and any intermediate dates. It shall incorporate outline method statements in respect of major items of work including construction sequences and primary item of plant, Construction Equipment, Temporary Works and the like. It shall fully explain the reasons for the main logic links in the Programme and include particulars of how activity durations are established. This shall include estimated quantities, production rates, hours per shift, work days per week and a listing of the major items of Construction Equipment planned for use on the project.

Activities, which may be expedited by use of overtime or additional shifts, shall be identified and explained. A listing of holidays, and other special non-work days being used for the computer reports shall be included.

6.5.11 Baseline Physical Progress 'S' Curve

The Contractor shall also submit a forecast Cumulative Physical Progress 'S' curve based on the time-phased distribution of cost in the CPM Network Logic Diagram, expressed in percentage terms. This 'S' curve shall be generated from the computerized CPM Network Logic Diagram.

6.5.12 Baseline Resource Charts

The Contractor shall also submit a Resource Charts, generated from the Contractor's CPM Network Diagram, showing the anticipated manpower and main Construction Equipment usage during the execution of the Project.

As an additional monitoring facility, indicator resources shall be assigned to relevant activities for the major items of work. Indicator resources shall be directly allocated for excavation (cum.), piling (no.), diaphragm walling (m.), concrete (cum.), tunnel lining (m), etc. Resource indicators may be input as a daily rate, expected required rate, or as an activity total in the relevant units. These are purely indicative quantities and do not form part of contract.

6.5.13 All submissions of proposed Works Programmes subsequently, after approval of the Initial Works Programme, shall include the actual physical progress of work and forecast of the remaining work. Actual progress shall be stated in percent complete, remaining duration, and actual start and finish dates for each activity in the Works Programme.

6.6 INITIAL WORKS PROGRAMME

6.6.1 The Initial Works Programme submitted as under Clause 6.4 above need not include the full details. It should be a condensed version with combined activities of longer. The outline Narrative Statement shall be in sufficient detail to clearly show the Contractor's intention.

6.6.2 After the Engineer's consent to the Initial Works Programme, the Contractor shall submit to the Engineer an expanded and more detailed version of the Initial Works Programme containing all of the information and detail required as per Key Date mentioned in Appendix 2.

6.6.3 Such submission shall make use of the Tender Programme submitted earlier but refined to include the best estimates of dates for the work of Interfacing Contracts which has impact on the Contractor's programme. Such programmes shall be amended subsequently to incorporate the actual dates/ schedule of the affecting contracts. It is the Contractor's responsibility to ensure timely co-ordination with the Interfacing Contractors to finalise the Initial Programme, without affecting progress of the work.

6.7 WORKS PROGRAMME REVISIONS

6.7.1 The Contractor shall immediately notify the Engineer in writing of the need for any changes in the Works Programme, whether due to a change of intention or of circumstances or for any other reason. Where such proposed change affects timely completion of the Works or any other Key Date the Contractor shall within fourteen (14) days of the date of notifying the Engineer submit for the Engineer's consent its proposed revised Works Programme and accompanying Narrative Statement. The proposed revised Works Programme shall show the sequence of operations of any and all works related to the change and the impact of changed

work or changed conditions.

6.7.2 If at any time the Engineer considers the actual or anticipated progress of the work reflects a significant deviation from the Works Programme, he may request the Contractor to submit a proposed revised Programme which together with an accompanying Activity Report and Narrative Statement, shall be submitted by the Contractor within fourteen (14) days after the Engineer's instruction. The proposed revised Works Programme shall show the sequence of operations of any and all work related to the change and the impact of changed work or changed conditions.

6.7.3 All activities that have negative float must be analysed by the Contractor to identify the impact on the timely completion of the Works or on the achievement of Key Date.

6.8 THREE MONTH ROLLING PROGRAMME

6.8.1 The Three-Month Rolling Programme shall be an expansion of the current Works Programme, covering sequential periods of three months. The Three-Month Rolling Programme shall provide more detail of the Contractor's plan, organisation and execution of the work within these periods. In particular, the Contractor shall expand each activity planned to occur during the next three (3) month period, if necessary, to a daily level of detail.

6.8.2 The Three-Month Rolling Programme shall be developed as a Critical Path Method (CPM) network, and shall be presented in bar chart and time-scaled network diagram format. Bar charts shall be presented on an A4 and time-scaled networks diagrams on an A1 size reproducible media. Tasks in the programme shall be derivatives of and directly related to tasks in the approved Works Programme.

6.8.3 The Contractor shall describe the discrete work elements and work element inter-relationships necessary to complete all works and any separable parts thereof including work assigned to sub-contractors.

6.8.4 Activity duration shall not exceed two (2) weeks unless otherwise consented to by the Engineer.

6.8.5 Each activity in the Three-Month Rolling Programme shall be coded, or described so as clearly to indicate the corresponding activity in the Works Programme.

6.9 THREE MONTH ROLLING PROGRAMME REVISIONS AND UPDATE

6.9.1 The Three-Month Rolling Programme shall be extended forward each month as described under Clause 6. 4 above. Each submission of the Three-Month Rolling Programme shall be accompanied by a Programme Analysis Report, describing actual progress to date, and the forecast for activities occurring over the next three-month period.

6.9.2 If the Three Month Rolling Programme is at variance with the Works Programme, the Programme Analysis Report shall be accompanied by a supporting Narrative Statement describing the Contractor's plan for the execution of the activities to be undertaken over the three-month period, including programme assumptions and methods to be employed in achieving timely completion.

6.9.3 The Contractor shall revise the Three-Month Rolling Programme or propose revisions of the Works Programme, or both, from time to time as may be appropriate to ensure consistency between them.

6.10 THREE WEEK ROLLING BAR CHART SCHEDULE

Once a week, on a day mutually agreed to by the Engineer and the Contractor, a meeting will be held to assess progress by the Contractor during the previous work week. The Contractor shall submit a construction schedule listing activity completed and in-progress from the previous week and the activities scheduled for the succeeding two weeks based on the detailed Works Programme. Copies of the schedule shall be submitted on A3 sized paper.

6.11 PROJECT CALENDAR

For the Project, the Contractor shall adopt 7 days a week calendar, identical calendar for the purpose of programming and Execution of Works. Official documents shall be transacted during 5 days week - Monday through Friday, except for National (Govt. of India) Holidays. For Project purposes, a week begins at 0001 hours on a Monday and ends at 2359 hours on a Sunday. The completion of an activity or the achievement of an event when given a week number shall be taken to mean midnight on the Sunday at the end of the numbered week. An access date or activity start date when given as a week number shall be taken to mean 0001 hours on a Monday of the Numbered week.

6.12 PROGRAMMING PERSONNEL

The Contractor shall submit, as part of its Staff Organization Plan, the names and required information for the staff to be employed on Works Programming. The Works Programmer shall hold reputable professional qualifications and relevant experience as per Attachment C-1 to Employer's Requirements – Construction .The programmer shall be employed by the Contractor full time on the Contract until the completion or such earlier time.

6.13 PROGRAMME AND REPORT SUBMISSION FORMAT

The Contractor shall submit one (1) original and three (3) copies and a soft copy of all submissions to the Engineer. All submissions shall be in A0, A1, A3 or A4 size, as appropriate except as may otherwise be agreed by the Engineer.

The format for all Programme and Report submissions shall be strictly in accordance with the format or as requested by the Engineer.

APPENDIX 7
MEETINGS

7. MEETINGS

7.1 Kick-Off Meeting

The Engineer shall hold Kick-Off Meeting within 7 calendar days from the Commencement Date. Purpose of the Meeting is formally to notify all parties concerned under the Contract that the project has begun, and every party has a common understanding and his role from the Commencement Date until issuance of the Taking-Over Certificate.

At the Kick-Off Meeting, followings will be, but not limited, discussed.

a) Outline of the Works

b) Communication rules (process, emails, approvals, etc.)

c) Other matters regarding proceeding and management of the Contract.

d) Profile of the Site

e) Time Schedule List of Contractual Events/Submissions, including Milestones, Time(s) for Completion and Defects Notification Period(s).

f) Introduction of key persons of the Contractor and Employer, with role, Function and authority of each person.

g) Role and responsibility of Emergency notification process.

7.2 Regular Meetings

7.2.1 The Engineer shall hold regular meetings with the Contractor as necessary for the proper management and co-ordination of the Works. The Contractor's representative and other personnel as considered necessary by the Engineer, shall attend such meetings.

7.2.2 Within twenty eight (28) days after the Commencement Date, the Engineer and the Contractor's Representative shall agree upon a programme for weekly and monthly meetings covering the first three (3) months after such twenty eight (28) days. The Contractor's Representative shall make sure that the Contractor's Personnel designated to attend meetings make themselves available for the meetings. The Engineer shall prepare the agenda for the meetings and the relevant documents to be submitted to the meeting, including as a minimum the minutes of the previous meeting. Thereafter, the programme for weekly and monthly meetings shall be updated monthly in the monthly progress meetings.

7.2.3 The Engineer may initiate ad-hoc meetings as and when the need arises, through prior consultation with the Contractor's Representative where possible, and the Contractor's Representative and other Contractor's Personnel designated by the Engineer and/or the Contractor's Representative shall attend such meetings. The Engineer shall prepare a proposed agenda of the meeting, for prior consultation with the Contractor's Representative where possible.

7.3 Monthly Progress Meeting

A Monthly Progress Meeting shall be called by the Engineer and shall be held every month within three (3) days following issuance of the Contractor's Monthly Progress Report. If the day specified, is not a working day, then the meeting shall be heldon the next working day after the specified date. The Engineer shall notify the Contractor of any change in the date or time, or both, of the meeting. The main purpose of the meeting is to discuss progress of the Works and if there is any delay in progress, being encountered by the Contractor, the Contractor shall indicate the cause of delay and present the method of recovery.The results of the discussions of the meeting shall be included in the Contractor's next Monthly Progress Report to be provided.

7.4 Co-ordination Meeting

The Contractor shall organize co-ordination meetings as required with related parties. Before conducting such co-ordination meetings with the related parties, the Contractor shall give prior notice and agenda of the meeting to the Engineer and the Employer.

7.5 Meetings called by the Contractor

The Contractor's Representative may request the Engineer to meet him and other Contractor's Personnel whenever necessary to discuss the issues pertaining to the Works and the Contract. The Engineer shall comply with the request where physically possible. The Contractor shall prepare a proposed agenda for the meeting and submit it to the Engineer when making request for the meeting.

7.6 Other Meetings

The Contractor's Representative shall attend, and shall arrange for representatives of the Subcontractors, public departments, transportation companies, utility undertakings and other contractors employed by the Employer to attend, meetings when required by the Engineer. The Contractor shall inform the Engineer in 48 hours (or such a shorter period as agreed by the Engineer) before conducting meetings with the public departments, transportation companies, utility undertakings and/or the other contractors and shall give the Engineer an opportunity to attend such meetings.

7.7 Minutes of Meetings

The Engineer in principle shall be responsible for the preparation of the minutes of meetings, circulating it to the parties who attended the meeting before the next relevant meeting. The Engineer shall also be responsible for the minutes of ad-hoc meetings in a similar manner, unless otherwise agreed with the Employer.

7.8 MONTHLY PROGRESS REPORTS

7.8.1 GENERAL

The Contractor shall submit to the Engineer, a Monthly Progress Report. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the period to which it relates. It shall be submitted in a format to which the Engineer shall have given his consent and shall contain sections/sub-sections.

7.8.2 FINANCIAL STATUS

a) A narrative review of all significant financial matters, and actions proposed or taken in respect to any outstanding matters.

b) A spread sheet summarising each activity, the budget, costs incurred during the period, costs to date, costs to go, cost forecast (total of costs to date and costs to go) and cost variance (difference between cost forecast and budget).

c) A spread sheet indicating the status of all payments due and made.

d) A report on of the status of any outstanding claims. The report shall in particular provide interim updated accounts of continuing claims.

7.8.3 PHYSICAL PROGRESS

a) It shall describe the status of work performed, significant accomplishments, including critical items and problem areas, corrective actions taken or planned and other pertinent activities, and shall, in particular, address interface issues, problems and resolutions.

b) It shall include a simplified representation of progress measured in percentage terms compared with percentage planned as derived from the Works Programme.

7.8.4 PROGRAMME UPDATE (For Entire Project)

a) The monthly Programme Update which shall be prepared by recording actual activity completion dates and percentage of activities completed up to the end of the month together with estimates of remaining duration and expected activity completion based on current progress. The Programme Update shall be accompanied by an Activity Report and a Narrative Statement. The Narrative Statement shall explain the basis of the Contractor's submittal:

(1) Early Work and Baseline Submittals – explains determination of activity duration and describes the Contractor's approach for meeting required Key Date as specified in the Contract.

(2) Updated Detail Programme Submittals – state in narrative the Works actually completed and reflected along Critical Path in terms of days ahead or behind allowable dates. Specific requirements of narrative are:

i. If the Updated Detailed Work Programme indicates an actual or potential delay to Contract Completion date or Key Date, identify causes of delays and provide explanation of Work affected and proposed corrective action to meet Key Date or mitigate potential delays. Identify deviation from previous month's critical path.

ii. Identify by activity number and description, activities in progress and activities scheduled to be completed.

iii. Discuss Variation Order Work Items, if any.

b) The Programme Status which shall:

(1) show Works Programme status up to and including the current report period, display Cumulative progress to date and a forecast of remaining work.

(2) be presented as a bar-chart size A3 or A4 and as a time-related logic network diagram on an A1 media, including activity listings;

c) The Activity Variance Analysis which shall analyse activities planned to start prior to or during the report period but not started at the end of the report period as well as activities started and/or completed in advance of the Works Programme.

7.8.5 KEY DETAILS STATUS

A report on the status of all Key details due to have been achieved during the month and forecasts of achievement of any missed Key details, and those due in the next month.

7.8.6 THREE MONTH ROLLING PROGRAMME

The monthly issue of the Three-Month Rolling Programme.

7.8.7 PLANNING AND CO-ORDINATION

a) A summary of all planning/co-ordination activities during the month and details of outstanding actions.

b) A schedule of all submissions and consents/approvals obtained/outstanding.

7.8.8 PROCUREMENT REPORT

a) A summary of all significant procurement activities during the month, including action taken to overcome problems.

b) A report listing major items of plant and materials which will be incorporated into the Works. The items shall be segregated by type as listed in the Specifications and the report should show as a minimum the following activities:

(1) purchase Order Date - Scheduled/Actual,

(2) manufacturer/Supplier and Origin,

(3) letter of Credit Issued date,

(4) manufacturer/Supplier Ship Date - Scheduled/Actual,

(5) method of Shipment,

(6) arrival Date in India- Scheduled/Actual.

7.8.9 SAFETY

A review of all safety aspects during the month including reports on all accidents and actions proposed to prevent further occurrence.

7.8.10 ENVIRONMENTAL AND SOCIAL

A review of all the environmental and social issues during the past month to include all monitoring reports, mitigation measures undertaken, and activities to control environmental impacts.

APPENDIX 8
MANAGEMENT PLANS AND SUBMISSIONS

8 MANAGEMENT PLANS

8.1 General

8.1.1 In order to ensure the Contractor understands and complies with the requirements of the Contract, a series of Management Plan shall be developed. These Management Plans will serve to structure the submittals in a manner that the Contractor can develop and prepare the submittals and the Engineer can review and comment on a prescribed programme.

8.1.2 The Management Plans shall be configured as a family of "stand-alone" plans and associated documents, each covering one of the subjects listed below.

8.1.3 The plans and documents shall be co-ordinated with each other and shall collectively define describe and encompass the Contractor's proposed methods, procedures, processes, organisation, sequencing of activities etc. and shall show how these combine together to assure that the work truly meets the requirements of the specifications in respect of the subject listed.

8.1.4 All plans and documents shall be submitted as per Key Dates mentioned in Appendix 2. Further submissions shall be made:

a) when required in accordance with the Works Programme;
b) whenever the development of the Contractor's designs or planning allows the plan to be developed further;
c) in response to comments made by the Engineer:
d) whenever any change occurs that invalidates the information contained in the previously submitted and reviewed document, within 14 days of the occurrence of such change; and
e) when requested by the Engineer from time to time.

8.2 General Organisation

The plans listed below shall be developed and submitted by the Contractor for the Engineer's review:

a) Project Management Plan
   1) Contractor's Project Plan
   2) Interface Management Plan

b) Works Quality Management Plan
   1) Works Quality Management Plan
   2) RAMS Plan
   3) Electromagnetic Compatibility Management Plan
   4) Software Quality Assurance Plan

c) Design, Procurement and Manufacturing Management Plan
   1) Design Plan

2) Factory Testing Plan
3) Procurement, Manufacturing and Delivery Plan

d) Construction and Installation Management Plan
1) Construction and Installation Plan
2) Environment, Social Health and Safety, Management Plan

e) Completion Management Plan
1) Commissioning Plan
2) Operational and Maintenance Manuals Plan
3) Training Plan
4) Spares Management Plan
5) Defects Management Plan

8.3 Project Management Plan

The overall management of the Works shall be the Contractor's responsibility. The organisation of the resources for the design, procurement, manufacture, delivery, installation, testing and commissioning, and setting to work is to be developed into a Project Management Plan. Each section of this plan shall fully describe the Contractor's understanding of the Works and management skills and structure required to achieve the same.

8.3.1 Contractor's Project Plan

a) The Contractor's Project Plan shall provide a clear overview of the Contractor's organisation, management systems and methods to be used for execution and completion of the Works.

b) The Contractor's Project Plan shall include a summary description of each and every stage of implementation of the Works, clearly showing the principal organisational interfaces both within the Contractor's own organisation (including sub-contractors of every tier) and with Other Contractors and Relevant Authorities, defining how each of these interfaces is to be managed and controlled. An organisation chart shall be produced to illustrate the subdivision of the work into elements for effective technical and managerial control, the reporting structure and the interface relationship among all parties involved. Names, addresses, telephone and fax numbers of all principle contacts shall be listed.

c) The Contractor's Project Plan shall contain structured organisation charts showing the hierarchical relationship of the Contractor's organisation (including sub contractors of every tier). The organisation charts shall be produced as a "family" such that the basic chart shows the overall organisation structure supported by subsidiary charts detailing the internal structure of various departments or sections of the overall organisation.

d) The Contractor's Project Plan shall include full details of the qualifications, experience, authority and responsibility of the personnel assigned to all key positions of the Contractor's organisation (including sub-contractors of every tier). As a minimum, this shall include all levels down to senior managers and shall include the personnel responsible for each individual department and functional group. A clear reference shall be given as to the location of staff (e.g. site resident or factory based, etc). Names, addresses, telephone and fax numbers of all principle contacts shall be listed.

e) The Contractor's Project Plan shall define the Contractor's management structure for the execution of the Works and for the control of the quality of the Works and shall, without

limitation, identify and set out:

(1) the procedure for audit;

(2) the procedures for the control of receipt and issue of all Works related correspondence so as to ensure traceability;

(3) the procedures for filing system to be implemented to maintain the Contractor's records during the course of the work. The filing systems used by the Contractor and sub contractors of any tier shall be compatible as for as is necessary;

(4) the procedures for the identification, production, verification, internal approval, review (when required) by the Engineer, distribution, implementation and recording of changes to all drawings, reports and specifications;

(5) the procedures for the evaluation, selection, engagement and monitoring of sub-contractor/suppliers together with the means of application of quality assurance to their work including audit and acceptance;

(6) the procedure for the regular review and revision of each type of quality plan and its supplemental individual specific quality plans to ensure their continuing suitability and effectiveness, in addition to the methods to be used for revision and issue of revised documentation;

(7) the procedures for the control, calibration and maintenance of inspection, testing and measuring equipment;

(8) the procedures for the selection, indexing, disposition and maintenance of project record for storage in the archives. A list of items to be archived, including their periods of retention shall be submitted for review by the Engineer;

(9) the procedures for identifying training needs and for the provision of training of all personnel performing activities affecting quality; and

(10) the procedures for the control of non-conformity.

f) The Contractor's Project Plan shall include details of Contractor's Office.

8.3.2 Interface Management Plan

The Contractor shall prepare Interface Management Plan in accordance with Appendix 5.

8.4 **Works Quality Management Plans**

8.4.1 The Contractor shall submit for review by the Engineer Works Quality Management plan in accordance with the requirements of Appendix 11

8.4.2 RAMS Plans

a) The Contractor shall implement a formal Reliability Plan and a formal Maintainability Plan in accordance with the PS.

b) The Contractor shall submit for review by the Engineer the Contractor's Reliability Plan and Maintainability Plan in accordance with the requirements of General Specification (S&T) . The Contractors Reliability Plan and a Maintainability Plan shall include Failure Modes, Effects and Criticality Analysis and the production of a Reliability Critical Items List.

c) The contractor shall submit for review by the Engineer the Contractor's Systems Safety Plan.

The Systems Safety Plan shall address all the factors referenced in this Specification and as required by the Particular Specification(S&T).

8.4.3 Electromagnetic Compatibility Management Plan

a) The Contractor shall prepare and submit for review by the Engineer, EMC Management Plan which shall, based upon a top-down approach, define the EMC philosophy, activities, means of control for the design processes and EMC submissions to be supplied to demonstrate compliance with the Particular Specification(S&T) and General Specification(S&T).

b) The EMC Management Plan shall identify a comprehensive list of specifications, standards, method statements and procedures to be submitted to the Employer's Representative for review. The EMC Management Plan shall also include a programme that shall identify the dates for EMC submissions.

c) The EMC Management Plan shall include an initial list of design documentation, test specifications land test reports with a single paragraph description of each document to indicate compliance with the Specification.

d) The EMC Management Plan shall include a definition and description of the process and methods used for Verification and Validation that the Works will achieve the required EMC parameters in all aspects.

e) The Contractor shall co-ordinate the levels of interference emissions and susceptibility of all equipment which are to be designed, manufactured, supplied and installed by the Contractor and its sub-contractors and suppliers. The Contractor shall designate a person as point of contact to deal with EMC matters. Details of the nominated person and any subsequent change of the nominated person shall be subject to review; by the Employer's Representative.

f) The Contractor shall liase and co-ordinate with all Other Contractors in the exchange of EMC data a related equipment performance characteristics and advises the Employer's Representative when any such information is requested from any Other Contractor. A copy of all EMC related information exchange shall be sent to the Employer's Representative for review.

g) The Contractor shall comply with the following EMC requirements:

(1) The Contractor shall ensure that all electrical and electronic apparatus is designed and constructed to operate without degradation of quality, performance or loss of function in the electromagnetic environment of the Project.

(2) EMC considerations shall be incorporated in the Contractor's procedures for product safety and design Verification.

(3) The design shall ensure that any electromagnetic interference emissions introduced into the environment do not exceed those detailed in the Particular Specification(S&T) and General Specification(S&T).The Contractor shall ensure that the specified electromagnetic compatibility (EMC) requirements are adequate. Any shortcomings shall be made known to the Employer's Representative immediately and recommendations for corrective action formulated.

(4) In respect of the design documentation, the Contractor shall demonstrate by theoretical analysis that the design of electrical and electronic systems is fully compliant with the EMC requirements identified. The Contractor shall state clearly in the documentation all the

assumptions made and parameters used in the analysis.

(5) The Contractor shall detail the methodology used in support of the analysis. Contractor shall prepare and submit to the Engineer for review reports of the validation of the models.

(6) The Contractor shall supply documentation showing how system safety and reliability is ensured. It shall include Failure Mode, System Failure, the effect of human intervention, how equipment has failed thresholds that have been set in order to keep them above worst case interference levels, and how equipment tolerances and other characteristics in the Specifications have been allowed for in designing the system.

(7) The Engineer may conduct an independent EMC audit for both the systems and its component parts and shall therefore require access to all the relevant design and production information. The Contractor shall supply sufficient documentation and analysis in a form reviewed by the Engineer.

(8) The Engineer may request at his discretion, attendance at the manufacturing factory prior to delivery to assist in providing confidence that the EMC requirement will be met. However, this will not give design acceptance that can only be given after successful completion of the System Acceptance Tests.

(9) The Contractor shall implement corrective actions to rectify any EMC problem identified during design, on-Site testing and when the whole system is in operational service.

(10) The Contractor must be fully aware of the EMC requirements and any modifications to the systems and equipment carried out by the Contractor during the Defect Notification Period shall not cause the immunity or emission levels of the installed systems and equipment to exceed such values. Detailed EMC documentation on all modifications carried out shall be submitted to the Engineer for review. Modification work shall not commence until the respective submission has been reviewed without objection by the Engineer.

8.4.4 Software Quality Assurance Plan

Where software is a design deliverable, the Contractor shall submit a Software Quality Assurance Plan in accordance with the requirements of Appendix 11 The Software Quality Assurance Plan shall address all elements of the design and development of software required as part of the Works.

8.5 Design, Procurement and Manufacturing Plan

The Design, Procurement and Manufacturing Plan shall be configured as a family of "stand-alone" plans and associated documents each covering one of the subjects listed below. The plans shall be coordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organization, sequencing of activities, etc. and shall show how these combine together to assure that the Works fully meet the requirements of the Specification in respect of the subjects listed.

8.5.1 Design Plan

a) Design shall be undertaken in various phases to ensure a smooth flow of information for review by the Engineer. Submissions shall be strictly in accordance with the Design Submissions Programme.

b) The Contractor shall perform his designs for the Works and prepare a Design Plan for his design work in accordance with the following design stages. The Contractor shall submit to the Engineer for his review, relevant design information.

8.5.2 Factory Testing Plan

a) The Contractor shall prepare and submit for review by the Engineer the Contractor's Factory Testing Plan detailing and explaining how the Contractor will plan, perform, and document all inspections and tests that will be conducted to verify and validate the Works prior to delivery to the Site. The plan shall consist of a narrative description supported by graphics, diagrams and tabulations as required.

The plan shall contain but not be limited to the following topics:

(1) the Contractor's strategy for inspection and Factory Acceptance Tests of all constituent parts of the Works and how this relates to the sequence of delivery;

(2) the sequencing and interrelationships of the inspections and tests including:

i. First Article Inspection

ii. all Quality Hold Points; and

iii. all Quality Control Points;

(3) the type and extent of inspection and Factory Acceptance Tests to be undertaken and the parts of the Works to be proven by that testing;

(4) the objective of each inspection or test, what particular design and operating criteria the test or inspection will prove and how the success of the test or inspection will be demonstrated or measured;

(5) organisation chart and CV of key personnel in inspection and test team;

(6) the plan for the production and submission of the inspection and test procedures tothe Engineer for review including the submission of the inspection and test reports and records; and

(7) Type Tests, Routine Tests, First Article Inspections and any other tests constitutingthe Factory Acceptance Tests.

b) The Contractor shall arrange for all equipment and systems manufactured for incorporation into the Permanent Works to undergo a Factory Acceptance Test (FAT) before shipment from the place of manufacture. Any particular requirements for inspection and testing at the place of manufacture are prescribed in the PS. Notice of Place of Manufacture for Signalling & Telecommunication equipment shall be submitted to the Engineer.

c) The Contactor shall be responsible for re-inspecting and re-testing any failed inspection and Factory Acceptance Test including regression testing on previously passed items.

d) Inspections and tests that are to be witnessed by the Employer or the Engineer shall be sensibly grouped and scheduled so that as many inspections and tests as possible may be witnessed during a single visit.

e) If required, Type Tests as detailed in relevant Particular Specifications shall be performed on all items of equipment to be installed as part of the Permanent Works under the Contract. The Type testing shall be based on the environmental class of the sites into which the equipment will be installed.

f) For all production items a First Article Inspection shall be undertaken. Latest drawings, inspection & test procedures, specifications and quality documentation for inspection of equipment shall be submitted for First Article Inspection to the Engineer. Routine production testing methods shall be detailed for review by the Engineer. Routine testing shall ensure that all samples of a production item are within the tolerances required for complete interchangeability.

g) The Contractor shall prepare two copies of an inspection or test report immediately after the completion of each inspection or test whether or not witnessed by the Employer or the Engineer. If the Employer or the Engineer has witnessed the inspection or test, he will countersign the inspection or test report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) contained therein. If the Employer or the Engineer has not witnessed the inspection or test (i.e. if a waiver has been granted, or the Employer or the Engineer has not witnessed the inspection or test for some other reason in accordance with the Contract), the Contractor shall forward two copies of the inspection or test report without delay to the Engineer. The Engineer will countersign the report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) and return one copy to the Contractor. Where the results of the inspection or test do not meet the requirements of the Specification, the Employer or the Engineer may call for a re-inspection or re-test.

h) For standard equipment which is serial or bulk manufactured, manufacturer's type test certificates (or equivalent) may, subject to review by the Engineer be accepted.

i) Test equipment and instrumentation shall be subject to approved calibration tests within a properly controlled calibration scheme, and signed calibration certificates shall be supplied to the Engineer in duplicate. Such calibration checks shall be undertaken prior to testing and if required by the Engineer shall be repeated afterwards.

j) Materials and equipment shall not be released for shipment until all applicable inspections and tests including Factory Acceptance Tests have been satisfactorily completed.

8.5.3 Procurement, Manufacturing and Delivery Plan

a) The Contractor shall prepare a procurement, manufacturing and delivery plans in respect of all items and goods. Separate parts of the plan shall be prepared for Contractor or sub-contractor off-site activities. Each plan shall identify the scope of work to be applied. In relation to such scope of work, it shall, without limitation, define:

(1) the organization of the Contractor's staff directly responsible for the day-to-day management of the manufacturing activity on or off the Site;

(2) the specific allocations of responsibility and authority given to identified personnel for the day-to-day management of the work with particular reference to the supervision, inspection and testing of the work;

(3) the interfacing or co-ordination required with the Contractor's other related plans;

(4) the specific methods of manufacture to identify any relevant method statements and develop those method statements to a degree of sufficient detail reviewed by the Engineer; and

(5) the list of procedures and work instructions to manage and control the quality of work during purchasing, manufacturing and delivery, including without limitation:

i. the purchasing of items and goods and ensuring they comply with the requirements of the Specification, including (without limit) purchasing documentation and specific Verification arrangements for Contractor/Engineer inspection of material or manufactured product prior to release for use;

ii. the manufacturing process so as to ensure compliance with the design;

iii. the manufacturing process so as to ensure clear identification and traceability of material and manufactured parts;

iv. the inspection and testing of incoming materials, in process and final product so as to ensure specified requirements for the material and/or manufactured product are met;

v. the identification of the inspection and test status of all material and manufactured products during all stages of the manufacturing process to ensure that only products that have passed the required inspections and tests are dispatched for use and/or installation;

vi. review and disposal of non-conforming material or product so as to avoid unintended use;

vii. the assessment and disposal of non-conforming material and manufactured product and approval for reworking or rejection as scrap;

viii. the identification of preventive action so as to prevent recurrence of similar non-conformance; and

ix. the handling, storage, packaging, preservation and delivery of manufactured product.

b) The Contractor shall prepare and submit the inspection and testing plans to manage and control any test and inspection activities ;

c) The Contractor shall propose a structured set of inspection hold points. The hold points shall

be structured such that a formal hold point is allowed for each significant element of the manufacturing process. At each hold point, the Engineer shall hold a formal inspection or advise that the inspection had been waived.

d) Once the inspection and any required remedial actions are completed to the satisfaction of the Engineer, the Engineer shall not withhold his notice of no objection for shipping unreasonably, provided all pre-delivery assembly and testing has been successfully completed.

e) Any unit delivered without the Engineer notice of no objection shall be rejected at the Site and all expenses thereby shall be borne by the Contractor.

8.6 Construction and Installation Management Plan

The Construction and Installation Management Plan shall be configured as a family of "stand-alone" plans and associated documents each covering one of the subjects listed below.

The plans shall be co-ordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organization, sequencing of activities, etc and shall show how these combine together to ensure that theworks truly meet the requirements of the Specification in respect of the subjects listed

8.6.1 Construction and Installation Plan

a) The Contractor shall prepare plans for the construction and installation activities on and off the site and shall ensure that these are properly related to the subsequent testing and commissioning activity.

b) Separate parts of the plan shall be prepared for other contractor(s) or sub-contractor(s) off-site activities.

c) Each construction plan shall identify the scope of activity to be controlled. In relation to scope of such activity, it shall, without limitation, define:

(1) the organisation of Contractor's staff directly responsible for the day to day management of the activity on or off the site;

(2) the specific allocations of responsibility and authority given to identified personnel for the day to day management of the works with particular reference to the supervision, inspection and testing of works;

(3) the interfacing or co-ordination required with the Contractor's other related plans;

(4) the specific methods of construction and installation to identify any relevant method statements to a sufficient degree of detail reviewed by the Engineer;

(5) a detailed method statement which shall include but not be limited to;

i. description of main operations and sub-operations;

ii. sequence of sub-operations;
iii. quantities of the work and production rates to be achieved;
iv. resources to be employed; and
v. quality checks to be carried out, supervision being exercised and safety precautions to be employed;

(6) the list of procedures and work instructions to manage and control the quality ofconstruction and installation works, including without limitation:

i. the inspection and testing activities of incoming materials, in process and final product so as to ensure specified requirements for the material and/or product are met;
ii. the purchasing of materials and ensuring they comply with the requirement of the specification, including purchasing documentation and specific Verification arrangements for Contractor/Engineer inspection of material or manufactured product prior to release for use/installation;
iii. the construction processes including Temporary Works so as to ensure compliance with drawings and specification. In addition, any software to be used in construction, installation and commissioning process shall be identified and details of the Verification and validation processes for the software application shall be given;
iv. the construction and installation process so as to ensure clear identification and traceability of material and manufactured product;
v. the identification of the inspection and test status of all material and manufactured product during all stages of the construction and installation process to ensure that only products that have passed the inspections and tests are dispatched for use and/or installation;
vi. review and disposition of non-conforming material or product so as to avoid unintended use/installation;
vii. the assessment and disposition of non-conforming material and product and approval of reworking or rejection as scrap;
viii. the identification of preventive action so as to prevent recurrence of similar non-conformance; and
ix. The handling, storage, packaging, preservation and delivery of product; and

d) The Contractor shall prepare and submit inspection and test plans to manage and control any test and inspection activities.

e) The following particulars shall be submitted to the Engineer for review within 28 days of the Commencement Date of the Works;

(1) drawings showing the layout within the Site of the Contractor's accommodation, project signboards, access roads and major facilities required early in the Contract;
(2) drawings showing the details to be included on Project signboards.

f) Drawings showing the location of stores, storage areas, work areas and other major

facilities shall be submitted to the Engineer for review as early as possible, but in any case, not later 28 days before construction of the facilities.

8.6.2 Environment, Social, Health and Safety (ESHS) Plan

ESHS plan shall be submitted by the Contractor in accordance with ESHS manual given in Appendix 13 for the Engineer's review within 28 days of issue of Letter of Acceptance.

8.6.3 Completion Management Plan

8.6.4 General

a) The Contractor shall organise the services required under the Contract to bring the Works into service under one plan. This co-ordinated approach shall allow the Engineer to review all aspects of completion in an integrated manner.

b) The Completion Management Plan shall be configured as an integrated plan with associated documents, covering the subjects described herein.

c) The plans shall be co-ordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organisation, sequencing of activities and the like, and shall show how these combine together to assure that the Works truly meet the requirements of the Contract with respect to the matters listed herein after.

8.6.5 Commissioning Plan

a) The Contractor shall submit the first draft of the Commissioning Plan to the Engineer within 180 days of the Commencement Date of the Works.

b) The Commissioning Plan shall consist of the following for all Signalling & Telecommunication work:

(1) Installation Tests Schedule

The Contractor shall submit to the Engineer a comprehensive schedule of the installation tests as required by relevant Particular Specifications and in accordance with the Installation Programme. The schedule shall be submitted within the period of time laid down in the Particular Specifications , or, if none is given, not later than 56 days in advance of the date for the commencement of the Installation Tests. Pre-Installation Inspection shall include the verification of FAT/Quality test report, Invoice, OEM manuals etc. Post installation test shall include the installation of equipment as per approved drawing, Particular specification etc. Power supply test shall be the part of Post-installation test.

(2) System Acceptance Tests Plan

The Contractor shall submit to the Engineer, a comprehensive System Acceptance Tests Plan including all requirements detailed in the relevant Particular Specification(S&T).The plan shall be submitted within the period of time laid down in the Particular Specification(S&T) or, if none is given, not later than 112 days in advance of the date for the commencement of the System Acceptance Tests. System

Acceptance test shall include the functional test of all equipment from the SM panel.

(3) Integrated Testing & Commissioning Plan

The Contractor shall submit to the Engineer a comprehensive Integrated Testing and Commissioning Plan including all requirements detailed in Particular Specifications . The plan shall be submitted within the period of time laid down in Particular Specifications , or, if none is given not later than 112 days in advance of the date for the commencement of Integrated Testing and Commissioning. This test shall include the test of equipment from the IMD/ control centre of the project.

8.6.6 Operation and Maintenance Manuals Plan

a) The Contractor shall develop an Operation and Maintenance Manuals Plan to suit staged commissioning of the system and to ensure timely preparation of the Operation and Maintenance Manuals and the "As-Built" Documents in a format and to a level of detail reviewed without objection by the Engineer.

b) The Contractor shall submit the Operation and Maintenance Manuals Plan not later than 45 days prior to the issue of the Taking Over certificate for the works and according to the staged commissioning, if applicable, of the proposed systems.

8.6.7 Training Plan

a) The Contractor shall ensure the timely preparation of the Contractor's Training Plan in a format and to a level of detail reviewed without objection by the Engineer and fulfilling the requirements.

b) The Contractor shall submit the Training Plan by the date stated in the Particular Specifications , or, if none is given, not less than 84 days prior to the start of installation activities for the works.

8.6.8 Spares Management Plan

a) The Contractor shall submit for review by the Engineer a Spares Management Plan to furnish a priced manufacturer-recommended list of spare parts, necessary to support continuous operation of all such equipment for a minimum period of 24 months after the commencement of revenue operations.

b) The Contractor shall submit the Spares Management Plan not less than 182 days prior to the issue of the Taking Over Certificate for the Works.

8.6.9 Defects Management Plan

The Contractor shall submit for review by the Engineer a Defects Management Plan to repair, replace and perform any remedial item upon the Works identified by the Engineer during Defects Notification Period (DNP). The first submission of this plan is required not less than 365 days prior to the issue of the Taking Over Certificate for the Works. The Contractor shall;

a) endeavour to complete all necessary work in a timely responsible manner;
b) not proceed with any remedial work without the consent of the Engineer;
c) submit a plan that details the method and timing of any proposed work; and
d) update the plan monthly, showing progress of the work and time to completion.

APPENDIX 9

DOCUMENTS, DRAWING AND CAD STANDARDS

9. General

A document may consist of document cover, revision history, table of contents, text and attachment(s) in this sequence where applicable.

1) Cover format (Times New Roman)
2) Heading and name of client shall be on top, in capital, size 10.
3) Name of the project in bold letters, size 22.
4) Content of document in bold capitals, size 16.
5) Document reference number in bold capitals, size 12.
6) Company name: capitals, size 14.
7) Company logo in size 35 x 40 (W x H) mm.
8) Address of the company in regular letters, size 10.
9) Document Format (Time New Roman)
10) General Regulations
11) Letter size: 12.
12) Paper size A4 (A3 is used for table and figures).
13) Periods and semicolons shall be placed right after the preceding letter or number.
14) The space between paragraphs and headings shall be 1.15 lines.
15) Main headings shall be placed in number order, with a period placed right after the number, followed by a space, with a heading text in bold capital letters. For example.:

9.1 IN BOLD CAPITAL

Other headings are placed in number order, with a period placed right after the number, followed by a space, with a heading in regular letters. For ex.:

a) In normal letter.
b) Notes

Notes relating to tables shall be included in the table; in case they are not able to be included, it shall be clearly specified that they are notes relating to a particular table reference.

The text of notes is usually given in italics.

9.2 Language of Communication and Units

The language for communications shall be the English language. The Contractor shall utilize the SI system of measurement units.

9.3 Photographs

The Contractor shall take digital photographs of the Works at least on monthly basis and include them in the Contractor's Monthly Progress Reports. These photographs shall be taken at locations agreed with the Engineer as appropriate to record progress, quality and other relevant aspects of the Works. The number of the photographs shall be sufficient to cover all aspects of the Works in progress.

The digital photograph shall be colour jpeg image format with standard aspect ratio 4:3 and resolution of 300 DPI for all graphics in the printing. Read Only Memory (ROM) based electronic media of digital photographs shall be included as an integral part of the submittal. The locations and directions of the photographs taken shall be marked on a key plan of the Site, to be included in the submittal.

Each photograph shall be properly numbered and dated and include a brief explanatory note of the subject matter of the photograph, for ease of understanding.

Immediately before the issue of any Taking-Over Certificates for Works or Sections, the Contractor shall commission a professional photographer (or any person with equivalent skills) and take photographs of (where applicable, the interior to be taken by wide angle lenses) of exterior and all salient sections and features of the Works, for record purposes. The Contractor shall submit to the Engineer for approval as an integral part of the As-Built Documents, four (4) separately bound sets of colour prints of such record photographs, including one (1) set of Read Only Memory (ROM)-based electronic media containing an original jpeg image file of each photograph in accordance with the directory and naming convention agreed with the Engineer. The number of colour print images in a set shall not exceed 100, and each hard copy set of photographs shall be of A4 size with a cover page indicating information such as date, titles of the project and the Contract, and name of the Employer and the Contractor. Each of the photographs shall be properly numbered, dated and include a brief explanatory note of the subject matter.

9.4 Videos

On a monthly basis, or earlier if directed by the Engineer, the Contractor shall take digital video records to record the progress of the Works on Site (minimum duration of each to be ten minutes, covering all the areas of the Site where works are ongoing) as agreed with the Engineer, and submit the videos every month along with the Monthly Progress Report. The first video shall be made before the Commencement of the Works on the Site.

Within twenty-eight (28) days of receipt of the Letter of Acceptance, but in no case later than the Commencement Date, the Contractor shall submit to the Engineer a proposal for the provision of digital video recordings along with commentary of the progress of the Works.

The videos shall be taken by a competent person from an approved professional service provider (or any person with equivalent skills). The video shooting locations are to be identified in the afore mentioned proposal. This video should be submitted in a video format acceptable to the Engineer, with or without editing.

Immediately before the issue of the Taking-Over Certificate for the whole of the Works, the Contractor shall complete video recording and start editing the videos taken, to produce a 60-minute digital video-audio presentation with a suitable title. Each section of the video shall indicate the date on which it was taken. The presentation material shall have narration in

English. The Contractor shall use a professional service provider to video, edit and produce the presentation material.

9.5 DRAWING AND CAD STANDARDS

a) The purpose of this document is to define the minimum Drafting and CAD standard to be achieved by the Contractor for all drawings produced by the Contractor for the purpose of the works.

b) By defining a common format for the presentation of drawings and CAD files, the exchange of drawn information is improved and will maximize the use of CAD in the coordination process.

c) All submissions shall be made in accordance with the Employer's Requirements in a format reviewed without objection and in accordance with the requirements in :

i. The Contract;

ii. The Document submittal instructions to Consultants and Contractors.

d) Paper and drawing sizes shall be "A" series sheets as specified in BS3429.

e) The following software (latest and updated version) compatible with Intel-Windows based computers shall be used, unless otherwise stated, for the various required electronic submissions.

Document Type	Electronic Document Format
Text Documents	**MS Word**
Spread Sheets	**MS Excel**
Data Base Files	**MS Access**
Presentation Files	**MS PowerPoint**
Programmes	**Primavera for Windows, Suretrack**
AutoCAD Graphics	**AutoCAD**
Photographic	**Adobe Photoshop**
Desktop Publishing	**Page Make 6.5,5**
CADD Drawings	**AutoCAD**

f) Media for Electronic File Submission - Email

One copy shall be submitted unless otherwise stated in CD-ROM

g) Internet File Formats/Standards

The following guidelines shall be followed when the Contractor uses the Internet browser as the communication media to share information with the Employer.

a) All the data formats or standards must be supported by Microsoft Internet Explorer (latest version) running on windows professional (latest version).

b) The following list shows the file types and the corresponding data formats to be used on Internet. The Contractor shall comply with them unless prior consent is obtained for a different Data format from the Employer's Requirements:

File Type	Data Format
Photo Image	Joint Photographic Experts Group (JPEG)
Image other than Photo	GIF to JPEG
Computer Aid Design files (CAD)	Computer Graphics Metafile (CGM)
Video	Window video (.avi)
Sound	Wave file (.wav)

h) The following states the standards to be used on Internet when connecting to database(s). The Contractor shall comply with them unless prior consent is obtained for a different standard from the Employer's Requirements

Function to be Implemented	Standard to be Complied With
Database connectivity	Open Database Connectivity (ODBC)
Publishing hypertext language on the World Wide Web	Hypertext Markup Language (HTML)

The hard copy of all documents shall be the contractual copy.

1) GENERAL REQUIREMENTS

General:

i) The Contractor shall adopt a title block similar to that used in the Drawings for all drawings prepared under the Contract.

ii) Each drawing shall be uniquely referenced by a drawing number and shall define both the current status and revision of the drawing.

iii) The current status of each drawing shall be clearly defined by the use of a single letter code as follows:

P - Preliminary Design Drawing

D - Definitive Design Drawing

C - Construction Reference Drawing

W - Working Drawing

B - As-Built Drawing

M - As Manufactured Drawing

E - Employer's Drawing

Types of drawings:

i) 'Design drawings' mean all drawings except shop drawings and as-built drawings.

ii) 'Working drawings' are design drawings of sufficient detail to fully describe the Works and adequate to use for construction or installation.

iii) 'Site drawings and sketches' are drawings, often in sketch form, prepared on site to describe modifications of the Working drawings, where site conditions warrant changes that do not invalidate the design.

iv) 'Shop drawings' are special drawings prepared by the manufacturer or fabricator of various items within the Works to facilitate manufacture or fabrication.

v) 'As-built drawings' show the Works exactly as constructed or installed. They are usually prepared by amending the working drawings to take into account changes necessitated by site conditions and described in Site drawings. These drawings shall be completed on a regular basis as the works progress, and shall not be left until completion of the entire works.

2) COMPUTER AIDED DESIGN STANDARDS

a) Introduction
Scope of Use

Data input procedures between the Engineer and contractors must be co- ordinated, and the key parameters used to form CAD data files must be standardized. The production of all CAD data files shall comply with the following requirements.

b) Objectives

The main objectives of the CAD standards are as follows:

i. To ensure that the CAD data files produced for Project are co-ordinated and referenced in a consistent manner.

ii. To provide the information and procedures necessary for a CAD user from one discipline or external organization to access (and use as background reference), information from a CAD data file prepared by another discipline or external organization.

iii. To standardize the information contained within CAD data files which may be common to more than one discipline such as drawing borders, title boxes, grid lines etc.

iv. To establish procedures necessary for the management of CAD data files.

v. To ensure all contractors use 'Model space' and "Paper space' in the production of their

CAD files.

c) General

i. To facilitate co-ordination between contractors, it is a requirement that all drawings issued by contractors for co-ordination or record purposes shall be produced using CAD methods. Drawings shall be issued in digital format in addition to the paper copies.

ii. The intent of the issue of digital information is to aid the related design by others. The definitive version of all drawings shall always be the paper orpolyester film copies which have been issued by the contractor or organization originating the drawing.

iii. (Drawings and drawing packages issued for co-ordination, record purposes or for acceptance shall be accompanied by a complete set of the corresponding CAD data files.

iv. Any contractor or organization making use of the CAD data from others shall be responsible for satisfying himself that such data is producing an accurate representation of the information on the corresponding paper drawing which is satisfactory for the purpose for which he is using it. Provided the general principles of this section have been achieved by the originator of the CAD data, contractors making use of the CAD data from others shall not be entitled to require alterations in the manner in which such CAD data is being presented to them.

v. In particular, automatic determination of physical dimensions from the data file shall always be verified against the figured dimensions on the paper or polyester drawings. Figured dimensions shall be taken as correct where discrepancies occur.

vi. The purpose is to ensure that total co-ordination is achieved between the CAD 'Model Space" file and the "Paper Drawing" output during the revision cycle of the design and production process. Duplicated data in "Model and Paper Space" file will not be acceptable unless an automatic update link exists between the two data sets. "Paper Space" files are not typically required as part of the CAD Media Receipt from contractors, unless specifically requested.

d) CAD Quality Control Check

(i) Random CAD Quality Control Audits will be carried out by Engineer on all CAD media received and transmitted.

(ii) These checks DO NOT verify the technical content of the CAD data received or transmitted (as this is the responsibility of the originating organization), however compliance with Project CAD and Draughting Standards shall be checked.

(iii) In addition, all contractors who transmit and receive CAD data from the Project shall have CAD quality control procedures in place. A typical control procedure shall contain CAD data quality checking routines coupled with standards for CAD data transmittal and archiving.

e) CAD Data Transfer Media and Format

i. Data exchange format between the Engineer and the Contractor, shall be as follows:

Documents including design sheets, tables and figures: Word (*.docx), Excel (*.xlsx) and PDF (*.pdf).

Drawings: Autodesk's AutoCad 2016 or higher release. Electronic Data

Transfer Media: Pen Drive/Hard disk.

ii. All documents/drawings shall be labelled on the data shield with: Name of Company/ Consultant

Project Tile Document/Drawing Filenames

iii. The Contractor shall ensure the supplied media is free from virus.

f) CAD Media Receipt & Transmittal

i. CAD Media Transmittal (from the Contractor to Engineer) – this will consist of the following:

a) CAD Digital Media (disk(s), CD's or tape(s)) shall typically contain CAD "Model Space" and "Paper Space" files.

b) CAD data sheet

c) CAD issue/revision sheet

d) CAD quality Checklist confirming compliance

e) Plot of each "Model Space" file issued on an A1 drawing sheet (to best fit).

ii. The above CAD media will be collectively known as "CAD Media Transmittal Set". The CAD data file transmittal format required by Employer' Representative from all contractors shall be in AutoCAD (version 14)

iii. All CAD media received from contractors will be retained by Engineer except for SCSI disk (if used) as an audit trial/archive of a specific contractor's design evolution.

iv. CAD Media Receipt (from Engineer to the Contractor)

a. CAD Media should normally be obtained from the respective interfacing contractor(s), but should Engineer issue CAD media it will consist of the following:

a) CAD Digital Media (disk(s) or tape(s) typically contain only CAD "Model Space" files.

b) CAD data sheet

c) CAD issue/revision sheet

b) The above CAD media will be collectively known as the "CAD Media Receipt Set". The CAD data file transmittal format used by Engineer to all contractors will be in AutoCAD (version 14).

c) Each CAD transmittal disk/tape will be labelled with proper disk label as approved by the Engineer. Any CAD data transmitted without this label is assumed to be provisional information not to have been quality checked and therefore not formally issued.

a) Revisions

i. All "Revisions", 'In Abeyance' and 'Deletions' shall be located on a common layer. This layer can be turned on or off for plotting purposes.

ii. The following example text indicates the current CAD file revision, i.e., "Revision [A]". This shall be allocated to a defined layer on all CAD "Model Space" files, in text of a size that will be readable when the CAD "Model Space" file is fitted to the screen, with all levels on.

iii. Libraries, Blocks, & Block Names

a. All Construction Industry symbols produced as CAD Cells shall typically conform to British Standard BS1192 – part 3.

b. All Blocks created shall be Primitive (i.e., Not Complex) and shall be placed Absolute (i.e. NOT Relative).

c. The Contractor's specific block libraries shall be transmitted to Engineer together with an associated block library list containing the filename (max. 6 characters) and block description. The contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.

d. All Blocks of a common type, symbols or details should initially be created within a CAD "Model Space File" specifically utilized for that purpose. These files will be made available on request by Engineer.

e. All Blocks created will typically be 2D unless 3D is specifically requested. In both instances they shall have an origin at a logical point located within the extents of each Block's masked area or volume.

b) CAD Dimensioning

Automatic CAD Dimensioning will be used at all times. Any dimensional change must involve the necessary revision to the model space file. If the CAD Quality Control Checks find that the revisions have not been correctly carried out, the rejection of the entire CAD submission will result.

c) CAD Layering

All CAD elements shall be placed on the layers allocated for each different discipline. The layer naming convention to be adopted by the Contractor shall be submitted for acceptance and inclusion within these standards.

d) Global origin, Location & Orientation on the Alignment Drawing.

Location or Plan information in "Model Space" files shall coincide with the correct location and orientation on the Project grid for each specific contract.

Location plans shall have at least three setting out points shown on each CAD "Model Space" file. Each setting out point shall be indicated by a simple cross-hair together with related Eastings and Northings co-ordinates. The Civil Contractor(s) will establish the three setting out co-ordinates for their respective works, which will then be used by all other contractors including the Contractor.

e) Line Thickness and Colour

To assist plotting by other users, the following colour codes will be assigned to the following line thickness/pen sizes.

Colour	**Code No**	**Line Thickness**
Red	10	0.18
White	7	0.25
Yellow	2	0.35
Brown	34	0.5
Blue	130	0.7
Orange	30	1.0
Green	3	1.4
Grey	253	2.0

f) CAD Utilization of 2D & 3D Files

Although the project standard is 2D CAD files, certain disciplines and contractors may use 3D CAD files for specific applications or where the isolated use of 3D aids the design and visualization process (i.e. Architecture, Survey and Utilities). In these specific instances 3D CAD data will only be transmitted if all other users can use this data. If this is not the case, a 3D to 2D translation shall be processed by the creator prior to issue.

g) CAD File Numbering

Contractors CAD File Numbering shall be described in 5.2.1 above. Employer CAD File Numbering Unlike most of the contractors, Employer will not be required to produced numerous CAD files. This will follow the numbering system Except that the status of the drawing in 5.2.1 (E) shall be "E".

h) CAD File Naming Convention – General

CAD "Model Space" files shall be named in accordance with general drawing conventions

Appendix- 10 Construction & Site Management

10. THE SITE

10.1 Location and Boundaries

10.1.1 Works Areas are those areas identified in Appendix 2 to these Employer's Requirements and on the Drawings.

10.1.2 Within 28 days from Commencement Date, the contractor shall submit detailed and comprehensive Site Environmental, Social, Health and Safety plan (Appendix-13 of Employer's Requirements) based on Environmental, Social, Health and Safety (ESHS) manual.

10.1.3 Within 28 days of the date commencement, the contractor shall submit detailed Quality Plan (Appendix-20 of Employer's Requirements) demonstrating the proposed method of achieving the required quality standards of the Employer as defined in the Employer's Requirements.

10.1.4 Normal working hours at site will be as stated in the Contract Data. However, the Contractor, if required, shall carry out work during night hours or in shifts with the approval of the Engineer. No increase in rates or extra payments shall be admissible for night work.

10.2 ACCESS TO THE SITE

10.2.1 The Contractor shall be deemed to have inspected, examined and made himself fully familiar with the access routes necessary for the proper execution of the Works and accounted for in the Accepted Contract Amount any costs arising in connection with the accessibility to the ROW. The Employer will not be responsible for any claims which may arise from the use of or otherwise in connection with any access route. The Employer does not guarantee the suitability or availability of any particular access route and will not entertain any claim for any non- suitability or non-availability of any such route for use (whether continuous or otherwise) during the Contract Period.

10.2.2 The Contractor shall make its own arrangements, subject to the consent of the Engineer, for access required to the Site. The Contractor shall negotiate with the landowners or other appropriate government agencies to seek temporary occupation of land and seeking necessary permission for construction of temporary access roads.

10.3 CONTRACTOR OPERATIONS OUTSIDE THE SITE

10.3.1 The Contractor shall be solely responsible for acquiring any additional land (land in addition tothe Site) required by him for his Temporary Works areas outside the ROW, at his own expense,including maintaining and reinstating the same on completion of the Works to the entire satisfaction of the land owner and the Engineer.

10.3.2 The Contractor shall make the necessary arrangements with landowners and relevant government authorities for any work to be undertaken outside the Site. Two copies of all the relevant documents/ permissions/ agreements, etc., as required by the Engineer in respect of the land arranged by the Contractor outside the Site, shall be submitted to the Engineer. Before commencing operations, the Contractor shall also submit to the Engineer a detailed plan and a programme of the Works to be carried out in the works area, including areas outside the Site.

10.3.3 When using and/or occupying works areas on existing public roads, the Contractor shall undertake all necessary procedures and mitigation measures as per the requirements set by the relevant authorities.

10.3.4 The Contractor shall submit to the Engineer proposals for the use and occupation of such works areas. Any such proposal shall be submitted to the Engineer at least twenty-eight (28) days prior to the start of the programmed use of the specific works area.

10.3.5 On completion of the Works, the land arranged by the Contractor outside the Site shall be restored back to its original condition to the entire satisfaction of the land owner and the Engineer.

10.4 SITE SECURITY

10.4.1 The Contractor shall be wholly responsible for security on the Site and any other areas being used by him or any Subcontractors for the purposes of the Contract. The Contractor shall implement and cause Subcontractors to implement proper security management procedures in accordance with the approved security management plan described in Appendix 13 (Environmental, Social, Health and Safety Management Manual)

10.4.2 The Contractor shall assign on the Site an appropriate safety and security organisation headed by experienced and professionally qualified safety and security personnel, who shall be primarily responsible for the Contractor's security services and shall fully cooperate with the Employer's security organization throughout the Time for Completion.

10.4.3 The Contractor shall prepare and submit to the Engineer for approval a security management plan (it may be included in the Environment, Social, Health and Safety Management Plan) fully complying with not only the relevant applicable Laws but also the regulations of the Employer which may be imposed from time to time on the Project within twenty-eight (28) days after the Commencement Date or at least one week before commencing the Works on the Site or any other area being used by the Contractor (whichever is the earlier). The plan shall include detailed procedures for daily security management operations as described in Appendix 13 (ESHS Manual) of General Specifications.

10.5 Possession of Third Parties Facilities

10.5.1 The definition of "Possession" to be applied in this Clause is 'possession of a segment or stretch of the Works and/or Indian Railways (IR) track(s) and/or other related authorities required by the Contractor from the Employer and/or IR and/or other related authorities for execution of the Works during the Time for Completion and/or after issue of the Taking- Over Certificate and during the Defects Notification Period for maintenance / rectification of any defects in the Works.

10.5.2 While undertaking construction activities within an existing railway line or road under the Contractor's Possession, the Contractor shall abide by the rules/guidelines included within the relevant manuals of Indian Railways and/or the National Highways Authority of India (NHAI)/Public Works Department (PWD)/ Panchayats/ Municipal Corporations and/or any other authority.

10.5.3 The Contractor shall undertake any construction activities on existing 'live' or operating lines only after the grant of Possession by the relevant authorities.

10.5.4 An area under the Contractor's Possession is the sole responsibility of the Contractor and all issues relating to safe working within that area, including the movement of traffic, are his responsibility.

10.5.5 If the Contractor has more than one work front within the same Possession, one person shall be nominated by the Contractor as the person responsible for the coordination for all work fronts within the Possession.

10.5.6 The Contractor shall ensure that construction activities shall be undertaken strictly within the area which is under the Contractor's Possession.

10.5.7 The Contractor shall appoint a responsible person who shall coordinate with the Employer, IR/ relevant authorities, Interfacing Contractors and Interfacing Parties as applicable and who shall act as the Possession Coordinator for the Contractor. The person appointed shall have experience of IR/ relevant authorities operations and shall be fully aware of IR Rules and Regulations related to possession of track for construction of railway works and in accordance with IR/ relevant authorities regulations to issue Possession requests. For the purposes of the Works, such person shall be duly certified in accordance with the said Rules and Regulations, if required.

10.5.8 The Contractor shall use Possessions on the line as follows:

10.5.9 For each particular Possession and depending on the duration and the location of the Possession, alternative route(s) may be required, such alternative diversion route(s) if required to be constructed, shall be at the Contractor's cost.

10.5.10 The normal alternative mode of transport will be proposed by the Contractor, and the route and timings of this alternative transport are to be agreed with the Engineer / IR / Road Authorities / Panchayat prior to obtaining Possessions.

10.5.11 The Employer shall provide assistance necessary to the Contractor to enable him to obtain the Possessions required by him, subject to being approved by IR, NHAI or relevant authorities. No claim shall be entertained by the Employer on this account.

10.5.12 The Contractor's request for Possession shall include a technical and organizational schedule and submit the same to the Engineer for his consent.

10.5.13 The Contractor shall submit his requests for Possessions well in advance as per requirements of relevant authorities.

10.6 Damage and Interference

10.6.1 General

Work shall be carried out in such a manner that there is no damage to or interference with:

a) watercourses and drainage system,

b) Utilities,

c) Structures (including foundations), roads including street fixtures or other properties;

d) Public or private vehicular or pedestrian access, and

e) Monuments, graves or burial grounds other than to the extent that it is necessary for themto be removed and reinstated to permit the execution of the Works.

10.6.2 Heritage structures shall not be damaged or disfigured on any account. The Contractor shall inform the Engineer as soon as practicable of any items which are not stated in the Contract to be removed or diverted but which the Contractor considers necessary to be removed or diverted to enable the Works to be carried out. Such items shall not be removed or diverted until the approval of the Engineer has been obtained.

10.6.3 Assets/ items of the Employer, Indian Railway (IR), Other Contractors and any other entities and relevant authorities which include, but are not limited to, water, sewage, gas authority, electrical, OFC communication cables etc. carried out shall be replaced / reinstated by the Contractor to the same condition as existed before the Works started and to the satisfaction of the Engineer and the concerned entity.

10.6.4 In case of damage to the existing cables, the Contractor shall have suitable procedure for cable joining under the technical supervision of IR or the relevant authority.

10.6.5 The Contractor shall indemnify the Engineer, Employer, Indian Railway, Other Contractors and relevant authorities against any damages or any penal action, any claim or legal action as a result of the damages.

10.7 Utilities

The Contractor shall follow the requirements on care for utilities as specified in this Appendix below.

10.8 Structures, Roads and Other Properties

10.8.1 The Contractor shall carry out a precondition survey of all roads and structures and drainage channels adjacent to the Site. Contractor originated deterioration of the roads and damage to adjacent structures and drainage facilities shall be reported to the Engineer with appropriate records.

10.8.2 The Contractor shall maintain / replace / reinstate to the same condition as existed before the Works started and to the satisfaction of the Engineer and the concerned entity.

10.9 Access

10.9.1 Where existing access to premises either public or private is damaged or unusable, alternative access shall be provided by the Contractor to enable the Works to proceed. The arrangements for the alternative access shall be as agreed by the Engineer, the relevant authorities and the owners of the premises affected.

10.9.2 Unless agreed otherwise, the permanent access shall be reinstated as soon as practicable after the Works are complete and the alternative access shall be removed immediately when it is no longer required, and the ground surfaces reinstated. Proper signage and guidance shall be provided for traffic/ users diversions.

10.10 Trees

10.10.1 Materials, including excavated materials, shall not be banked around trees. Trees shall always be protected from damages.

10.10.2 Unless otherwise consented to by the Engineer, trees shall not be trimmed or cut as stated in Appendix 13 [ESHS Manual]

10.11 Removal of monuments, graves, burial grounds and other obstruction

If any graves and other obstructions are required to be removed in order to execute the Works and such removal has not already been arranged, the Contractor shall draw the Engineer's attention to them in good time to make the necessary arrangement for authorization for removal.

10.12 Protection of the Other Adjacent Structures and Works

The Contractor shall take all necessary precautions during the construction to protect structuresor works being carried out by others, adjacent to or within the Site from the effects of vibrations,undermining or any other earth movements or the diversion of water flow, arising from its work

10.13 Defined Area and Train Operation

10.13.1 When the Project under construction has been made available for track and system related installation works, the area will be classified as a Defined Area for train movement. The definedarea shall be controlled by the Lead Contractor (as nominated by Engineer) with regard to access.

10.13.2 All persons whose duties require them to work within a Defined Area must have been required to be examined for safety knowledge and to have been safety inducted. Evidence of safety induction must be exhibited whenever present or working in a defined area. All persons present in defined areas are required to observe safety rules and procedures to be defined by the Contractor and reviewed without objection by the Engineer.

10.13.3 The Contractor shall ensure that the necessary rules and procedures for all persons are published from time to time and communicated to the workers and/or agents and the Interfacing Contractors on the Site. The Contractor shall also ensure that all such rules and procedures are being followed during the course of all works and construction activities at the Site.

10.13.4 When overhead lines are energized, Train Sets/Cars may be moving in the Defined Area. No work shall be undertaken on the tracks when Train Sets/Cars are moving. Procedures for obtaining access to the energized tracks will be detailed in the rules. The Contractor shall make requests for obtaining access to the energized track or in the vicinity of the tracks as per the approved and notified rules and procedures.

10.13.5 After overhead lines are installed, the lines are energized, the Contractor shall comply with the rules / measures against electric shock.

10.14 Site Clearance

The contractor shall clear the Site as required by demolishing all buildings, structures (above and below ground such as brick, concrete, steel, etc.) and removing all rubbish as agreed by the Engineer. The Site shall also be cleared of vegetation, trees, stumps roots, etc. as mentioned in Appendix 13 (ESHS Manual). All material so cleared from the site shall be disposed off by the Contractor outside the ROW as directed by the Engineer.

10.15 MOBILIZATION AND DEMOBILIZATION

10.15.1 General

a) The Contractor shall mobilize to the Site the Contractor's Equipment and the Contractor's Personnel as appropriate for the execution and completion of the Works in strict accordance with the requirements of the Contract.

b) The Contractor shall demobilize Contractor's Equipment and Contractor's Personnel from the Site as appropriate when they are no longer required to be on the Site.

10.15.2 Engineer's Consents

a) The Contractor shall inform the Engineer regarding mobilization of Contractor's Equipment, including that required for use by any Subcontractor, at least seven (7) days before the date planned for the mobilization of same to the Site. The Contractor should note that:
   i. the Contractor shall be solely responsible for the consequence of any such mobilization;
   ii. the relevant insurances shall be in place as evidenced by insurance documents included in the application;

b) The Contractor's Equipment shall be mobilized to the Site complete with all necessary spare parts, consumables and the like indispensable for proper operation and maintenance thereof. The Contractor shall provide maintenance facility complete with qualified maintenance personnel on or in the vicinity of the Site.

c) The Contractor shall obtain a written consent from the Engineer before removing any of the Contractor's Equipment from the Site or any managerial person among the Contractor's Personnel mobilized exclusively for the Contract. Provided that the proposed demobilization is in accordance with the Contractual Works Programme to which the Engineer has given consent and that the Contractor shall be solely responsible for any consequences of such demobilization, the Engineer shall not unreasonably withhold consent.

d) Although they are deemed intended for exclusive use on the Works as set forth in Sub-Clause4.17 of the General Conditions of the Contract, the Contractor may divert any of the Contractor's Equipment to other uses within the Site, provided that the Contractor's written undertaking to return the same to the Works whenever needed is submitted to the Engineer and the Engineer's written consent to such diversion is granted.

10.16 Records

In addition to the Monthly Progress Reports described in Appendix 7 [Monthly Progress Report Requirements] of the Employer's Requirements, the Contractor shall submit to the Engineer, on a daily basis, details of the mobilization and demobilization of any of the Contractor's Equipment or any managerial person among the Contractor's Personnel.

Without undue delay after demobilization from the Site, the Contractor shall submit to the Engineer copies of certified evidence of lawful re-export from the Country of any Contractor's Equipment imported into the Country on a temporary basis exclusively for use on the Contract.

10.17 Mobilization

10.17.1 The Contractor shall mobilize to the Site the Contractor's Equipment and the Contractor's Personnel as appropriate for the execution of the design, construction and completion of the Works. An Initial Mobilization Plan for the 3 months following the Commencement Date shall be submitted to the Engineer within 7 days after the Letter of Acceptance has been received by the Contractor. An overall Mobilization Plan for the Works shall be submitted to the Engineer for his approval within 90 days after the Commencement Date.

10.17.2 In the event that manufacturing activities are to be carried out outside the Republic of India, the Contractor shall submit detailed organizational structure(s) for such manufacturing teams. This submission shall include the organization of such teams and details of the key personnel,

including contact address, i.e., the addresses of the locations where such manufacturing activities are carried out and the e-mail address of each key personnel.

10.17.3 The Mobilization Plan shall include, but not be limited to the following:

a) Details of each major item of Contractor's Equipment, i.e., the name, size and capacity etc. of each item.

b) The number of each equipment and the time of mobilization and duration of the use of each equipment.

c) The name and details of key personnel for each section of the Works and their responsibilities.

d) Details and time for installation of temporary facilities for the Works including temporary facilities for the Employer and the Engineer.

e) The numbers of Contractor's Personnel, including site engineers, administrative staff and labour in each trade category.

10.18 Demobilization

Demobilization shall be carried out in accordance with the provision of Sub-Clause 4.22 [Contractor's Operation on Site], and Sub-Clause 11.11 [Clearance of Site] of General Conditions. Upon receiving the Performance Certificate under Sub-Clause 11.9 [Performance Certificate], the Contractor shall carry out the Clearance of the Site and the Contractor shall inform in writing to the Employer the completion of Demobilization or Clearance of Site and obtain the consent of the Employer. In case the Clearance of Site has not been completed in a specified period by the Contractor, the Employer may carry out the Clearance of Site. The Employer shall be entitled subject to Sub-Clause 20.2 [Claims for Payment and/or EOT] to payment by the Contractor of the costs reasonably incurred in connection with, or attributable to, such sale or disposal and reinstating and/or cleaning the Site, less an amount equal to the moneys from the sale (if any). In case the Taking-Over is conducted section by section, the Contractor shall inform in writing to the Employer the completion of Demobilization of the section and obtain the consent of the Employer or the Engineer as a representative or on behalf of the Employer.

10.19 SITE ACCOMMODATION FOR THE EMPLOYER/ ENGINEER

10.19.1 One Site Accommodation (total area 250 sqm) for the Engineer's & Employer's Staff including Meeting Room shall be provided.

10.19.2 Offices shall be accessible only from a corridor within the building. The corridor and reception area shall be provided with an external double door. The office will be provided with electronic surveillance system as approved by Engineer.

10.19.3 Materials for the construction shall be new, robust and durable. The building shall be weather proof, vermin proof, well insulated thermally and acoustically. Internal walls shall be soundproof. Electrical power/lighting, shall be proved to each room, including air-conditioning and heating to maintain the internal temperature within the range of 20 to 24 degrees Celsius at all times.

10.19.4 Internal doors shall be flush, fitted with door closers, mortice locks with keys and lever handles.

10.19.5 External doors shall be a pair of solid core doors, external quality, hung on heavy duty hinges, one leaf fitted with barrel bolts top and bottom and the other leaf fitted with a Yale or similar lock.

10.19.6 Windows, of area not less than 10% of the floor area, shall be provided to all rooms, securely barred, fitted with blinds and having opening sections fitted with locks and mosquito screens.

10.19.7 The building shall be provided with a continuous water supply and drainage to Kitchen, Washroom and Toilets. The Toilets shall be equipped with low level suites and be adequately ventilated through the ceiling.

10.19.8 The Kitchen shall be fitted out with a 2-drainer stainless steel double sink unit, worktop with cupboards under, tiling above the sank and worktop and wall mounted cupboards.

10.19.9 Fire and Safety regulations shall be complied with and fire fighting equipment shall be provided in accordance with the statutory requirements.

10.19.10 The Contractor shall provide, erect, and maintain appropriate name boards as specified, for each of the offices. The working shall be agreed with the Engineer.

10.19.11 The Contractors shall provide the following new furniture and equipment for the exclusive use of the Engineer's Staff:

No.	Item	Nos
	Furniture	
1	Sofa set	2
2	Desk with side drawers.	10
3	Swivel Office Chair with arm rests	8
4	Swivel Office chair without arm rests.	10
5	Typist Chair	12
6	Visitor's Chair	1
7	3-Shelf Bookcase	2
8	4-Drawer Lockable Filing Cabinet	5
9	Lockable Cupboard 2m high, with shelves.	10
10	Table	3
11	Photocopier A4/A3 capable of reduction	2
12	Paper shredder	1
13	Desk Tray sets	2
14	Desk mounted pencil sharpeners	4
15	4-hole paper punches	4
16	Waste paper baskets	1

17	Refrigerator	1
18	Potable Water-cooler cum dispenser	1
19	Microwave oven	1
20	Cups, glasses, plates, cutlery for 12 persons,	2 sets
21	Electric kettle, coffee and tea pots	As required
22	Office consumables for the duration of site activities	As required

10.19.12 The Contractor shall provide protective clothing and safety equipment for 20 persons, comprising, as a minimum – Safety Helmets Safety Harness, Steel-toed construction boots (size to be notified), Day-Glo waistcoat, industrial safety goggles, Ear protectors.

10.19.13 The Contractor shall provide an adjacent shaded parking area for 5 cars.

The Contractor shall arrange for upkeep, service and security of the offices and compound. These to be thoroughly cleaned and for rubbish and waster to be removed, at least once per day.

10.20 SURVEY AND SETTING OUT

10.20.1 General

a) A survey shall be carried out of the Site to establish its precise boundaries and the existing ground levels within it. This survey shall include a drone cum photographic survey sufficient to provide a full record of the state of the Site before commencing the work with particular attention paid to those areas where reinstatement will be carried out later on. The survey shall be carried out before the site clearance wherever possible and in any case prior to the commencement of work in any Works Area. The survey shall be carried out by the Contractor and agreed with the Engineer. Videography by drone shall also be done at all work places every one month as per Outline Construction Specifications for Civil Works.

b) The Contractor shall plan and programme for the validation of any Site data provided by the Employer and develop a Survey Plan and Programme. The Contractor shall submit a Survey Plan and Programme to the Engineer for consent within 28 days after the Commencement Date. Generally, the contents of the Survey Plan and Programme shall comprise the following:

(1) The Contractor shall establish a horizontal and vertical control system (x, y, z) at the Site and establish Haryana Orbital Rail Corridor (HORC) benchmarks using the TBMs provided by the Employer and locate/ confirm the ROW marks given by the Employer. The scaling factor shall be as approved by the Engineer.

(2) The Contractor shall carry out validation of the Site data provided by the Employer, and any additional topographic surveys considered necessary by the Contractor, in order to:

i. validate the Horizontal and Vertical Alignment with no change in alignment;

ii. prepare Alignment "Plan and Profile" Drawings; and

iii. review the data with which the Contractor shall eventually draw up the cross-section drawings at required locations.

The Contractor shall summarize the results of their validation of the Site data and any additional surveys carried out in a Survey Report and develop a Site Location Map, and a Structure Setting-Out Map and submit them to the Engineer for consent. Finally, the Contractor shall set out the Works to commence the construction with consistent accuracy and entirely throughout the construction stages.

10.20.2 Horizontal and Vertical Control System

a) A set of the benchmarks comprising a horizontal control system (x, y) and vertical control system (z) shall be established at the Site based on the Temporary Bench Marks which are established and maintained by the Employer and the Global Navigation Satellite System (GNSS) Survey, applying the Universal Transverse Mercator (UTM) coordinate system and World Geodetic System 84 (WGS 84). A description of the various benchmarks along the route alignment has been provided by the Employer along with their height above Mean Sea Level. The Contractor shall ensure that the horizontal and vertical position (x, y. z) of each HORC benchmark shall not be subject to any interference and that they shall not be affected by any of the Permanent and Temporary Works.

b) All pillars shall be of CC in dimensions of 450 mm x 450 mm x 900 mm with a projection of 300 mm above ground . The exposed surfaces of the pillars shall be appropriately painted with enamel paint of a colour as specified by the Engineer so as to be easily identifiable. The foundation shall be as indicated in the Reference Information/Reports. Details shall be developed by the Contractor and be submitted to the Engineer for review. Each pillar shall be protected by retractable fencing or other similar measures so as to prevent the occurrence of any movement, disturbance, interference and/or damage.

c) The Contractor shall establish additional benchmarks (x, y, z) which shall be staked and identified, and clearly painted in a different colour from the HORC benchmarks as approved by the Engineer. These temporary benchmarks shall be used for running a closed traverse for checking the HORC benchmarks. The pillars for additional benchmarks shall be staked at an interval of 500 m on both sides of the alignment at ROW and at abutment locations of major RUB.

d) The Contractor shall plan and programme to establish a horizontal and vertical control system at the Site by GNSS and correlate and adjust the system based on the benchmarks provided by the Employer or with reference to the existing control points as specified by the Engineer. The Contractor shall develop such plan and programme as part of the Survey Plan and Programme and submit to the Engineer. The Survey Plan shall include, but not be limited to, details of survey methods, error adjustment/correction, accuracy achieved, means to maintain accuracy, and coordination with others with respect to consistent accuracy in entirety.

e) The Contractor shall summarize the Traverse Survey results with verification studies in a HORC Benchmark Establishing Report.

f) Upon establishing the HORC Benchmarks and completing all necessary adjustments, the final and detailed survey data of the HORC Benchmarks shall be submitted to the Engineer for consent. Upon receipt of the Engineer's consent to the HORC Benchmark Establishing Report, the system shall be the sole horizontal and vertical control system (x, y, z), with reference pillars provided with coordinates (x, y, z), as described herein and shall be referred to as the HORC Benchmarks which shall be consistently applied to the Works under this Contract. A HORC Benchmark Establishing Report containing Traverse Survey results shall also be included as part of the Survey Report.

g) The HORC Benchmarks shall be periodically checked (at such intervals as consented to by the Engineer) by running closed traverses and closed level works. The Contractor shall submit the results to the Engineer for review. The periodical checks shall include the nearest equivalent benchmarks established by Interfacing Contractor(s), with whom the Contractor shall communicate and coordinate. If any discrepancy deemed to be crucial is found, the Contractor shall carry out appropriate corrective measures under the instruction of the Engineer.

h) The equipment to be used in the survey to establish the horizontal control system shall be Static GNSS System (horizontal/vertical) and Total Stations of 1" accuracy and to establish the vertical control system shall be Digital Level (and/or auto levels) which have sufficient accuracy to meet the requirements given hereinafter. The Contractor shall submit a certificate from the manufacturer or his authorized service agent for the equipment and peripherals. The date of the calibration certificate shall not be more than one (1) month from the date of commencing the survey. The calibration shall be checked and re-validated at pre-determined intervals, and in any event before the expiry of the calibration certificate.

i) Universal Transverse Mercator & Global Coordinates of TBM are described in Reference Information/Reports for the Contractor's reference.

10.20.3 Requirements for Horizontal Control

a) The Contractor shall establish a horizontal control system at the Site by GNSS, providing each HORC Benchmark with a horizontal coordinate (x, y). The horizontal coordinate (x, y) shall be checked with reference to the existing control points, if available. The Contractor shall coordinate with adjacent Interfacing Contractor(s) to ensure that the HORC Benchmarks established by the Contractor and the equivalent benchmarks established by the Interfacing Contractor(s) are consistent. The Contractor shall include the survey results and the description in the Survey Report as described in the following paragraphs. Upon consent of the Engineer, the system shall be the sole horizontal control system for the Works under this Contract.

b) The horizontal control system shall be developed by GNSS and by running a closed traverse on the HORC Benchmarks and the temporary benchmarks along the alignment.

c) The maximum length of a traverse to be closed shall be around 5km and the number of azimuth courses within an azimuth check shall not exceed twenty-five (25). The Contractor shall compute angular closing error of the traverse followed by linear error. Limits of traverse for horizontal control shall have the following accuracy:

Angular error of closure:	15" (N)0.5 (N: number of angles measured) Where N shall not exceed twenty-five (25)
Total linear error of closure:	1 in 25,000 (after angular adjustment)

d) The error within the permissible limits of the traverse line shall be balanced by the Transit Method. In case the errors are beyond the above permissible limits, a traverse survey shall be carried out until the resulted error is within the permissible limits.

e) The Contractor shall summarize the established coordinates (x, y) with necessary adjustments of all HORC Benchmarks, along with raw observation data downloaded from the Total

Station, together with the calculation process and descriptions of all HORC Benchmarks and submit them to the Engineer for his review.

10.20.4 Requirements for Vertical Control

a) The Contractor shall establish a vertical control system at the Site by Direct Levelling, providing each HORC Benchmark with a vertical coordinate (z). The vertical coordinate (z) shall be checked with reference to as many of the GTS Benchmarks of the Survey of India as practical, to ensure the entire vertical control system is consistent, including the equivalent system of adjacent Interfacing Contractor(s). The Contractor shall include the survey results and the description in the Survey Report as described in the following paragraphs. Upon consent of the Engineer the system shall be the sole vertical control system for the Works under this Contract.

b) The vertical control system shall be developed by running a closed level work on the HORC Benchmarks and the temporary benchmarks along the alignment. The Contractor shall close the level work at an appropriate interval and find out the closing error as described in the following paragraph.

c) Each level work shall be connected with the HORC Benchmarks which have consistent accuracy and entirety in the system and the system of adjacent Interfacing Contractor(s) and shall be properly maintained at the Site. The closing error of loop closure shall not exceed 12 (K)0.5 [mm], where K is the circuit length in kilometres, where K shall not exceed 5 kilometres. In case the accuracy of loop closure exceeds the limit defined herein, the entire loop shall be repeated until the desired accuracy is achieved.

d) The Contractor shall summarize the established coordinates (z) of all HORC Benchmarks with necessary adjustments along with raw observation data, calculation sheets and descriptions of all control marks in spreadsheet (MS Office Excel) format and submit to the Engineer for review.

10.21 Topographic Survey

a) The Contractor shall be responsible for carrying out validation of any Site data provided by the Employer and any additional surveys considered necessary by the Contractor for the execution of the Works, and shall ensure that the topography of the Site has been accurately recorded so that he can be fully satisfied to commence and proceed with the Works. The HORC Benchmarks as established by the Contractor shall be consistently used for surveys.

b) The Contractor shall confirm and locate all the Right of Way (ROW) marks given by the Employer at the Site and provide them with coordinates (x, y, z) so that both the Alignment and ROW are located based on the same horizontal control system.

c) The Contractor shall develop the documents including all reports, drawings, and maps. The Contractor shall summarise the results of Validation of Data, Additional Survey and Setting Out in the Survey Report. The submittals to be developed by the Contractor shall include but not be limited to the following:

a) the HORC Benchmark Establishing Plan;

b) the Survey Plan;

c) the HORC Benchmark Establishing Report;

d) the Survey Report;

e) the Site Location Map;

f) the Structure Setting-out Map;

g) the As-Built Alignment Plan and Profile Drawings; and

h) the Cross-Section Alignment Drawings (as required).

d) During the traversing of peripheral areas, the Contractor shall survey and record the broad alignment of important geographical and other features such as roads, watercourses and the locations of important buildings and facilities, etc., whenever considered necessary for development of the design.

10.22 Horizontal Alignment Staking

a) The Horizontal Alignment defined by the coordinates (x, y) of the centerline of the track of Priority Section shall be staked at an interval of twenty (20) meters in addition to TPTC, TP, TPCC points along the proposed alignment. While staking the Horizontal alignment at Site, the Contractor shall confirm the Right of Way (ROW) staking already done by the Employer at Site and provide and install any missing stakes. The Contractor shall ensure that staking of the ROW is carried out as per the relevant provisions of Indian Railways Engineering Code.

b) The Contractor shall consistently use the TBMs provided by the Employer in addition to the benchmarks established by the Contractor for staking the alignment. The proposed formation level shall also be also marked on stakes to indicate embankment height or excavation depth.

c) Upon completing the Horizontal Alignment staking and providing all the ROW marks with coordinates (x, y, z), the Contractor shall submit to the Engineer the final coordinates (x, y, z) data of the Vertical Alignment at an interval of twenty (20) meters, the ROW coordinates (x, y, z) at an interval approximately twenty (20) meters, horizontal alignment calculation report including curve details at every twenty (20) meters (transition curves, circular curves, IP coordinates (x, y, z) and direction).

d) The Contractor shall summarize the survey results of the Right of Way marks given to the Contractor by the Employer and the Centre Line Survey and the Right of Way staking and submit to the Engineer for his consent.

e) Upon the consent of the Engineer to the report, the confirmed Alignment and Right of Way marks, including maps and drawings which confirm the ROW as well as any control points established by the Centre Line and Right of Way staking, shall become the responsibility of the Contractor. The Contractor shall ensure that these marks and control points are protected and maintained and remain consistent throughout the Time for Completion.

10.23 Setting Out

a) The Contractor shall set out the Works at the Site. The Contractor shall ensure that all the

b) Permanent Works are accurately set out.

c) The setting-out of the Works shall be carried out based upon the Drawings which have been issued with a approval and have been issued to the site ''For Construction''

d) The Contractor shall consistently apply the HORC Benchmarks to the setting-out.

10.24 Auxiliary Works

In addition to the requirements specified elsewhere in the Works Requirements and the Conditions of Contract, the Contractor shall follow good industry practice when carrying out surveying, setting out and associated activities, which includes but is not limited to the following:

a) performing all necessary calculations accurately and presenting all computations and results clearly in order to facilitate verification by the Contractor and Engineer;

b) removing machinery and obstructions from required sight-lines;

c) prior to carrying out surveys, setting out or similar works, stopping or relocating any operating machinery, drilling, blasting, pile driving or the like which may cause ground or structure vibration; and stopping any activity which could generate smoke, dust, gas, etc., thereby obscuring clear views or causing refraction, which would thereby interfere with such survey works;

d) restricting or stopping pedestrian and/or vehicular traffic near instruments or in sight-lines during instrument observations, as required;

e) providing adequate equipment, labour and materials as deemed necessary and suitable to carry out control and any other surveys required.

10.25 Geotechnical/Geological Survey

a) Contractor's Surveys

b) The Contractor shall be responsible for carrying out validation of any Site data provided by the Employer and any additional geotechnical/geological or other surveys which, in the Contractor's opinion, are considered necessary for the execution of the Works.

c) Geotechnical Interpretative Report

d) The Contractor shall prepare and submit to the Engineer for review a Geotechnical Interpretative Report which includes site investigation results and the geotechnical interpretation of site investigation work including that undertaken by the Contractor in sufficient detail to confirm and justify parameters used in the design of temporary works. The report shall include full borehole logs, geological profile and descriptions of confirmatory boreholes drilled by the Contractor. The requirements for this Report are described in the Works Requirements.

10.26 Other Related Surveys

The Contractor shall be responsible for carrying out validation of any Site data provided by the Employer and any other surveys considered necessary by the Contractor for the execution of the Works. Such surveys may include, but are not limited to, the following:

a) Topographic Survey

b) Utilities Survey including Adjacent Structures and Works with Works Areas

c) Environmental Survey

10.27 Temporary Facilities

10.27.1 General

a) The Contractor shall be entirely responsible for the provision, erection, maintenance and removal on completion of all required temporary facilities, as part of the Temporary Works, which are required for the proper execution and completion of the Permanent Works. Such temporary facilities shall include the Contractor's offices, laboratories, workshops, stores, utilities, services, accommodation, canteens, recreational and welfare facilities, health, safety, security and environmental protection facilities and the like, whether on or off the Site.

b) The Contractor's Personnel shall not be allowed to live on the Site. A limited number of security personnel designated to secure the Contractor's facilities will be permitted to stay after working hours subject to the approval of the Engineer. The Contractor shall make all necessary arrangements for suitable off-Site accommodation and transportation for the Contractor's Personnel.

c) All of the Contractor's temporary facilities on the Site or elsewhere within the Project site shall be designed, provided, erected, maintained and removed to the satisfaction of the Engineer and in strict accordance with applicable Laws. The Contractor shall obtain all necessary approvals and permits from the relevant authorities having jurisdiction for the provision, erection, operation, maintenance and removal of the Contractor's temporary facilities.

d) All of the Contractor's temporary facilities, other than those designated to remain, are to be removed on the completion of the Works and the ground surfaces reinstated to the satisfaction of the Engineer.

e) When deemed essential for the preservation or maintenance of health, safety, security and/or environmental protection, the Engineer may instruct the Contractor to modify the Contractor's temporary facilities, regardless of any approvals or consents previously given, and the Contractor shall promptly comply with such instructions. These instructions shall not constitute Variations.

10.28 Location of Area for Temporary Facilities

10.28.1 The Contractor shall be aware that the area for temporary facilities is not for the Contractor's exclusive use, and the Contractor shall cooperate fully with the Interfacing Contractors if it becomes necessary for the efficient use of a limited area among the said Interfacing Contractors.

10.28.2 The precise locations of the Contractor's Temporary Works including the temporary facilities within and outside the Site area shall be proposed by the Contractor and approved by the Engineer.

10.28.3 The Contractor shall submit drawings showing the proposed locations and outlines of the proposed temporary facilities. Drawings and details of the Temporary Works for a particular part of the Permanent Works may be submitted as part of the shop or working drawings and/or the work method statements forming part of the Contractor's Documents. These locations and outline drawings for the temporary facilities shall be submitted twenty-eight (28) days before commencing the construction of any temporary facility or twenty-eight (28) days after the Commencement Date. These drawings and outlines shall be updated whenever addition or removal of any facility is planned. Detailed drawings for any particular temporary facility, showing all necessary utilities and services, shall be submitted at least fourteen (14) days before the planned commencement date of construction thereof.

10.28.4 The areas for the Contractor's temporary facilities may also be used for temporary storage of excavated material suitable for reuse in embankment or fill for the Works, or for use by the Employer in future projects or on other works packages.

10.28.5 The Contractor shall dispose of all surplus topsoil and all subsoil materials arising from the Works in the designated area wherever available within the ROW of the Project as agreed by the Engineer. In case area for disposal of surplus soil is not available, the Contractor shall make his own arrangements outside the ROW and the Contractor shall bear all costs including royalty for using/disposing of excavated material unless otherwise specified in the Contract.

10.28.6 The Contractor is free to make his own arrangements for any additional areas required for the proper execution of the Works, and the costs of same shall be borne by the Contractor.

10.29 Site Offices

10.29.1 The Contractor shall be responsible for identifying and establishing suitable facilities for the Contractor's office facilities as approved by the Engineer.

10.29.2 The Contractor's Site offices and facilities shall be provided within or in the vicinity of the work site, with all necessary facilities including furniture, office equipment, office supplies, utility services, sanitary system and vehicle parking. The Engineer will have one (1) Sub-Site Office established for this Contract. The Contractor shall establish the same number of Sub-Site Office and Site Huts in close proximity to the Engineer's Offices.

10.30 Project Information Signboards

10.30.1 The Contractor shall provide one project profile sign board at each of the Site Offices of a size, minimum 1.5 m x 2.5 m, and maintain them in good condition. All information on the signboards will be written in English and local language for separate signboard. The signboards will be positioned on a steel frame as directed by the Engineer. The Contractor shall submit proposals for the signboard materials, the text layout (in English and local language) and installation of the signboards at the Site Offices of the Engineer and the Contractor for Engineer' s approval. Each sign board shall show:

a) The name of the Project and the Works,
b) The Location Map,
c) The name of the Bank,
d) The name of the Employer,
e) The name of the Engineer,
f) The name of the Contractor, and
g) All other details as required by the Engineer

10.30.2 The Contractor shall maintain the sign boards and remove them on completion of the Works or when instructed by the Engineer. The Contractor shall clean, update, maintain and replace the signboards if damaged, throughout the duration of the Contract. No additional payment shall be applicable for damaged signs which are required to be replaced.

10.30.3 Within twenty eight (28) days from the Commencement Date, the Contractor shall provide and install a Project information sign, as per the requirements for signboards at the Employer's/Engineer's Site Offices, at each of the entrance points to each Site Office location

(both the Contractor's and Employer's/Engineer's offices) and the Site entrances, or, as directed by the Engineer.

10.30.4 The Contractor shall maintain the signboards and remove them on completion of the Works or when instructed by the Engineer, so as to inform the public of the implementation of the Works and the Project and to advise road users of on-going construction.

10.30.5 The Contractor shall clean, update, maintain and replace the signboards if damaged, throughout the duration of the Time for Completion. No additional payment shall be applicable for damaged signs which are required to be replaced.

10.31 First Aid Station

10.31.1 The Contractor shall construct, equip, and maintain First Aid stations at a sufficient number of appropriate locations on the Site and at each labour camp.

10.31.2 The Contractor shall comply with all requirements specified in the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management]) and the Conditions of Contract.

10.32 Labour Accommodation Camps

10.32.1 The Contractor shall supply, equip and maintain facilities as necessary for the living accommodation, feeding and welfare of its employees by providing, servicing, and maintaining a camp at appropriate location(s), as necessary.

10.32.2 The Contractor shall comply with all requirements specified in the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management]) and the Conditions of Contract.

10.33 Site Storage and Yards

10.33.1 The Contractor's Site storage areas and yards shall be utilized for, among other things, material and equipment storage, casting of precast structural elements, workshops, warehouses and secure storage.

10.33.2 The Contractor shall erect a 2.0 metres high chained security fence around the Site storage areas and yards, complete with suitable lighting and lockable gates.

10.33.3 The location of each Site storage area and yard shall be determined prior to the commencement of the works and the Contractor shall propose the locations and details of same and submit to the Engineer for consent.

10.34 Borrow Areas and Quarries

10.34.1 It shall be the responsibility of the Contractor to arrange for borrow areas (for fill material) and quarry sites (for ballast, aggregate and rock material) using his own resources. The Contractor shall be responsible for carrying out his own investigations to verify the availability, sufficiency, quality and quantity of materials from such sources. The Contractor may also arrange any additional borrow areas and quarry sites as required by him, all at his own discretion. No claim whatsoever shall be entertained by the Employer in this regard.

10.34.2 All costs and charges, including but not limited to permits, royalties, duties, taxes, rental or other costs associated with land or the temporary use of same, etc. as applicable, for arranging borrow areas and quarry sites and access thereto, including for the extraction of material therefrom, shall be borne by the Contractor.

10.34.3 Before commencing operations in each of the borrow areas and quarry sites, the Contractor shall submit a detailed plan of his operations and demobilization/grading and finishing/reinstatement, etc. in respect of the same to the Engineer for his approval, together with relevant drawings.

10.34.4 The quality of fill material, aggregates, etc. extracted from borrow areas and quarry sites shall meet the Works Requirements and be subject to the consent of the Engineer.

10.34.5 Borrow areas, quarry sites and the installation of rock crushers shall not be permitted within the ROW.

10.34.6 On completion of the Works, the Contractor shall leave borrow areas in a safe and stable condition.

10.34.7 The Contractor shall indemnify the Employer against all claims in relation to borrow areas and quarry sites both during the Time for Completion and after the Works are completed and taken over.

10.35 Stockpile Areas

10.35.1 The land available, if any, within the ROW may be used by the Contractor for storage of materials required for the project, subject to the consent of the Engineer.

10.35.2 The Contractor may also arrange any additional stockpile areas as required by him at his own discretion and cost.

10.35.3 The location and size of stockpile areas proposed by the Contractor shall be subject to consent of the Engineer. The Engineer's consent may be withheld, if:

a) in the opinion of the Engineer, a stockpile area or access thereto may be such as:
   i. would have a detrimental effect on the natural and social environment;
   ii. would disturb drainage system(s) around the stockpile areas;
   iii. would constitute a danger to the public; or
b) at the Engineer's discretion, a stockpile would become too high.

10.35.4 Before commencing operations, the Contractor shall submit detail drawings of the proposed stockpile areas, together with the proposed method of operation, including stockpile heights, angles of repose, runoff / dust control measures, access road layouts, drainage, measures to be taken for restoration, all verified by appropriate calculations and analysis.

10.35.5 On completion of stockpiling operations, the Contractor shall reinstate stockpile area(s) to a safe and stable condition.

10.35.6 The Contractor shall indemnify the Employer against all claims in relation to stockpile area(s), both during the Time for Completion and after the Works are completed and taken over.

10.36 Contractor's Plants.

10.36.1 The Contractor shall plan, install, erect, maintain, dismantle and remove all plants required for the Works, including but not limited to major items such as concrete batching/mixing plants, rock crushers, casting yard, curing yard, stacking yard etc. of sufficient number and capacity to meet planned peak requirements during construction. The capacity of such plants shall be subject to consent by the Engineer. The location of concrete batching plants is subject to environmental approval from the appropriate authorities and shall not able to operate until such approval is obtained. All control and measuring equipment shall be regularly checked

and calibrated and the Contractor shall regularly submit calibration certificates for same to the Engineer.

10.36.2 The land available, if any, within the ROW may be used by the Contractor for storage of materials, concrete batching/mixing plants, casting yards, curing yard and stacking yards subject to the consent of the Engineer. The Contractor shall arrange any additional areas as required by him at his own discretion and cost.

10.37 Material Testing Laboratories

10.37.1 The Contractor shall design, construct, equip, maintain, dismantle and remove all required material testing laboratories and associated facilities on the Site and / or at work areas as are required for the sampling and testing of materials as required in the Works Requirements. The Engineer's consent shall be obtained to the location of material testing laboratories.

10.37.2 Laboratory buildings shall be supplied with adequate electricity, water, air-conditioning, etc., and shall have sufficient area(s) for storing samples.

10.37.3 The laboratory equipment to be supplied and the methods of testing shall be in accordance with relevant International, Indian and/or other standards and codes as detailed in the Works' Requirements. All apparatus and equipment shall be brand new and of the latest design and manufactured by a reputable manufacturer. The proposed type and number of items of laboratory equipment shall be submitted to the Engineer for review and consent prior to purchase.

10.37.4 The laboratory equipment and apparatus shall be checked and calibrated before testing starts and thereafter at regular intervals as specified by the manufacturer and as directed by the Engineer. The Contractor shall regularly submit calibration certificates for same to the Engineer.

10.37.5 The Contractor shall complete the design, construction and installation of the laboratory facilities for operation within one hundred and forty (140) days after the Commencement Date and operate and maintain the facilities until the issue of Taking-Over Certificate, unless otherwise authorized by the Engineer. The Contractor shall also make all facilities and services available to the Engineer as required. All sampling and testing to be undertaken shall be under the direct supervision of the Engineer. The material testing laboratory shall be staffed by Contractor's personnel fully experienced in the sampling and testing of materials, and quality control.

10.37.6 Any testing which may be required in accordance with the Works Requirements and which cannot be performed in the Contractor's laboratory due to lack of time or equipment shall be assigned to an independent organization having NABL accreditation and as duly consented to by the Engineer. The Contractor shall accept all results, instructions or restrictions stipulated by the Engineer based on such tests.

10.38 Wheel Washing Facilities

10.38.1 In and around residential and commercial area, the Contractor is required to install wheel washing area within ROW at the "Exit" points/gates of the construction area to ensure the removal of wheel/band dirt from construction vehicles and machines. Wheel washing area design shall be proposed in CEMP. As a part of the Contractor's method statement for the site preparation plans, wheel washing area shall be proposed and approved by the Engineer

before the commencement of the work. The facilities are required to have access for cleaning out the sludge which collects together with provision for 2 high pressure hose connections and adequate water supply.

10.39 Temporary Roads

10.39.1 The Contractor at his own discretion construct and dismantle/alter/dispose of the temporary roads after the completion of Contract as directed by the Engineer.

10.39.2 Before constructing any temporary roads outside the ROW, the Contractor shall make all necessary arrangements, including payment if required, with the public authorities or landowners concerned, for the use of the required land and shall obtain the consent of the Engineer. Such consent will be dependent on the Engineer being satisfied with the Contractor's proposals for items such as capacity, signage, lighting and surface quality of the temporary road, together with proposed maintenance arrangements. Such consent shall not relieve the Contractor from any of its responsibilities under the Contract.

10.39.3 The Contractor shall note that temporary road shall not be for the Contractor's exclusive use and shall be subject to relocation or restrictions at his cost during the execution of the Works as and when such relocation or restriction is inevitable. Except in an emergency, the Contractor will be given a prior notice of any such relocation or restriction. The road layout and design proposal shall be revised and re-submitted to the Engineer for consent whenever road arrangements are to be modified for whatsoever reasons.

10.39.4 Within forty-two (42) days after the Commencement Date and consequent to the surveys performed by the Contractor, the Contractor shall submit for the Engineer's review and approval of the proposed design, including layout, and details of the temporary road, fences, protection to underground pipes and culverts at road-crossing points and all additional temporary pipes and culverts that shall be provided by the Contractor, to sustain road traffic, irrigation and drainage flow in all existing streams, irrigation canals and ditches, drainage canals and ditches, and utilities or services, whether buried or exposed, all of which, in the opinion of the Engineer, are necessary for the proper execution of the Works.

10.39.5 During the transportation of Goods and Contractor's Personnel, the Contractor shall be responsible for keeping all railways, roads, bridges, watercourses, utilities services, etc. free from damage and from spillage of construction materials, detritus, oils, etc. and shall repair any damage howsoever caused to any such structure or property (whether on or off the Site) by Contractor's Equipment (including that of any Subcontractor). In that respect the Contractor will be required to carry out a condition survey of all roads and other facilities in and adjacent to the works area which will show in detail the state of those items prior to the commencement of construction. The full records shall be submitted to the Engineer and the status monitored throughout the course of construction with further records maintained.

10.39.6 At the junction of temporary roads with existing roads, the Contractor shall provide suitable traffic marshals to warn and regulate the traffic as per the requirements.

10.39.7 The Contractor shall be responsible for upholding and protecting all slopes at the boundaries of the Site against slippage into adjacent properties. As adjacent areas may be irrigated, this requirement will also therefore include the provision of temporary coffering as appropriate.

10.39.8 All temporary roads, culverts, ditches and the like required for the Contractor's or Subcontractors' or any other Contractor's operations shall be provided and maintained by the

Contractor, kept in good condition by cleaning, watering, rolling, grading, repairing and maintaining, all to the approval of the Engineer.

10.39.9 If the Engineer has provided drawings or details of any temporary works, then such drawings or details shall be understood to be indicative of the minimum required standard only. The Contractor shall remain responsible for the design of Temporary Works.

10.39.10 Unless otherwise approved by the Engineer, the demolition of any existing roads, culverts, etc. shall not commence until the replacement facilities therefore have been completed by the Contractor.

10.39.11 When any of the temporary approach roads are no longer required, or earlier if so directed by the Engineer, the Contractor shall carefully dismantle the temporary bridge or road, and remove and dispose of all surplus materials in compliance with the applicable Laws, and reinstate the area to its original condition to the approval of the Engineer.

10.40 Vehicles

10.40.1 The Contractor shall provide all necessary vehicles required for the transportation and movement of Goods and Contractor's Personnel, including but not limited to trucks, cranes, trailers, cars, motorcycles, etc.

10.40.2 The Contractor shall provide competent and licensed drivers and operators for all such vehicles. Vehicles shall be licensed and insured in accordance with the applicable Laws and the Contractor shall be responsible for all servicing, repairs and maintenance required.

10.41 Contractor's Equipment

10.41.1 The Contractor shall ensure that all Contractor's Equipment whether on or in the vicinity of the Site, including apparatus, machinery, vehicles and other similar things to be operated by him or his Sub-Contractors for the execution and testing of the Works, are maintained and operated in a good and safe condition.

10.41.2 All lifting and hoisting equipment shall be regularly certified in accordance with the applicable Laws, and the safe working load limits shall not be exceeded.

10.41.3 The Contractor shall operate and maintain an equipment repair facility within or in the vicinity of the Site, so that downtime of Contractor's Equipment can be minimized. Temporary fuel and lubricant stores shall be properly designed, constructed, secured, fire- and spill-guarded, and be well ventilated so as to comply with the relevant applicable Laws.

10.42 Utilities for Temporary Facilities

10.42.1 Power Supply and Lighting:

i. Electric power supplies for the Contractor's temporary facilities, including but not limited to Contractor's camps, offices, Site, work areas and other facilities as described herein, shall be arranged by the Contractor.

ii. The Contractor shall install, operate and maintain its own electrical distribution systems for the electrical supply required for his temporary facilities as described in paragraph (1) above.

iii. The Contractor shall also furnish, install and keep operational the diesel power generating facilities of such capacity as the Contractor considers necessary to prevent any interruption to the progress of the Works.

iv. The Contractor shall ensure adequate lighting is provided for all his operations at the Site and the temporary facilities and camp according to the National Building Code of India (2016).

10.42.2 Water Supply

i. The Contractor shall design, install, operate and maintain water supply systems including pumps, piping systems, valves, storage tanks etc., at the Site with respect to:

a) Industrial water supply system
For construction use the water quality shall meet the quality requirements in the Works Requirements.

b) Potable water supply system
For supply to all the Contractor's temporary facilities including but not limited to Contractor's camps, offices, Site, work areas and other facilities for human consumption and use.

ii. In case the Contractor plans to install bore well(s) for water supply, he shall thoroughly investigate the relevant legislation and regulations imposed by the competent authorities and the installation shall be subject to approval by the said competent authorities and/or consent of the Engineer.

iii. Throughout the Time for Completion the Contractor shall take samples from all water supplies at regular intervals and test it for suitability for the intended use.

10.42.3 Sanitation and Sewerage

i. All operational parts of the Site, offices, workshops, fabrication yards, laboratory, camp and other facilities, etc. shall be provided with sanitation and sewage handling and disposal systems complying with the statutory requirements and applicable Laws, codes and standards.

ii. If required, portable sanitary facilities including chemical toilets shall be provided and maintained by the Contractor for the use of all personnel at all work locations.

iii. All the requirements of the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management] of the General Specifications) and the Conditions of Contract shall also be complied with.

10.42.4 Waste and Garbage Disposal

i. The Site and the work areas shall be kept clean and free of detritus at all times.

ii. The Contractor shall collect waste material and garbage from Site, camp, offices, yards, workshops, etc. on a daily basis and dispose of same in an approved disposal area(s) and as per guidelines prescribed by local and governmental authorities having jurisdiction. No waste of any kind shall be deposited in any watercourses.

iii. All the requirements of the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management Management] of the General Specifications) and the Conditions of Contract shall also be complied with.

10.42.5 Fencing, Site Security and Safety

i. The Contractor shall be responsible for the security and safety of the Site. Accordingly, the Contractor's temporary facilities including offices, workshops, fabrication yards and storage compounds, campsites, all construction areas, storage areas shall be adequately fenced, gated, lighted and guarded on a twenty-four hour, seven days a

week basis. Firefighting equipment shall be provided in accordance with the applicable Codes and the requirements of local authorities.

ii. Any storage facilities for explosives shall comply with the relevant Laws and regulations of India and shall be situated at locations approved by the competent authorities. Detonators and fuses shall be stored in facilities separate from explosives. In no case shall detonators and fuses be transported in the same vehicle as explosives. Storage facilities for explosives, detonators, fuses, etc. shall be secure, kept locked and the keys shall be accounted for at all times.

iii. All the requirements of the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management Management] of the General Specifications) and the Conditions of Contract shall also be complied with.

iv. The Contractor shall be responsible for any losses occurring within the Site premises.

10.42.6 Inspection by the Employer or Engineer

The Employer and the Engineer have the right at any time to inspect any part of the Contractor's temporary facilities and to require immediate rectification to comply with the specified requirements.

10.42.7 Final Clean-Up

i. Upon the completion of Works, or when any of the Contractor's Equipment and/or temporary facilities have fulfilled or completed their function, the Contractor shall dismantle and demobilize such Contractor's Equipment and/or temporary facilities and remove all equipment, machinery, materials, refuse, debris, objectionable material, and reinstate, including filling, grading and dressing all areas to their original condition prior to completion of the Works.

ii. The Contractor shall not proceed with any demobilization and/or removal of temporary facilities and equipment without the prior consent of the Engineer.

10.43 Maintenance of Temporary Facilities

10.43.1 The Contractor shall provide all necessary maintenance requirements and shall keep the temporary facilities and other areas established for the Works, clean, tidy and litter-free.

10.43.2 The Contractor shall be responsible throughout the Time for Completion for keeping the Site and temporary facilities to the satisfaction of the Engineer.

10.43.3 The Contractor shall maintain all existing security fences required for the Works until completion of the Works. Existing fences which interfere with construction operations, shall not be relocated or dismantled, until written permission has been obtained from the fence owner.

10.44 Damage to Existing Property

10.44.1 The Contractor shall be responsible for any and all damage that may occur to any existing structures, works, materials, or equipment that is due to any operation(s) for which the Contractor is responsible, including any operation(s) of any Subcontractor.

10.44.2 The Contractor shall repair or replace any damaged structures, works, materials, or equipment to the satisfaction of the Engineer.

10.44.3 The Contractor shall be responsible for all damage to roads, railway infrastructure, curbs, sidewalks, highways, shoulders, embankment, ditches, drains, culverts, bridges, or other public

or private property, which may be caused by their construction activities and shall indemnify for losses due to such damages.

10.45 UTILITIES

10.45.1 General

a) The Contractor shall at all times work with due diligence to ensure the safety of all personnel and property from injury and damage from known ("Charted Utilities") and unknown utilities ("Uncharted Utilities").

b) The Contractor shall always take care of concerning buried Charted and Uncharted Utilities and if any such Utilities infringe the work, the Contractor shall make the area affected safe and ensure that no unauthorised member of the workforce or members of the public shall enter such area.

c) Contractor shall be responsible for relocation/diversion/shifting/modification of all charted/uncharted utilities infringing the Works.

d) Contractor shall indemnify the Employer against any losses/claim/damage cost to any damage to utility/services during execution of Works.

10.46 Utilities, Services and Facilities

10.46.1 The Utilities are categorised as (i) Charted Utilities, which have been identified by the Employer and may be affected during the execution of the Works. and, (ii) Uncharted Utilities, which are not known and would get identified during the execution of the Works.

10.46.2 Charted Utility

The Charted Utilities identified by the Employer are enclosed in Part 2, Section VII-12-Employer's Requirements, Tender Drawings and Documents. These are further categorised as discussed under:

i. Type A –Overhead Electrical Crossings

a. These are Overhead Electrical Crossings, traversing the proposed HORC alignment and likely to infringe during execution of the work primarily due to inadequate ground clearance. The Employer has already taken action to remove these infringements by either raising or laying underground cables. The infringements due to LT and HT (up to 33 KV) utilities shall be removed by the Employer within 90 days of the award of Contract. The Crossings shifted underground shall normally be laid within ten (10) metres of the chainages given in the list of Overhead Electrical Crossings except at locations where stations and buildings of HORC are proposed. At the stations and HORC buildings, the utility will be shifted beyond the structure area. For cables crossing the HORC alignment, extra length of 3m to 5m is being provided on both sides, so that cable can be slewed if required during construction. The Contractor shall consider the effect of these shifted utilities in his work planning and price. The coordinates of the new locations where utilities have been shifted will be shared with the Contractor once the shifting is completed. Electrical utilities which have been laid underground, will be considered as charted utilities. The Contractor shall design the span in such a way that further utility shifting is avoided unless inescapable.

b. The infringements due to EHT (above 33 KV) Utilities will be progressively removed and is likely to be completed within 12 months of the award of the Contract. However, these

utilities will not infringe the working of Contractor. The Contractor shall plan his works taking this aspect into consideration.

ii. Type B – Overground Utility

These are various utilities which existed on ground at the time of acquiring the land by the Employer and may affect the execution of the work. The Employer takes the responsibility to dismantle these utilities up to ground level and hand over the land to the Contractor free of these encumbrances. Removal of remaining portion below ground level, wherever required, shall be responsibility of the Contractor. The Accepted Contract Amount shall be deemed to include all such works and risks.

iii. Type C- Underground Utilities

These are various charted underground utilities which are existing and Contractor shall consider and take into account the effect of these in his price.

10.46.3 Uncharted Utility

The Uncharted Utilities will be those unknown utilities which get identified during execution of the Works. These may be identified during Ground Penetration Survey or anytime during execution of the Works.

10.46.4 The Contractor shall do a general survey and Ground Penetrating Radar (GPR) Survey of the Site after possession and notify the Engineer of Charted & Uncharted Utilities, which may obstruct the works and need to be relocated.

10.46.5 For all Charted & Uncharted Utilities requiring relocation identified by the Contractor in the Utilities survey, the Contractor shall inform the Engineer and provide relevant details, including but not limited to, the following:

i. location of the Utility;

ii. date on which Utility was encountered;

iii. nature and size of the Utility;

iv. condition of the Utility

v. type of the Utility & its owner:

a) Electrical cables;

b) OFC & Telecom cables;

c) Gas pipelines;

d) Water/sewerage/drainage/storm water/hume pipelines;

e) Irrigation pipelines/channels;

f) Telecom towers;

g) Overhead Water tanks and others overhead tanks;

h) Others, if any

vi. Reasonable estimate of time required for shifting of Unchartered Utilities.

vii. The information shall also cover the details of the agency/department carrying out the utility shifting.

10.46.6 The trial trenching, arrangements and working methods to be employed in respect of such Charted & Uncharted Utilities which warrants removal/relocation, including proposed protection measures, diversions, reinstatements in consultation with utility owner shall be done within 56 days after Handing Over of the Site by the Employer. The Contractor shall provide relevant justification for the identified utilities (Charted & Uncharted) which require removal/diversion for proceeding with the works.

10.46.7 The Engineer will accord approval within 21 days to the Contractor for initiating required action for the utilities warranting removal/relocation/modification.

10.46.8 The Contactor shall be responsible for taking prompt necessary action for such identified utilities (Charted & Uncharted) including the following but not limited to:

i. Identification of the extent of the utility to be relocated

ii. Coordinate and get permissions from utility owner & all relevant authorities.

iii. Preparation and submission of relevant documentation to the authorities.

iv. Mitigate the situation and re-arrange the work to minimise the effect on the timeline of the Works

v. Continue with other related works in as much as possible to maintain the timeline of the Works.

Any relocation/removal/diversion of Charted Utility shall be entirely the Contractor's responsibility and any cost on this account shall be borne by the Contractor.

10.46.9 The relocation/removal/diversion of identified Uncharted Utilities shall be assigned to the Contractor to be carried out through the utility agencies, or their specified contractor or by the Contractor himself. The cost of relocation/removal/diversion of Uncharted Utility shall be paid by the Employer as mentioned below:

i. If Uncharted Utility relocation/removal/diversion is carried out by Utility agency or theirspecified contractor, the Contractor shall make the payment to such agency or specified contractor. The Employer shall reimburse such amount as Specified Provisional Sum based on invoices.

ii. If Uncharted Utility relocation/removal/diversion is carried out by Contractor himself, then he shall be paid under Specified Provisional Sum.

10.46.10 The Contractor shall not divert, remove or relocate any such identified Charted & Uncharted Utilities without having first received the Engineer's consent to such diversion, removal or relocation.

10.46.11 The Contractor shall liaise and co-ordinate with the relevant Utilities Companies to ensure that all the above-mentioned works of relocation/diversion, support and protection are executed satisfactorily. Contractor shall obtain necessary clearances from the Utility company/owner prior to the start of any relocation/removal/diversion works of the utilities. The same shall be submitted to the Engineer prior to start of the works.

10.46.12 Throughout the execution of the Contract, the Contractor shall reasonably comply, in all respects, with the requirements of all the utility owners and authorities regarding the handling, protection and maintenance of the utility facilities. The responsibility in respect of diversion/ modification/ relocation/ protection etc. of the Utilities (Charted or Uncharted) to facilitate safe construction lies with the Contractor. If required, the employer shall provide

support to facilitate approvals/permits from utility owner/concerned department for the proposed diversion/relocation of utilities.

10.47 Prevention of Damage and Interference

10.47.1 Temporary supports and protection methods proposed by the Contractor and agreed by the utility owner shall be provided to the utilities. The permanent supports and protection shall be provided wherever required for the safety and security of the utility service.

10.47.2 The Contractor shall not interfere in any manner with the Utility lines and services without prior approval of the Utility owner and Engineer. Whenever the interfering necessity arises, the Contractor shall submit a proposal to the Engineer for his approval. Any unintentional interference caused shall be immediately corrected without causing danger and trouble to any on-going operations or the existing utility lines or services. The Contractor shall immediately inform the Engineer and the utility agencies of:

i. damage to utilities;

ii. leakage of utilities;

iii. discovery of utilities not previously identified; and

iv. Any hazardous material found during the excavation.

a) location of utility

b) date on which the utilities were encountered;

c) nature and sizes of the utilities;

d) condition of utility;

e) temporary or permanent supports provided; and

f) diversions made –temporary or permanent

The Contractor shall include the details (plan, location, ownership, size and material) of all such utilities in the As-built Drawings.

10.48 Drainage Systems

10.48.1 All existing drainage systems that are affected by the Temporary and the Permanent Works shall be protected, relocated and/or diverted as required for the Works, by the Contractor.

10.48.2 Such protection, relocation or diversion works shall be carried out by the Contractor, and his designs shall be approved by the utility owners / relevant authorities and the Engineer.

10.48.3 Upon completion of the works, all the diverted or temporarily diverted drains/box culverts and canals shall be fully reconstructed to their original size or to a revised size as required by the utility owners /relevant authorities. However, if the utility owner or relevant authority requires to keep the Utility at the original location, the same shall be reconstructed at the original location.

10.49 Building Service Connections

10.49.1 Building service connections shall be maintained and protected or if required to be shifted, shall be informed to the Engineer during the execution of the works. The Contractor shall take necessary steps to ensure these services with the approval of utility owner and the Engineer.

10.49.2 Building service connections shall include the branch pipes from the main water pipe, water meter chambers/bulk meter, sewer and drainage discharge pipes, grease traps, etc.

10.49.3 Building service connections shall be identified by trial trenches or other methods approved by the relevant Utility Companies. Where these service connections interfere with the works, the Contractor shall follow the methodology as approved by the relevant Utility Companies and the Engineer.

10.50 Street Furniture and Minor Service

Where street furniture, including lamp posts, traffic lights, fire hydrants, signage, minor electrical cables, water services, etc. are required to be dismantled and stored or relocated temporarily or permanently, the Contractor shall propose such works to the Engineer and Utility Companies or relevant authorities for their approval.

10.51 TRAFFIC MANAGEMENT PLANS

10.51.1 General

a) The Contractor shall thoroughly acquaint itself with existing traffic conditions and understand the importance of maintaining traffic safety and the avoidance of excessive traffic delay. The Contractor shall co-operate with the relevant agencies regarding traffic control and all details shall be subject to the Engineer's approval.

b) The requirements concerning temporary road works shall include, but not be limited to, construction of detours, temporary bridge approach roads, traffic control devices and services for the control and protection of traffic through areas of construction.

c) The Contractor shall be responsible for investigating and establishing the requirements for traffic control and ensuring safety at each site and shall submit such details in the form of a Temporary Traffic Control Plan for the Engineer's review and consent.

d) All temporary roadworks and traffic management shall be as specified in this appendix, unless specified otherwise elsewhere in the Contract or local Indian regulations and standards, and the more onerous provision shall apply.

10.52 Temporary Traffic Control Plan (TCP)

10.52.1 Submission, Consent and Change

a) Within twenty-eight (28) days after the Commencement Date, the Contractor shall submit a Temporary Traffic Control Plan (TCP) to the Engineer for review and consent. The Engineer's consent shall be obtained prior to the start of Works on Site.

b) The Contractor shall comply with the TCP which has received the Engineer's approval and any Engineer's instructions issued concerning traffic control.

c) Should the Contractor propose any to change to the TCP which has received the Engineer's approval, the Engineer shall be notified in writing at least seven (7) calendar days prior to the date planned for the implementation of any such proposed change. Changes proposed are subject to receipt of the Engineer's consent. If the Engineer makes any subsequent recommendations or issues instructions concerning the TCP in writing, the Contractor shall revise the TCP accordingly.

10.52.2 Contents of Temporary Traffic Control Plan

a) The main contents of the Temporary Traffic Control Plan shall include, but not be limited to, the following:

i. Type and main specifications of traffic control devices and facilities;

ii. A scale plan of the location(s), clearly identifying existing road(s), proposed diversions ofpedestrian and road traffic, locations of warning signs and traffic control measures;

iii. Details of all lane widths, temporary surfaces, etc.;

iv. Construction details of any proposed diversion(s);

v. Safety measures including signage and staffing;

vi. Program for installation and erection of traffic control devices and facilities;

vii. Traffic control means during non-working time and during night time;

viii. Protection/diversion of any existing utilities;

i. Environmental measures to be implemented, e.g. dust suppression, noise abatement,

ix. watercourse diversion and the like; and

x. Person responsible for overseeing implementation of all aspects of the TCP.

b) In addition to the above and prior to the implementation of any Site-specific traffic control schemes, the Contractor shall obtain any necessary approval letters from relevant authorities who have jurisdiction over or ownership of the existing traffic way including the Traffic Police, NHAI, PWD and any other local government/authorities and other related parties having jurisdiction, as applicable and as required.

10.52.3 Number of Lanes for Traffic Control

a) The existing traffic on roads at the Site must be maintained at all times during the execution of the Works and if diversions are required these must be of the same traffic capacity as the original road. Notwithstanding the above, the Engineer may give consent to reductions in traffic capacity if the Contractor can demonstrate that such will not cause excessive delays to traffic flow. If such consent is given, the Engineer may specify the hours during the day when the reduction in capacity may be applied and it should be anticipated by the Contractor that these hours will not include any peak periods for the traffic movement.

b) The Contractor shall cooperate with relevant authorities having jurisdiction regarding traffic control and all details will be subject to receipt of the Engineer's consent.

10.52.4 Temporary Traffic Ramps and Speed Breakers

a) In locations where it is necessary (for example, pipeline crossing a road above ground), the Contractor shall construct and maintain temporary traffic ramps.

b) In cases where it is necessary (for example, requirement by an agency having jurisdiction) or required by the Engineer, the Contractor shall provide and maintain temporary speed breakers.

10.52.5 Traffic Control for Public Roads

a) The Contractor shall maintain close liaison with the Traffic Police, NHAI, PWD and any other local government/authorities and other related parties having jurisdiction, as

applicable to traffic control requirements and shall comply with all approval and permit requirements from such authorities.

b) In order to facilitate traffic through or around the Works, or wherever ordered by the Engineer, the Contractor shall erect and maintain at prescribed points on Site roads and at approaches to the Works, a temporary fence made of corrugated metal sheet supported by hard posts with foundations and horizontal bars, traffic signs, lights, barricades, traffic cones with traffic warning lamps and other facilities for the direction and control of traffic. The fence is to be painted and maintained in good condition. Drawings and details of the fence are to be prepared and submitted to the Engineer for review and issue of a approval.

c) Where required, or as directed by the Engineer, the Contractor shall provide competent flagmen whose sole duties shall consist of directing the movement of traffic through or around the Works.

d) In addition to the requirements as described above, the Contractor shall furnish and erect, within or near Works areas, such warning and guide signs as may be ordered by the Engineer.

e) For all traffic safety precautions, the Contractor shall refer to Traffic Management and Site Barricading. The Contractor shall refer to Section VII-4, Reference Information/Reports for details of barricading.

f) The repair of any existing roads that have been damaged by the Contractor during the execution of the Works (including any damage caused by Contractor's Equipment) shall be at the risk and cost of the Contractor.

10.53 Extraordinary Traffic

The Contractor shall be responsible for carrying out any necessary investigations and the obtaining of approvals, licenses, escorts and any other necessary facilities in order to enable extraordinary traffic to be moved on the roads in the Works area.

10.54 Maintenance and Protection of Traffic

10.54.1 During the execution of the Works the Contractor shall keep open to traffic existing roads, provided that where required or as directed by the Engineer, the Contractor shall arrange detours subject to the consent of the Engineer. The Contractor shall at all times keep roads and footpaths affected by its operations, free from obstruction and nuisance and suitable for public use.

10.54.2 The Contractor shall take necessary care at all times during the execution of the Works to ensure the convenience and safety of residents along and adjacent to public roads and highways that may be affected by the Works. Street lighting shall be relocated as necessary to maintain the same standard of lighting during the course of the Works, until new lighting facilities are brought into operation.

10.54.3 Any failure of the Contractor to meet these requirements will entitle the Engineer to carry out such works as he deems to be necessary and to charge the Contractor with the full cost thereof plus ten percent of such cost, which sum will be deducted from any money due or which may become due to the Contractor under the Contract.

10.55 Vertical Clearance

In general, any Temporary Works placed over roads or diversions used by public traffic shall maintain a vertical clearance of at least 5.5 metres unless otherwise directed by the Engineer. Where required by the Engineer the Contractor shall erect and maintain suitable check-gates, fitted with warning signs indicating the vertical clearance.

10.56 Materials

Materials and other specifications related to traffic control devices shall conform to IRC Standards unless otherwise specified elsewhere in the Contract.

10.56.1 Retro-reflective Material

Unless otherwise specified in the Contract, sign panels, barricades, traffic cones, vertical panels, and flagmans' paddles shall have retro-reflective sheeting, as consented to by the Engineer.

10.56.2 Sign Panels

Sign panels shall be yellow with black legend unless otherwise specified in the Contract or local Indian regulations and standards.

10.56.3 Sign Posts

Sign posts shall be fabricated from materials as acceptable to the Engineer. Signs shall be provided with suitable foundations and be designed so as to be capable of remaining in position during normal traffic flow and wind conditions.

10.56.4 Barricades

Barricades shall be constructed in accordance with the Drawings.

10.56.5 Traffic Cones

a) Traffic cones shall be capable of withstanding impact without damage to the cones or vehicles. All cones shall be orange with highly reflective white bands which is easily visible both in daylight and darkness. Traffic cones shall be capable of remaining visible and in position during normal traffic flow and wind conditions in the area where they are used. Lamps for cones shall be suitable for purpose.

b) Where traffic cones are used for the diversion of pedestrians the cones shall be fitted with yellow/black reflective cone bars to prevent pedestrians walking outside the protected walk area.

c) All cones shall be as above unless otherwise specified in the Contract or local Indian regulations and standards, whichever is more onerous.

10.56.6 Warning Lights (flashing or steady-burn)

High visibility traffic warning lights shall be provided and used at all locations where Works are being carried out and visible warnings are required, i.e. road works, excavations, pedestrian diversions, etc. The requirements for warning lights shall be:

i. Lens colour shall be amber;

ii. Lens diameter shall be not less than 185mm;

iii. Flashing shall be 110 per minute;

iv. Suitable for fitting to traffic cones;

v. Battery operated; and

vi. Continuous operation of more than 600 hours.

10.57 Construction Requirements

10.57.1 The Contractor shall keep the length of construction areas to manageable lengths such that traffic will be accommodated safely. Traffic control devices and services shall be provided and maintained both inside and outside the limits of work as required to facilitate traffic guidance, should this be necessary. The provision of traffic control devices and services shall comply with the provisions of the Works Requirements and the Conditions of Contract and local Indian regulations and standards.

10.57.2 Prior to the start of construction operations, the Contractor shall erect such signs, barricades, and other traffic control devices as may be required by the Works Requirements and the Conditions of Contract or as directed by the Engineer. Traffic control devices shall be operated only when required and only those devices that apply to conditions actually in existence shall be operable.

10.57.3 Wherever required or directed by the Engineer, temporary fences shall be placed to provide a visual barrier between the work area and adjacent traffic or buildings.

10.57.4 Any devices provided under this clause that are lost, stolen, destroyed, or deemed unacceptable while in use on the Works shall be replaced by the Contractor at the Contractor's risk and cost.

10.57.5 During non-working hours and following completion of a particular construction operation, all warning signs, except those necessary for the safety of the public, shall be removed or entirely covered with either metal or plywood sheeting so that the sign panel will not be visible.

10.57.6 Retro-reflective sheeting on signs, barricades, and other devices shall be kept clean. Stretches, rips, and tears in the sheeting shall be promptly corrected by the Contractor. Retro-reflective sheeting shall have a maintained retro-reflection.

10.57.7 Nighttime operations shall be illuminated by a lighting system which has received the Engineer' s consent. The lighting system shall be positioned and operated to avoid glare to road users.The heat produced by any lighting system shall be considered and allowed for. The use of lights with flames (such as gas-powered lighting) will not be permitted.

10.57.8 The Contractor shall ensure that no Contractor's Equipment leaves the work sites with mud, debris or rock that may drop or be deposited on a public highway or private right-of-way, and the roads in the vicinity of the Site shall be kept clean. Suitable vehicle washing facilities shall be provided by the Contractor.

10.58 PACKAGING STORAGE SHIPPING AND DELIVERY

10.58.1General

a) Unless otherwise required by the Particular Conditions, Plant and the Materials shall be delivered to the Site at the most suitable time(s) in accordance with the Works Programme and Procurement Work Segment Programme, so as to avoid undue damage and/or deterioration due to a storage period of excessive duration.

b) All Plant and the Materials, if manufactured or assembled off-Site, shall be properly and securely packed at the point of origin, in order to prevent damage during transport to the Site and due to storage in the weather conditions to be encountered at the Site.

c) The Contractor shall securely crate or box all consignments for ocean shipment in a manner suitable to protect them from damage in transit and shall be responsible for and rectify any and all damage due to any improper packing. Crates shall have external markings identifying the Contract reference number, origin, destination, contents and consignee.

d) The Contractor may be required to furnish the Employer, by courier or other approved means with advance copies of shipping documents, invoices and other pertinent papers showing the date and origin of shipment, a description of the Goods, the shipping weight of each item, destination, name of the vessel and other pertinent information.

e) The Contractor shall also be responsible for the trans-shipment up till the delivery to the installation sites.

f) The Contractor shall ensure, prior to delivery of Plant or Material, that adequate storage facilities and/or areas are available on Site to properly store and protect the Plant or the Material so as to prevent any damage or deterioration. Air-conditioned or other controlled-environment storage shall be provided for Plant items sensitive to high humidity and/or temperature.

g) Materials of an inflammable, explosive, toxic or similarly hazardous nature shall be securely stored separately at approved locations. The Contractor shall provide adequate security and safety control at such locations throughout the storage period. Before delivery of such Materials to Site, all necessary permits and licenses shall have been obtained from the authorities having jurisdiction, all in accordance with the applicable Laws.

h) When Plant or Materials arrive on Site it shall as soon as practicable be inspected by the Contractor in the presence of the Engineer, for damage or deterioration. The Contractor shall be responsible for unpacking and re-packing in an appropriate manner and for provision of all necessary equipment, tools, materials and labour at his own expense. If damage or deterioration has occurred as determined by the Engineer, payment for shall not be made for such damaged or deteriorated Plant or Materials, and such shall be removed from the Site and repaired or replaced according to the instructions of the Engineer, at the Contractor's risk and cost.

i) For the Plant or the material which is subject to deterioration after opening the packing, appropriate alternative inspection measures shall be determined on Site between the Engineer and the Contractor. No payment shall become due to the Contractor for those uninspected Plant or Material, unless otherwise determined by the Employer.

j) Packing materials shall remain the property of the Contractor and shall be removed from the Site immediately when no longer required on the Site, as determined by the Engineer.

k) The Contractor shall be responsible for the safe and secure storage and handling of Plant and Materials on Site until the issuance of the Taking-Over Certificate for the relevant part of the Works, regardless of any transfer of ownership thereof to the Employer.

l) Any action taken by the Engineer in inspecting Plant or Materials upon arrival on Site or any determination subsequently made by the Engineer shall not relieve the Contractor of any of his responsibilities under the Contract.

10.59 Storage of Plant and Materials

10.59.1 The Contractor shall provide and maintain storage facilities at acceptable locations in consultation with the Engineer, for the equipment and materials of all kinds intended for use in carrying out the Permanent Works or for incorporation into the Permanent Works.

10.59.2 The Contractor shall prepare, protect, provide security and store in an agreed manner for all Works, Contractor's Equipment, equipment and materials until the Project completion so as to safeguard them against any loss, damage and any other hazards arising during shipment, storage on/off the Site or climatic influences.

10.60 Crating

The Contractor shall provide all packing, crates and markings. In doing so, it shall comply with the following requirements:

a) Each case, crate or package shall be waterproof, rot, insect and rodent proof. It shall be of robust construction and fit for its intended purpose. The Contractor shall, in determining the packaging materials to be used, take into consideration the climatic conditions likely to occur during the period of transport, shipment and storage.

b) Each case, crate or package shall be legibly and indelibly marked in large letters with the Site address, Contract number, "right way up", opening points and other markings as necessary to permit materials to be readily identified and handled during transit and when received at the Site.

c) Each case, crate or package shall contain a comprehensive packing list showing the number, mark, size, weight and contents, together with any relevant drawings. A second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each case, crate or package. Distribution of additional copies of each packing list shall be in accordance with the Engineer's instructions.

d) All items heavier than 100 kg shall be marked on the outside of the case, crate or package, indicating the gross and net weights, the points for slinging, and where the weight is bearing.

e) Care shall be taken to prevent movement of items within cases, crates or packages by the provision of bracing, straps and securing bolts as necessary. Bags of loose items shall be packed in cases and shall be clearly identified by well-secured metal labels on which the quantity and name of the parts and their index or catalogue number have been stamped.

f) All packing shall be free from sharp edges to prevent injury to persons or other objects.

g) Each bulky/heavy case, crate or package shall include wedge(s) for easy loading and unloading by mechanical handling equipment such as forklift truck.

h) Electronic circuit boards, integrated circuits and the like shall be well protected by using appropriate packing, e.g. anti-static bubble wrap or similar.

i) Rubber products and the like shall be suitably packed to avoid damage including but not limited to hardening, deformation and peel-off.

10.61 General Precautions

10.61.1 Spare parts shall be tropicalized in their packing for prolonged storage in accordance with appropriate international/ Indian standards and shall be suitably and individually labelled to indicate:

a) Name of parts;

b) Shelf life and date of manufacture;

c) Type or condition(s) of storage and special handling information;

d) Description of item and relevant part number;

e) Serial number, if applicable;

f) Inspection/test certificate number and batch number; and g) Contract number, order number and item number.

10.61.2 Tubes, cable, conductor and other similar openings shall be properly sealed and blanked off to prevent ingress of dirt or moisture.

10.61.3 Spare ball and roller bearings and similarly protected items shall not be removed from the manufacturer's wrappings or packing.

10.61.4 Fragile materials shall be packed in such a way that they shall not be damaged during transit and when they are properly unpacked for quality inspection. Glass items shall be capable of being easily re-packed without removing the original wrappings or packing for long- term storage within the same packing case.

10.61.5 Appropriate precautions in accordance with the Contractor's safety regulations, the regulations of the Employer, Appendix 13 [Environmental, Social, Health and Safety Manual] and statutory regulations in respect of all hazardous, toxic, inflammable, etc. materials.

10.62 Packaging Procedures

10.62.1 All required inspection/test certificates shall be supplied and packed together with individual materials. All packaging materials and procedures shall be subject to review by the Engineer.

10.62.2 All empty cases, crates or packages, whether or not returnable, shall be removed from the Site by the Contractor or stored by the Contractor in such a way that they do not interfere with the progress of the Works.

10.63 Shipping

10.63.1 The Contractor shall notify the Engineer at least fifteen (15) days in advance of any expected shipment date and give further notification of the actual shipment date and routing when such information is subsequently established. This shall complement the inspection requirements prior to delivery as specified herein.

10.63.2 Two (2) copies of packing lists and quality certificates shall be attached with each case or package to be shipped. One copy shall be placed inside the package and the second copy shall

be enclosed in a watertight enclosure on the outside of each case or package. A copy of packing lists and quality certificates shall be sent to the Engineer after each package of the Works, the equipment, spare parts and other items have been shipped.

10.63.3 Without prejudice to any other provisions of the Contract, the Contractor shall be responsible for all legal requirements, insurance, customs, duties, dues, taxes and other such requirements and expenditures required for the plant, equipment, spare parts and other items to be supplied under the Contract.

10.64 Delivery

10.64.1 The Contractor shall deliver Plant and Materials required for the Works and all items to be supplied under the Contract to the Site.

10.64.2 The Contractor shall unload all items to be supplied under the Contract at the designated delivery point and place them in position or store them.

10.64.3 Any part of the Works or any item to be supplied under the Contract that is damaged in transit shall not be considered as delivered until repairs or replacements have been made and all necessary spare parts or items have been delivered to the Site.

10.64.4 All documents, manuals, drawings and other deliverables shall be delivered to an address to be designated by the Engineer in writing.

10.64.5 The Contractor shall store and secure Plant and Materials until the same have been inspected by the Engineer and are considered delivered at the designated point.

10.64.6 The Contractor shall remove temporary fittings required for shipment and re-assembly of Plant and Materials and shall complete this prior to the inspection of same and before they are considered delivered.

10.64.7 An item shall be considered delivered when all damage has been repaired and all documentation and post-delivery preparation has been completed.

APPENDIX 11

WORKS QUALITY MANAGEMENT PLAN

11.1. General

The Contractor shall implement a Project Quality Management Plan in accordance with ISO-9001 "Quality System - Model for Quality Assurance in Design/Development, Production, Installation and Servicing" to ensure that all materials, workmanship, plant and equipment supplied and work done under the contract meets the requirements of the contract. This plan shall apply to all activities related to the quality of items, including designing, purchasing, inspecting, handling, assembling, testing, storing, and shipping of materials and equipment and different elements of construction work and installations of system components.

The Quality Plan to be prepared by the Contractor and submitted to the Engineer shall follow the requirements of ISO 9000 and address each element therein.

Registration of the Contractor's organisation, or subcontractors or subconsultants is not required for this Project but the Project Quality Management Plan as submitted shall meet the intent of the ISO 9000 requirement in that there is a comprehensive and documented approach to achieving the project quality requirements.

11.2. Works Quality Management Plan

The Works Quality Management Plan (WQMP) shall as a minimum address the quality system elements as required by ISO 9001, generally noting the applicability to the Contractor's Works Programme for the Project. Procedures or Quality Plans to be prepared by others (Suppliers, Subcontractors, Subconsultants) and their incorporation in the overall WQMP shall be identified.

The Contractor shall provide and maintain a Quality Assurance Plan (QA) to regulate methods, procedures, and processes to ensure compliance with the Contract requirements. The QA Plan, including QA written procedures, shall be submitted to the Engineer for his review.

Adequate records shall be maintained in a readily retrievable manner to provide documented evidence of quality monitoring and accountability. These records shall be available to Employer at all times during the term of the Contract and during the Defects Liability Period and for a five-year period thereafter.

The Plan shall identify:

- Design Process: that control, check and verify the accuracy, completeness and integration of the design shall be performed by certified personnel and in accordance with documented procedure that have the written consent of the Engineer.
- Special Processes: that control or verify quality shall be performed by certified personnel and in accordance with documented procedures that have the written consent of the Engineer;
- Inspection and Test: Inspection and testing instructions shall provide for reporting nonconformances or questionable conditions to the Engineer; Inspection shall occur at appropriate points in the installation sequence to ensure compliance with drawings, test specifications, process specifications, and quality standards. The Engineer shall designate, if necessary, inspection hold points into installation or inspection planning procedures;
- Receiving Inspection: These procedures shall be used to preclude the use of nonconforming materials and to ensure that only correct and accepted items are used and installed;

- Identification and Inspection Status: a system for identifying the progressive inspection status of equipment, materials, components, subassemblies, and assemblies as to their acceptance, rejection, or non-inspection shall be maintained;
- Identification and Control of Items: an item identification and traceability control shall be provided;
- Handling, Storage, and Delivery: provide for adequate work, surveillance and inspection instructions.

The Plan shall ensure that conditions adverse to quality such as failures, malfunctions, deficiencies, deviations, and defects in materials and equipment shall be promptly identified and corrected.

The Plan shall provide for establishing, and maintaining an effective and positive system for controlling non-conforming material including procedures for the identification, segregation, and disposal of all non-conforming material. Dispositions for the use or repair of non-conforming materials shall require the Engineers consent.

11.3. Plan Implementation and Verification

The Plan shall clearly define the QA Organisation. Management responsibility for the QA shall be set forth on the Contractor's policy and organisation chart. The Plan shall define the requirements for QA personnel, their skills and training. Records of personnel certifications shall be maintained and monitored by the QA personnel. These records shall be made available to the Engineer for review, upon request.

The QA operations shall be subject to the Engineers, Employer or Employer's authorised representative's verification at any time, including: surveillance of the operations to determine that practices, methods and procedures of the plan are being properly applied; inspection to measure quality of items to be offered for acceptance; and audits to ensure compliance with the Contract documents.

Monthly Quality Report (MQR): The contractor shall submit the Monthly Quality Report to the Engineer. MQR will contain, apart from the Material Testing Reports, the following major items:

a) Status of Approval of Method Statements: The Contractor shall submit Method Statements including check lists & ITP (Inspection & Test Plan) for execution of each and every item of work including temporary works at least four weeks before their execution, conforming to the outline construction specifications given in the contract document for review and approval by the Engineer. (copies of sample Method Statements are available with the Engineer).

b) Quality Walk: Quality Walk of the project site shall be held once in a week by the employer/Employer's authorized representative.

c) Weekly Quality Report (WQR): The contractor shall submit the Weekly Quality Report for review of the quality by the Engineer in weekly progress review meeting. The WQR will be based on the lines of MQR.

d) Internal Quality Audit (IQA): The contractor shall conduct an internal audit of the quality of the project by the quality team of their HQ every month and shall submit the report to the Engineer.

e) External Quality Audit (EQA): The contractor shall get conducted the External Quality Audit quarterly by the reputed agency approved by the Engineer and shall submit the report to the Engineer.

f) Calibration of Batching Plant: The contractor shall be done the calibration of batching plant, immediately after installation of the batching plant and at an interval of six months thereafter, by a reputed external agency approved by the Engineer. However,

the contractor shall check the calibration in presence of Engineer's authorized representative on regular basis at least once in a month.

g) Laboratory at Site: The contractor shall get calibrated the Laboratory equipment and their dial gauges from the reputed agency/laboratory accredited by NABL and approved by the Engineer. The calibration certificate including their validity shall be displayed near each and every equipment of the Lab.

h) External Laboratory for Conducting Tests: The contractor shall get conducted the tests of materials and elements of the work for which testing facility is not available in the field Lab, from the external laboratories having valid accreditation of NABL approved by the Engineer. In addition to this, the contractor shall get conducted 5% of the tests, for which testing facility is available in field Lab also, in the external Lab, to facilitate independent review.

i) Water: The contractor shall get the water tested, from the reputed external laboratory approved by the Engineer, at the start of the work and at an interval of three months thereafter. The contractor shall also conduct the testing of the water at least once in a month in the field laboratory.

j) Status of deployment of Machinery and other T&P (Tools & Plants): The contractor shall deploy machinery and other T&P as per the provisions of the contract. Method statements approved by the Engineer and as per the requirement of the site. The contractor shall indicate the schedule of deployment of the machinery and other T&P in the Monthly Quality Report. The fitness of the machinery and other T&P shall be regularly got checked by the contractor by external inspection/Audit Team.

k) NCNs (Non-Conformity Notice) of quality issued by Engineer/Employer & NCR's (Non-Conformity Report) of quality raised by the Contractor: The status of NCNs and NCRs of quality shall be included by the contractor in the Monthly Quality Report.

The Contractor shall provide all necessary access, assistance and facilities to enable the Engineer to carry out on-site and off-site surveillance of Quality Assurance Audits to verify that the quality system which has the consent of the Engineer is being implemented fully and properly.

APPENDIX 12 CONTRACTOR'S SITE LABORATORY

12. SITE LABORATORY

12.1 The Site Laboratory shall be approximately 250m^2 in area. It shall consist of the following accommodation:

1 concrete laboratory	60m2 floor area
1 Soil laboratory	30m2 floor area
2 office	each15m2 floor area
1 store room	10m2 floor area
1 kitchen	10m2 floor area
male toilets, changing room & shower	sufficient for 6 persons

12.2 The remainder of the 250m2 shall consist of storage area for concrete cube curing tanks. The laboratory, office etc. shall be in one building; the curing tank storage building may be in a separate building, but if so, it shall be adjacent to the laboratory building & connected to it by a level, weatherproof passageway. In addition, an area of covered hard standing of 50m2 for motor vehicles shall be provided adjacent to the laboratory.

12.3 STANDARD OF CONSTRUCTION

12.3.1 The laboratory shall be constructed to the best Engineering practice and as approved by the Engineer. Two independent telephone lines with two extensions each shall be provided for the laboratory. Telephones shall be located in areas as agreed with the Engineer.

12.3.2 A water tank with minimum capacity of 2000 litres shall be installed, as a source of constant water pressure (15 kPa minimum) for each laboratory.

12.3.3 In the case of sinks used for washing samples, adequate trapping and/or separating devices shall be provided to ensure the proper functioning of the facility.

12.4 FURNISHINGS AND FIXTURES

The contractor's site laboratory shall be provided with required furnishings and fixtures.

12.5 LABORATORY EQUIPMENT

12.5.1 The laboratory equipment, as listed below, shall be approved by the Engineer. The Contractor shall submit for the Engineer's approval within 2 weeks of the order to commence work the name of the supplier it intends to use for each piece of apparatus together with the relevant catalogue number.

12.5.2 The layout of the equipment in the testing laboratory shall be instructed by the Engineer. The equipment shall be maintained to an accuracy appropriate to the required testing methods with routine calibration by an accredited organisation as recommended by the appropriate Authority. Equipment shall also be calibrated after maintenance or relocation.

12.5.3 The Contractor's site laboratory shall be equipped with the following material testing equipment as a minimum. The nature and quantity of equipment required for testing may be varied by the Engineer depending on the detail of the Contractor's Design and Construction methods or for any other reason which he deems to be valid and necessary for the proper control of quality:

Determining Liquid Limit (1 complete set)	
Liquid limit device (Casagrande type)	1 set
Grooving tools	1 No.
Evaporating dish	1 No.
Spatula 100mm blade	1 No.
Laboratory balance, capacity 500 gm,	1 No.
(sensitivity 0.01 gms.)	
Wash bottle, capacity 500 ml.	1 No.
Moisture cans, capacity 50 ml.	24 No.
Determining Plastic Limit (1 complete set)	
Evaporating dish	1 No.
Spatula 100mm blade	1 No.
Glass plate 250mmx250mmx12mm	2 No.
Moisture cans, capacity 50 ml.	12 No.
Stainless steel rods, 3 mm dia.	2 No.
Determining Moisture Content (1 complete set)	
Micro Oven, capacity 35 litres, control temperature	
up to 200 °c	1 No.
Balance, capacity 200 gm., sensitivity 0.01 gm.	1 set
Lab. Tongs	1 No.
Moisture cans 75ml. with lid	36 No.
Compaction Characteristics (1 complete set)	
Standard compaction mould 100mm dia.	1 No.
Modified compaction mould 150mm dia.	1 No.
Standard compaction Rammer, 2.5 kg.	1 No.
Modified compaction Rammer, 4.5kg.	1 No.
Straight edge 300mm long	1 No.
Sample ejector for 100mm and 150mm mould	1 No.
Sample tray 60 x 60 x 8 cm	3 No.
Wash bottle, 500 ml.	2 No.
Moisture cans 250 ml.	24 No.
Density of soil in-place by sand cone method (2 complete set)	
Sand density cone apparatus, 150mm	2 No.
Plate, 300mmx300mm with centre hold 150mm	2 No.

Glass jug for sand cone		2 No.
Chisel 25mmx 150mm		2 No.
Hammer		2 No.
One-gallon field cans		24 No.
Sampling spoon		2 No.
Soft hair brush		2 No.
Moisture cans 250 ml.		48 No.
Sieve Analysis		
Sieve shaker (portable)		1 unit
Coarse sieves	In Sizes from 100mm to 10mm	(1 set
Fine Sieves	#4,#8,#16,#30,#40,#50,#100,#200	each)
Pans & Covers		
Specific Gravity and Absorption of Coarse Aggregate		
Wire basket, 200mm dia.		
Heavy duty suspension balance, 20 kg x 1 gm. with accessory		
for weight in water		1 set
Suitable water container		1 No
Unit Weight of Aggregate		
Balance, 100 kg. capacity with 10 gm precision		1 No.
Tamping rod 16mm diameter x 600mm long		1 No.
Measuring containers (3,10,15,30 litres)		1 each
Flakiness and Elongation		
Flakiness gauge, elongation index		1 set
Soundness Test		
Sodium sulphate		25 kg
Soaking tank		1 No.
Balance, Capacity 3 kg., Sensitivity 0.1 gm.		1 set
Sieves: Coarse		1 set
Fine		1 set
Concrete		
Buckets for concrete sampling		12 No.
Slump cone		12 No.
Tamping rod		12 No
Base plate		12 No.

Mixing pan for concrete	2 No.
Scoop for general purpose	2 No.
Concrete thermometer	1 No.
Concrete cylinder mould, 150 mm * 300 mm;	30 each
150 mm * 200 mm	30 each
Concrete cube mould, 100 mm cube & 150 mm cube	10+100 each
Adjustable spanners for dismantling cube moulds	6 No.
Capping set	2 No.
Capping compound	
Concrete curing tank with capacity for 270 cubes, temperature controlled, with circulation system drain and lockable cover	5 No.
Schmidt test hammer	1 No.
Compression testing machine (Fully automated)	1 No.
Mould oil	
Temperature chart recorder	1No.
Miscellaneous	
Vernier callipers to measure up to 200mm, with elongated jaws	5 No.
Steel rule, 300 mm long graduated	2 No.
Rubber gloves	10 pr.
Cotton working gloves	20 pr.
First aid kit	1 set
Wire brush	6 No.
Steel tape, 3m, 5m, 30m	3 each
Ball peen hammer, 1 kg	2 No.
Paint scraper. Approx. 100mm wide	8 No.
Float, steel Approx.280 x 120 mm	8 No.
Sack barrow	1 No.
Shovel: Square Mouthed	2 No.
Round Mouthed	2 No.
24-wheel trolley, heavy duty, approx. 0.7m x 1.0m long pneumatic tyred type	1 No.
Wheelbarrow, rubber tyred	1 No.

Comprehensive tool kit. To include screwdrivers, pliers, claw hammer, multi-grips, spanners (adjustable)	1 No.
Type NR Schmidt Hammer and tester with recording device	1 No.
Testing Anvil for Schmidt Hammer test (SHT)	1 No.
Chart recording paper for SHT	10 pkts
Covermeter for detecting metal objects to depth of 100mm below the surface of non-magnetic objects	3 No.
Noise meter	1 No.
RCPT Testing Machine with mould	1No.
Permeability Testing Machine	1No.

APPENDIX 13

ENVIRONMENT, SOCIAL, HEALTH AND SAFETYMANAGEMENT MANUAL

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1. ESHS FRAMEWORK

General

1.1.1. The Contractor shall be responsible for Environment, Social, Health and Safety (ESHS) on the Site and any other areas being used by him for the purposes of the Contract. Each Contractor shall develop his own contract specific ESHS Management Plan, which will represent his approach to the management of ESHS activities on his work, sites under the Contract with the Employer. The ESHS Management Plan should contain all the measures in the project Environmental and Social Management Plan (ESMP) which is part of the EIA.

1.1.2. The Contractor shall ensure that all appropriate ESHS measures are implemented throughout the execution of the Works.

Scope

1.1.3. The Environment, Social, Health and Safety Management Manual defines the principal requirement of the Employer and forms an essential part of the overall Environment, Social, Health and Safety Management System proposed to be employed by the Employer for the construction of the Project.

Definition

a) HEALTH & SAFETY – Conditions and factors that affect the well-being of employees, temporary workers, Contractor personnel, visitors and any other person at the workplace;

b) ENVIRONMENT – Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interaction;

c) ENVIRONMENT ASPECT – Element of an organization's activities or products or services that can interact with the environment;

d) ENVIRONMENT IMPACT – Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects;

e) HAZARD – Source, situation, or act with a potential for harm in terms of human injury or ill health or a combination of these;

f) Ill Health – Identifiable, adverse physical or mental condition arising from and/or made worse by a work activity and/or work-related situation;

g) Incident – Work related event (s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred:

- "Accident" is an incident which has given rise to injury, ill health or fatality;
- "Emergency" is an incident having potential to affect many persons orsevere property damage;
- "Near Miss" is an incident or a situation with clear potential for an undesirable outcome to occur, even though no actual negative consequenceshappened. In other words, it is an event with potential to cause injury, property damage, environmental release or an adverse community reaction; and
- "Dangerous Occurrence" is an unplanned and undesired occurrence(incident) which has the potential to cause injury, and which may or maynot cause damage to property,

equipment or the environment.

h) AUDIT – Systematic examination to determine whether activities planned areimplemented effectively and related results are suitable for achieving theorganization policy and objectives;

i) INTERESTED PARTIES – Individual or group concerned with or affected by the ESHS Management Performance of an Organization;

j) NON-CONFORMITY – Any deviation from work standards, practices, procedures, regulations, management system performance, etc. that could either directly or indirectly lead to injury or illness, property damage, damage to workplace environment, or a combination of these;

k) OBJECTIVES – Goals in terms of ESHS Management Performance that an organization sets itself to achieve;

l) ESHS MANAGEMENT SYSTEM – Parts of overall management system that facilitates the management of the ESHS risks associated with the business of the organization. This includes the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the organization's ESHS Management Policy;

m) ORGANIZATION – Company, operation, firm enterprise, institution or association, or part thereof, whether incorporated or not, public or private, that has its own functions and administration;

n) PERFORMANCE – Measurable results of the ESHS Management System, related to the organization's control on environment, health and safety risks, based on its ESHS Management Policy and objectives;

o) RISK – Combination of the likelihood and consequences of a hazardous event occurring;

p) RISK ASSESSMENT – Overall process of establishing the magnitude of risk and deciding whether the risk is tolerable;

q) ACCEPTABLE RISK – Risk that has been reduced to a level that can be tolerated by the organization having regard to its legal obligations and its own ESHS Policy;

r) DEVIATION – Is defined as something not in compliance with quality standard, specification or measuring requirements, or as deviations from specified procedures or way of working within production, environment, working environment (safety) or security;

s) CORRECTIVE ACTION – Action taken to eliminate the causes of an existing non-conformity, defect or other undesirable situation;

t) PREVENTIVE ACTION – Action taken to eliminate the causes of a potential non-conformity, defect or other undesirable situation to prevent occurrence or recurrences;

u) ENGINEER – Employer's Representative

v) Abbreviation

- "Ministry of Environment, Forest and Climate Change, Government of India" is abbreviated as MoEFCC;
- "Central Pollution Control Board" is abbreviated as CPCB;

- "State Pollution Control Board" is abbreviated as SPCB;
- "Haryana Pollution Control Board" is abbreviated as HPCB;
- "National Green Tribunal" is abbreviated as NGT;
- The use of "shall" indicates a mandatory requirement. "ESHS" means Environment, Social, Health and Safety;
- "Haryana Rail Infrastructure Development Corporation Limited" is the Employer abbreviated as HRIDC;
- "ESHS Manager" is an officer approved by the Engineer who is overall responsible for monitoring all ESHS functions prescribed in this document on behalf of the Contractor;
- "BOCWA" Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and amendment done thereafter;
- "BOCWR" Haryana Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2005 and amendment done thereafter;
- "BOCWWCA" Building and Other Construction Workers' Welfare Cess Act, 1996;
- "BOCWWCR" Building and Other Construction Workers' Welfare Cess Rules, 1998;
- "CHIEF INSPECTOR" is the Chief Inspector of Inspection of Building and Other Constructions of Government of Haryana;
- "HIRA" is Hazard Identification and Risk Assessment; and

Application of This Document

1.1.4. This document applies to all aspects of the Contractor's Scope of Work including Subcontractors and all other agencies. There shall be no activity associated to the Contract, which is exempted from the purview of this document.

Purpose of This Document

1.1.5. The objective of these guidelines is to ensure that adequate precautions are taken for incident/occupational illness free safe work execution as well as to avoid harmful effects on the environment and social during construction.

1.1.6. This document:

a) Describes the Environment, Social, Health and Safety interfaces between theEngineer and the Contractor;

b) Details the processes by which the Contractor shall manage Environment, SocialHealth and Safety issues while carrying out the work under the contract.

1.1.7. These requirements shall be read together with, ISO 45001: 2018 Occupational Health and Safety Management System and ISO 14001: 2015 Environmental Management Systems.

2. ESHS MANAGEMENT

General

2.1.1. This document defines the principal requirements to be practiced at the Site at all times.

ESHS Targets and Goals

2.1.2. Following ESHS targets and goals shall be set and achieved by the Contractor/Subcontractor based on time bound work plan:

a) Zero total recordable injuries;

b) Zero non-conformances in respect of statutory laws related to Environment, Health, Socail and Welfare measures, living conditions and Safety regulations.

c) Total compliance of recording and reporting of all types of incidents.

d) 100% compliance on Safety Induction of all personnel

e) Total compliance of conducting inspections and audits as per approved ESHSManagement Plan;

f) 100% incident recording and reporting;

g) 100% adherence to usage of appropriate PPEs at work;

h) Executing construction work with least disturbance to the environment, adjoiningroad users and traffic;

i) Minimize waste generated at sites and maximize reuse of materials;

j) Maintaining environment conditions of site as per statutory requirement of HPCB,NGT etc. to avoid penalty;

k) To achieve construction site as zero discharge site as far as possible.

Contractor's Obligation to Abide by Mandatory Legislations and Standards

2.1.3. The construction works shall be undertaken in accordance with the Employer's ESHS Management Policy and Management Systems as amended from time to time provided in ESHS Management Manual.

2.1.4. The construction works shall be undertaken in accordance with all updated applicable legislation listed below, but not limiting to:

a) Indian Electricity Act 2003 and Electricity Rules, 2005;

b) National Building Code, 2016;

c) Factories Act, 1948 and state respective factory Rules;

d) Motor Vehicles Act as amended in 1994 and The Central Motor Vehicles Rules,1989;

e) Indian Road Congress Code IRC: SP: 55-2014 'Guidelines on Safety in Road Construction Zones';

f) The Petroleum Act, 1934 and Rules, 1976;

g) Gas Cylinder Rules, 2003;

h) Indian Explosives Act, 1884, along with the Explosives Substance Act, 1908 andthe Explosives Rules, 1983;

i) Environmental and Social Legislations as listed in Clause 6.0 of this document.

Contractor's Environmental, Social, Health and Safety Management Policy and Plan

2.1.5. The Contractor as per Rule 39 of the BOCW Central Rules shall formulate an Environment, Social, Health & Safety policy and display it at conspicuous places at work sites in English and Hindi so that the policy shall be understood by majority of the construction workers. The policy shall contain the following as minimum coverage:

a) The intention and commitments of the Contractor regarding Environment, Social, Health & Safety protection of the workers;

b) Organisational arrangement made to carry out the policy specifying the responsibilities at different levels of hierarchy;

c) Responsibilities of the Contractors, Subcontractor, transporter or other agencies involved in the construction work ;

d) Techniques and methods for assessment of Aspects/Impact and risk to safety and health and remedial measures;

e) Arrangement for training of workers, supervisors or other persons engaged in the construction work;

f) Other arrangements for making the policy more effective.

2.1.6. The Contractor shall revise the policy whenever any modification having implication on the Environment, Social, Health and Safety of the workers is made or any new construction work, substances, or technique are introduced which have implication on environment, health and safety of workers.

2.1.7. The contractor shall submit ESHS Management plan for review by the engineer within 28 days after the commencement date.

2.1.8. The Contractor shall revise and submit the ESHS Management Plan if at any time the ESHS Management Plan is insufficient in the Engineer's opinion. The Contractor shall within 7 days submit the revised ESHS Management Plan to the Engineer for review.

2.1.9. Any omissions, inconsistencies, and errors in the ESHS Management Plan or the Engineer's acceptance or rejection of the ESHS Management Plan and/or supplements thereto shall be without prejudice to the Contractor's obligations with respect to site safety, industrial health and environment and shall not be excused for any failure by the Contractor to adopt proper and recognized safety practices throughout the execution of the Works. The Contractor shall adhere to the ESHS Management Plan and shall ensure, as far as practically possible, that all supervisors and subcontractors of all tiers each have a copy of the ESHS Management Plan on the Site and comply with its provisions.

2.1.10. The details of contents to be covered in the ESHS Management Plans are given in Attachment - 1[Contents of ESHS Management Plan] of this document.

2.1.11. Contractor will inform AIIB of any significant ES events such as accidents, near misses, fatalities. AIIB is to be informed within two days of the event.

Designer's Role

2.1.12. The Designer's primary role includes to minimize the risk to environment, safety and health of those who are going to construct, maintain, clean, repair, dismantle or demolish the structures and anyone else like adjoining road users/public, who might be affected by the work.

2.1.13. Every temporary structure like scaffold, temporary deck, earth retaining structures etc. shall be properly designed.

Site ESHS Organisation

2.1.14. The Contractor shall appoint the required ESHS Management Personnel as prescribed in the

Contract.

In order to effectively implement labour welfare provisions and to interact on such provisions with the Employer and the statutory authorities enforcing the labour welfare legislations, every Contractor shall employ fulltime, qualified, and experienced Labour Welfare Officer.

2.1.15. Conduct and Competency

The Contractor shall ensure that all personnel are competent to perform the job assigned to them. In the event that the Contractor is unable to demonstrate the competency of any person whose activities can directly impact the Works' Environment, Social, Health & Safety performance, the Engineer shall remove that person from the Site without any procedural formalities.

Labor Code of Conduct: The Contractor shall have a Code of Conduct for the Contractor's Personnel. The Contractor shall ensure that each Contractor's Personnel is provided a copy of this Code of Conduct, written in a language comprehensible to that person, and shall seek to obtain that person's signature acknowledging receipt of the same.

2.1.16. Approval from The Engineer

The name, address, educational qualification, work experience and health condition of each ESHS personnel deployed shall be submitted to the Engineer for approval well before the start of the Works or before deployment whichever is earlier. These personnel are authorised to work only after approval of the Engineer. In case any ESHS personnel leaves the Contractor, the same shall be intimated to the Engineer within a week. Non-informing the employer will attract penalty. The Contractor shall recruit new personnel and fill up the vacancy before relieving a person. Proper handing over of all the documents shall be ensured before relieving a person.

2.1.17. The Contractor shall provide all ESHS Management Personnel with such facilities, equipment and information that are necessary to enable them to discharge their duties effectively. The minimum requirements of such facilities/equipment to be provided for ESHS Management Personnel are given in Attachment-4 [General Instruction:ESHS/GI/001].

Responsibility of ESHS Personnel

2.1.18. PICOW (Person In-Charge of Work)

a) "Person in Charge of Work" under whose supervision, the Workers operate as per approved method statement and ESHS Management Manual.

b) PICOW shall lead/supervise and direct the Workers to undertake the work in a safe manner.

c) Each Request for Inspection (RFI) must indicate the name of PICOW for that work.

2.1.19. Responsibility of a PICOW

PICOW should ensure that:

a) A safe system of work is adopted;

b) Everyone in the group is briefed and understand the system of work before work starts;

c) The current system of work is altered whenever there is any change in conditions or circumstances make it necessary and ensure that everyone understands the new arrangements; and

d) The work is stopped and everyone moved to a position of safety immediately, should there be any doubt whether the work may safely continue.

2.1.20. All ESHS Management Personnel are to report to the ESHS Manager who shall always report directly to the Contractor's Project Manager. Their primary role is to oversee environment, social, health and safety aspects at work site. The Engineer shall always monitor adherence to this procedure. In case of non-adherence penalty shall be levied.

ESHS Committee

2.1.21. The Contractor shall form Site ESHS Committee within 60 days of award of the Contract and notification regarding the same shall be communicated to the members.

2.1.22. The Terms of Reference for the Site ESHS Committees shall be as follows:

a) To oversee implementation of the Contractor's Environment, Social, Health and Safety policies and practices;

b) To monitor the adequacy of the Contractor's ESHS Management Plan and ensure its implementation;

c) To review ESHS training;

d) To review the Contractor's ESHS monthly reports;

e) To identify probable causes of accident and unsafe practices in construction work and to suggest remedial measures;

f) To stimulate interest of the Workers in environment, health and safety by organizing environment/safety week, safety competition, talks and film-shows on environment/safety, preparing posters or taking similar other measures as and when required or as necessary;

g) To go around the Site with a view to check unsafe practices and detect unsafe conditions and to recommend remedial measures for their rectifications including first-aid medical and welfare facilities;

h) Committee team members should perform a site inspection before every committee meeting and to monitor ESHS inspection reports;

i) To bring to the Notice of the Engineer hazards associated with use, handling and maintenance of the equipment used during the course of construction work;

j) To suggest measures for improving environment, social, health and safety in construction work at the Site;

k) To investigate the health hazards associated with handling different types of explosives, chemicals, and other construction materials and to suggest remedial measures including personal protective equipment; and

l) To review the last ESHS committee meeting minutes and the remedial measures taken for Non-Compliance.

Chairman	Project Manager
Secretary	ESHS Manager (Will be nominated by Project Manager)
Members	i) Contractor's ESHS staff. ii) Labour Welfare Officer; iii) In -charge of Plant and Machinery & Site Electricals; iv) In-charge of Special Work Operations (e.g. bridge, viaduct, and tunnel, etc.); v) In-charge of Stores; vi) Subcontractor's representative; and vii) Workers' representatives;
Engineer's Representatives	To be nominated by the Engineer

2.1.23. Minimum time between two monthly ESHS Committee meetings

A minimum period of 21 days shall be maintained between any two ESHS monthly committee meetings.

2.1.24. Agenda

The Secretary shall circulate the agenda of the meeting at least seven working days in advance of the scheduled date of the meeting to all members as well as to the Employer.

2.1.25. The agenda should broadly cover the following:

a) Chairman's overview of ESHS Management Performance;
b) Confirmation of minutes of last meeting;
c) Previous month ESHS statistics;
d) Incident and accident investigation/Dangerous occurrence/Near miss report;
e) Site ESHS inspection and compliance report;
f) The Contractors' ESHS issues;
g) Report from the Employer and Engineer;
h) Non-compliances raised by Engineer/Statutory Authorities;
i) Report and compliance of GRC; and
j) Any other concern.

2.1.26. In case of station and other contiguous areas where more than one main Contractor is working together, the Engineer shall instruct the other Contractors to join for the monthly ESHS committee meeting of the main civil Contractor, to discuss and decide about the common provision of safety, security, lighting, toilet, drinking water etc. and sharing the maintenance cost of the same etc.

2.1.27. The Minutes of the Meeting shall be prepared as per the format provided and sent to all members

within 2 working days by mail. Minutes of ESHS Committee Meeting shall also be displayed on the notice board for wider publicity to all concerned.

2.1.28. The chairman shall inform the members of any outstanding issues in the meeting and in case of repeated offence/ non-compliance by some members or other Subcontractors shall impose suitable disciplinary action including provisions of monetary penalty as per Clause 7. [Financial Deduction/Withholding].

2.1.29. In addition, there shall be a Project ESHS Committee whose composition shall be as follows:

Chairman	Project Director
Secretary	ESHS Manager (Will be nominated by PD)
Members	i) Deputy Project Director/Civil ii) Project Manager along with ESHS manager from each Contract Package iii) ESHS experts of GC
Employer's Representatives	Chief Project Manager

2.1.30. Project ESHS Committee shall also meet once a month after the meeting of Site ESHS Committee. Project ESHS Committee shall oversee the implementation of ESHS Policy and ESHS Management Plan of the Contractor in execution of the Project. This Committee shall also redress the grievances/complaints/representations received from public, other stakeholders and employees of the Contractor and Subcontractors. The agenda of the meeting shall be circulated by the Secretary of the Committee after taking approval from the Project Director.

ID Card and Safety Induction

2.1.31. The Contractor shall ensure that all personnel working at the Site receive an induction ESHS training immediately on the first day of joining explaining the nature of the work, the hazards that may be encountered during the site work. Personnel shall only be deployed at site once he/she has completed ESHS induction. The training shall cover the contents as given in Clause 8, Attachment-4[General Instruction: ESHS/GI/002].

2.1.32. All personnel shall be issued a photo identity card as per the format given in Clause 8, Attachment-4[General Instruction: ESHS/GI/003].

2.1.33. The Contractor shall also issue a Personnel pocket ESHS Booklet in a language known to the Workers, which provides information on ESHS and emergency procedures

Other ESHS Training

2.1.34. The Contractor shall organize the ESHS training to engage managers, supervisors and other personnel in behavioural change and improve safety performance. The contents of ESHS training to managers/supervisors as given in Attachment-4[General Instruction: GI/005].

2.1.35. The Contractor shall provide a training/workshop on ESHS to all its workers/staff/employees/subcontractors of at least 2 days. It shall be completed in various

modules and each employee/worker shall have a record of completing all modules.

2.1.36. On-the spot practical skill development training on height safety including scaffold safety, crane safety, welding safety, electrical safety, and traffic safety for marshals shall also be conducted.

2.1.37. Every employee including workman shall take a safety oath followed by toolbox talk every day.

2.1.38. All vehicles and machine drivers including heavy work vehicle and machine operators shall be trained on defensive driving with necessary certificate or license.

ESHS Inspection

2.1.39. The Contractor shall evolve and administer a system of conducting ESHS inspection and other risk management analysis on a periodical basis.

2.1.40. The purpose of ESHS inspection is to identify any deviation in construction activities and operations, machinery, plant and equipment and processes against the ESHS Management Plan and its supplementary procedures and programs.

2.1.41. The Contractor shall initiate a fortnightly joint site ESHS Management inspection with the Engineer and report shall be generated on the same day with the corrective action and accepted target date (within a week) by the Engineer.

2.1.42. The Compliance of the joint inspection "Non-Conformance" shall be witnessed/accepted by the Engineer.

2.1.43. The Contractor shall evolve and administer a system of conducting ESHS inspection and other risk management analysis on a periodical basis.

2.1.44. Following ESHS inspections program shall be adopted:

a) Planned general inspection;

b) Routine inspection;

c) Specific inspection; and

d) Other inspection.

2.1.45. Planned general inspections are performed at predetermined intervals. Inspections that will be classified under this inspection program are:

a) Monthly Contractor and subcontractor's site safety committee inspection;

b) Weekly safety inspection by construction supervisors (the Contractor and the Subcontractor); and

c) Daily safety inspection by the Contractor site ESHS team.

2.1.46. Routine inspections are often referring to the inspection of the Site, equipment and temporary structures performed by the Site and equipment operators and temporary structure erectors.

Inspections that will be classified under this inspection program are:

a) Daily inspection of plant and equipment by operators;

b) Weekly inspection of scaffold by scaffolding supervisors;

c) Monthly Inspection of electrical hand tools by competent electrical supervisors;

d) Quarterly inspection of temporary electrical systems by competent electrical supervisors; and

e) Half-yearly inspection of lifting machinery, lifting appliances, equipment and gears by Govt. approved competent persons.

f) Quarterly inspection of lifting gears, tools tackles and appliances.

g) Quarterly colour coding of lifting gears, tools & tackles. The recommended colour coding for the 4 quarters of the years shall be as under

i) January – March: GREEN

ii) April – June: YELLOW

iii) July – September: BLUE

iv) October – December: WHITE

2.1.47. The list mentioned above is not exhaustive. The Contractor may add additional categories. The ESHS Manager will ensure that a system of routine inspections is carried out periodically to all plants, equipment, powered tools and any other temporary structures that will pose a hazard to operators and workmen.

2.1.48. Specific Inspection

Specific inspections are performed on activities without a predetermined date. Competent supervisors usually perform inspections for ensuring an activity whether it is executed in accordance to a general set of rules; Method Statement submitted or developed procedures.

The following are examples that will be commonly performed as required on the Site:

a) Inspection performed before a heavy lifting operation;

b) Inspection performed before and after the entry of person into a confined space;

c) Inspection performed before and after a welding and gas cutting operation;

d) Inspection of formwork before concreting by formwork erector.

The list mentioned above is not exhaustive. The Contractor shall ensure that a competent supervisor inspects all high-risk processes and activities.

2.1.49. Other inspections include the following:

a) Mandatory inspections by Labour Department of Government of Haryana; and

b) HRIDC site ESHS management team.

c) Inspections by Central Pollution Control Board, Haryana Pollution Control Board, Ministry of Environment and Forest and Climate Change, National Green Tribunal etc.

2.1.50. The Contractor shall prepare all required safety inspection checklist for all activity operations and equipment. Checklists will be prepared based on the Indian Safety Standards, Rules and Regulations and the Works requirements.

2.1.51. All inspection records and reports will be properly kept and filed for audit purpose. Inspection reports of planned general inspection and routine inspection will be used for discussion during safety committee meetings.

ESHS Audit

2.1.52. The purpose and scope of ESHS Audit is to assess potential risk, liabilities and the degree of compliance of the ESHS Management Plan and its supplementary procedures and programs against applicable and current ESHS legislation regulations and the Works requirements.

2.1.53. The Contactor's project manager shall hold the ultimate responsibility in ensuring implementation of ESHS audit program during the construction work.

2.1.54. Monthly Audit Rating Score (MARS)

2.1.55. Monthly Audit Rating Score (MARS) will be performed once in a month. A team consisting of the Contractor's project manager and the Engineer's representative based on the pre-designed

score-rating format will conduct it.

2.1.56. This Monthly ESHS Audit Rating Score (MARS) report will enable the Engineer to evaluate the general compliance by the Contractor with the Conditions of Contract, and the ESHS Management Plan. A Minimum Compliance level to achieve 75% overall Audit Rating is essentially required. Falling this, the Engineer will take punitive action which includes non-processing of running account bills.

2.1.57. The Contractor's project manager accompanied by the Engineer's representatives shall carry out the Audit. The Contractor's senior manager and the ESHS in-charge should also be invited to attend.

2.1.58. Timing

The Monthly Audit Rating Score (MARS) should be conducted at least 7 days prior to the scheduled date of monthly ESHS Committee Meeting.

2.1.59. Evaluation

The numerical scoring has been weighed on a 1-10 scale. The audit team will use their observations noted in evaluating the points to be awarded against each of the elements of the audited section. Wherever some topics and sub-topics are not applicable the score rating need not be given. The overall audit ratings shall be achieved by:

$$\text{Overall Audit rating} = \frac{\text{Actual Score Achieved}}{\text{Maximum Possible Score}} \times 100$$

The criticality of the required actions for the respective sections of the Audit will be classified as:

S.No.	Score	Description	Action
1	< 60%	Immediate	Require the Contractor to rectify within 24 hours
2	< 75%	Improvement Necessary	The Contractor rectification within 7 days and confirmed in writing to the Engineer
3	< 90%	Improvement Desirable	The Contractor rectification within 1 month and confirmed in writing to the Engineer

2.1.60. Report

A copy of each Audit Report will be sent to the Engineer and to all subcontractors, with whom it will then be discussed in detail at the monthly ESHS Committee Meeting to ensure that any corrective actions are agreed upon.

2.1.61. External ESHS Audit

External ESHS Audit is to be conducted by the external agencies that are competent with ISO qualified auditors with the prior approval of the Engineer.

a) Areas of Competence of Audit Team

i) The Audit team shall have practical understanding of BOCWR/A statutory requirements on health/medical and welfare of workmen, construction hazardsand its prevention and control, traffic management, electrical safety, rigging, safety of construction equipment and environment and social management.

ii) Audit shall be conducted as per the guidelines of ISO, ILO and national standards. Audit report shall also be presented as per the formats given in thestandards; and

iii) External ESHS Audit shall be conducted on a quarterly basis throughout the currency of the Contract.

b) Targets of ESHS Audit:

The contents and coverage of the audit shall include the following items:

i) ESHS Management:

- ESHS Organization;
- ESHS Policy and Plan;
- ESHS committee;
- ESHS orientation;
- ESHS training;
- ESHS communication and motivation;
- ESHS submittals to the Employer;
- ESHS promotional and awareness program;
- Incident reporting &investigation;
- Onsite/offsite emergency preparedness plan;
- Hazard identification and risk assessment;
- Implementations of work permit system.

ii) Technical:

- Work Method Statement;
- Operational control procedures/ Safe operating procedures;
- Working at height;
- Hand tools and power tools;
- Electrical safety;
- Fire prevention and control;
- Housekeeping;
- Overhead protection;
- Slipping, tripping, cutting, drowning and falling hazards;
- Lifting appliances and gear, tools and tackles;
- Lifting and launching operation;
- Construction plant and machinery;
- Machine and area guarding;
- Material handling;
- Hot work;
- Demolition;
- Excavation and tunnelling;
- Work permit system;
- Traffic management;

- Chemical handling;
- Dangerous and harmful Environments;
- Maintenance matrix of mechanical and electrical machines / equipment;
- Working on or under water;
- Working near or under high tension line;
- Personal protective equipment;
- Visitors at Site;
- Occupational health and welfare measures;
- All statutory forms, returns under various statutes;
- First-aid and medical facilities;
- Welfare measures; and
- Environmental and Social management.

c) Audit Documents:

The Contractor shall make the below itemized documents available for review by the Audit team;

a) ESHS Policy;

a) ESHS Management Manual;

b) ESHS Rules and Regulation;

c) ESHS Organization chart;

d) Annual ESHS objectives/programs;

e) Accident/near miss statistics and analysis;

f) ESHS training program/records for all personnel;

g) Operating manuals and maintenance manual of all equipment;

h) Safe worthiness certificates of all lifting appliances and gears;

i) Medical fitness record for all personnel;

j) Risk identification, assessment and control details;

k) Environmental and Social management reports;

l) Emergency management records including mock drill;

m) Housekeeping inspection records;

n) Minutes of ESHS committee meetings;

o) Calibration and testing records;

p) Safety budgets;

q) Records of previous audits;

r) Safety inspection records;

s) First Aid, medical facilities and other welfares measures;

t) Maintenance procedure of plant &machinery;

u) Records of Industrial hygiene surveys (noise, ventilation, and illumination level,

airborne and toxic substances, explosive gases).

d) Reporting

Audit report shall be prepared and directly sent to the Engineer within 7 days of conducting the audit.

e) Report Contents:

a) Executing Summary - Based on the finalized checklists as written the findings to the Engineer by the audit team members, the audit leader will compile a concise and accurate summary of observations and findings;

b) Introduction- This will contain basic information regarding the facilities or organization audited, the specific audit dates (inclusion of those for preparation and post-audit activities);

c) Principal Positive Findings - This will contain the summary of positive aspects as observed by the auditors. It will also contain highlights of those issue, which may warrant dissemination as best practice regarding methodology used or achievement;

d) Audit Findings - All audit findings as detailed in the audit checklists shall be grouped together as priority 1 and 2 as detailed below in a separate listing:

i. Priority 1: Actions to rectify gaps or weakness should generally beimplemented within two-weeks' time if risk potential is high or unacceptable; and

ii. Priority 2: Actions should be generally implemented or rectified with a maximum of 3- 4 weeks, if not rectified would create a likelihood of minor injury or business loss.

f) Conformity Report Action to the Engineer:

a) The auditor shall inspect the Site after 14 days of conducting initial audit for checking the adequacy of implementation of items maintained under priority 1 by the Contractor and shall submit a Conformity/Non-conformity Report to the Engineer;

b) The auditor shall again inspect after 28 days of conducting initial audit for checking the adequacy of implementation of items mentioned under priority 2 by the Contractor and shall submit a Conformity/Non-conformity Report to the Engineer; and

c) In case of non-conformity of items mentioned by auditor, the Engineer shall take necessary steps including stoppage of work and or imposing any penalty for getting the item implemented.

d) If the Contractor fails to conduct the External ESHS Audit in time, the Engineer shall get it done. All expenses related to the external ESHS audits shall be borne bythe Contractor.

ESHS Communication

2.1.62. The Contractor shall make every effort to communicate the ESHS Management measures through posters campaigns/billboards/banners/glow signs being displayed around the Site as part of the effort to raise ESHS awareness amongst the work force. Posters should be in Hindi, English and other suitable language deemed appropriate. Posters/billboards/ banners/glow signs should be changed at least once in a month to maintain the impact.

2.1.63. The Contractor shall also observe important days as listed in Attachment-4[General Instruction: ESHS/GI/006] and printing and displaying safety signage and posters as listed in Attachment-4[General Instruction: ESHS/GI/007].

ESHS Submittals

2.1.64. The Contractor's ESHS Management shall send the following reports to the Engineer

periodically in soft copy:

a) Daily reporting of total number of workmen;
b) Monthly ESHS Reports;
c) Minutes of ESHS Committee meeting;
d) ESHS inspection and compliance reports; and
e) ESHS audits reports;
   - Monthly Audit Rating Score (MARS) reports;
   - External ESHS audits;

2.1.65. The Contractor shall prepare a Monthly ESHS Report consisting of the following within 7th of next month to the Engineer:

a) Monthly man-hour details as specified in the ESHS Management Plan;
b) Monthly accident/incident details as specified in the ESHS Management Plan;
c) ESHS committee details;
d) ESHS inspection and compliance report;
e) ESHS internal audit details.;
f) ESHS communication activities undertaken in the month indicating the number of posters displayed and balance availability in stock;
g) Monthly Environment (including air, noise, water and soil testing results) and Social Report;
h) Graphical representation of monitored results over past four reporting periods;
i) Details of interactions with regulators (e.g. Pollution Control Board, Forest Department etc.) including dates, subjects, outcomes (report the negative if none);
j) Details of Clearance/ Permission//Permit obtained;
k) Compliance status for conditions of all relevant clearances /permissions / consents/permits for the Work, including quarries, etc.;
l) Tree felling, transplanting and compensatory planation details;
m) Details of consumption of construction material, energy and water;
n) Details of different types of waste and scrap generated during the month and sold to authorised recyclers;
o) Summary of complaints, results of investigations and follow-up actions;
p) Gender: Number of female workers, percentage of female workforce, gender issue raised and dealt with;
q) HIV/AIDS: Provider of health services, information& training;
r) GBV/SEA: Details of training conducted;
s) Grievances: List of grievances received in the reporting period and unresolved past grievances by date received, complaint how received, to whom referred to for action, resolution and date (if completed), date of resolution of community grievances if any.
t) Toolbox talks details;
u) PPE details: Quantity purchased, issued to the workmen and stock available;
v) Details on IP 44 panel boards, lighting poles, welding and cutting equipment, Ladders,

Hoists, Tools & Tackles;

w) Monthly lux meter study results;

x) Housekeeping;

y) Barricade maintenance details;

z) No of critical excavations;

aa) Health and welfare activities;

bb) ESHS activities planned for next month.

Formats in which information to be given for monthly Environment and Social aspects are given in Attachment 4 [General Instruction: ESHS/GI/008]

Accident Reporting and Investigation

2.1.66. All accidents and dangerous occurrences shall immediately be informed through message to the Engineer and the Employer. AIIB is to be informed within two days of the event. This will enable the Engineer to reach to the scene of accident/dangerous occurrences to monitor/assist any rescue work and/or start conducting the investigation process so that the evidences are not lost.

2.1.67. Reports of all accidents (fatal/injury) and dangerous occurrences shall also be sent within 24 hours by the Contractor.

2.1.68. No accident/dangerous occurrences are exempted from reporting to the Employer.

2.1.69. Any wilful delay in verbal and written reporting to the Employer and Engineer shall be penalized as per Clause 7. [Financial Deduction/Withholding].

2.1.70. In addition to the above verbal and written reporting to the Employer and Engineer, as per Rule 276 of HBOCWR, notice of any accident to a worker at the Site that:

a) Causes loss of life; or;

b) Disables a worker from working for a period of 48 hours or more immediately following the accident; shall forthwith be sent by telegram, telephone, fax, orsimilar other means including special messenger within 4 hours in case of fatal accidents and 72 hours in case of other accidents, to:

i) The Assistant Director, Industrial Safety and Health having jurisdiction in the area in which the establishment in which such accident or dangerous occurrence took place is located. The Assistant Director, Industrial Safety and Health shall be the authority appointed under section 39 of the Act;

ii) Board with which the building worker involved in accident was registered as a beneficiary;

iii) Chief inspector; and

iv) The next of kin or other relative of the Worker involved in the accident.

2.1.71. Further, notice of any accident shall be sent in respect of an accident which:

a) Causes loss of life; or;

b) Disables the injured worker from work (for a period of more than 10 days) to;

i) The Officer-in-charge of the nearest police station;

ii) The District Magistrate or, if the District Magistrate by order so desires to;

iii) The Sub-Divisional Magistrate.

2.1.72. In case of an accident-causing minor injury, first-aid shall be administered, and the injured

worker shall be immediately transferred to a hospital or other place for medical treatment.

2.1.73. Where any accident-causing disablement that subsequently results in death, notice in writing of such death, shall be sent to the authorities within 72 hours of such death.

2.1.74. The following classes of dangerous occurrences shall be reported to the inspector having jurisdiction, whether any disablement or death caused to the Worker, namely:

a) Collapse or failure of lifting appliances, or hoist, or conveyors, or similar equipment for handling of building or construction material or breakage orfailure of rope, chain or loose gears; or overturning of cranes used in construction work;

b) Falling of objects from height;

c) Collapse or subsidence of soil, tunnel, pipelines, any wall, floor, gallery, roof or any other part of any structure, launching girder, platform, staging, scaffolding or means of access including formwork;

d) Explosion of receiver or vessel used for storage of pressure greater than atmospheric pressure of any gas or any liquid or solid used as building material;

e) Fire and explosion causing damage to any place on the site where the Workers are employed;

f) Spillage or leakage of any hazardous substance and damage to their container;

g) Collapse, capsizing, toppling or collision of transport equipment; and

h) Leakage or release of harmful toxic gases at the Site.

2.1.75. In case of failure of launching girder, lifting appliance, loose gear, hoist machinery and transport equipment at the site, such appliances, gear, hoist, machinery or equipment and the site of such occurrence shall, as far as practicable, be kept undisturbed until inspected by the authorities.

2.1.76. Every notice given for fatal accidents or dangerous occurrences shall be followed by a written report to the concerned Authorities under Section 39 of BOCWA and the Chief Inspector of Government of Haryana in the specified Form **XLVI** of the **HBOCWR.**

2.1.77. Actions to be taken post incident/accident:

a) In case any incident/accident happens at site leading to injury to the worker, the worker/s is/are required to be taken to the nearest hospital immediately;

b) Project Manager/ESHS Manager/Labour Welfare Officer of the Contractor

c) needs to report the incident to the Engineer immediately without fail for all the death cases including natural deaths;

d) In case of fatal accident, doctor from the nominated hospital is the only authorized person to declare the death of the worker. It is not to be decided suo-moto by any other person. FIR should be registered for all the fatal cases which happen at the Site/labour camp;

e) Post Mortem of the dead body is mandatory in all the death cases i.e. whether it is natural or due to any incident / accident;

f) Family members of the injured / deceased worker are to be informed immediately;

g) In case of fatal accident, the dead body is to be handed over to the family members. Arrangement of sending the dead body to the native place shall be made by the contractor including cash payment for meeting out last rites expenses as per Rules;

h) Fatal accident report is to be sent to State Labour Authority in Form EE (as per workmen's compensations act) within seven days and to the Licensing Authority in Form XLVI within 24 hours of the incident/accident;

i) Workmen's Compensation dues are to be deposited with the Employee's Compensation Commissioner within 30 days of the death or the period of notice served by the Employee's Compensation Commissioner;

j) Copy of all the documents deposited with any labour authority, FIR, Post Mortem, Medical Reports etc. shall be submitted to the Engineer in duly approved Labour Welfare Fund (LWF) Form;

k) The Contractor shall be liable for getting disbursement of Provident Fund benefits, compensation under Employee compensation Act, benefits of ESI Act to the workman/dependents of the deceased workman. The Contractor shall also provide accommodation and transportation to dependents of the deceased workman or to the disabled workman who come for settlement ofterminal claims.

2.1.78. Accident Investigation:

a) Investigations shall be conducted in an open and positive atmosphere that encourages the witnesses to talk freely. The primary objective is to ascertain the facts with a view to prevent future and possibly more serious occurrences;

b) Accidents and dangerous occurrences which result in death, serious injury or serious damage must be investigated by the Contractor immediately to find out the cause of the accident/occurrence so that measures can be formulated to prevent any recurrence; and

c) Near misses and minor accidents should also be investigated by the Contractor as soon as possible as they are signals that there are inadequacies in the ESHS Management System.

2.1.79. Procedure of Incident Investigation

It is important after any accident or dangerous occurrence that information relating to the incident is gathered in an organized way. The following steps shall be followed:

a) Take photographs and make sketches;

b) Examine involved equipment, work piece or material and the environmentalconditions;

c) Interview the injured, eye-witnesses and other involved parties;

d) Consult expert opinion where necessary; and

e) Identify the specific Contractor or subcontractor involved.

2.1.80. Having gathered information, it is then necessary to make an analysis of incident:

a) Establish the chain of events leading to the accident or incident;

b) Find out at what stage the accident took place;

c) Considering all possible causes and the interaction of different factors that led up to the accident and identify the most probable cause, the cause of an accident should never be classified as carelessness; and

d) The specific act or omission that caused the accident must be identified.

2.1.81. The next stage is to proceed with the follow-up action:

a) Report on the findings and conclusions;

b) Formulate preventive measures to avoid recurrence; and

c) Publicize the findings and the remedial actions taken.

2.1.82. The Engineer's Independent Incident Investigation

In case of fatal/dangerous occurrence, the Engineer shall also conduct independent investigation. The Contractor and his staff shall extend necessary co-operation and testify about the accident.

2.1.83. The Contractor shall take every effort to preserve the scene of accident till the Engineer completes the investigation.

2.1.84. All persons summoned by the Engineer in connection to witness recording shall obey the instructions without delay. Any wilful suppression of information by any person shall be removed from the site immediately and/or punished as per Clause 7. [Financial Deduction/Withholding].

Emergency Preparedness Plan

2.1.85. The Contractor shall prepare as required under BOCWR, an Emergency Response Plan for the Site as a part of the Contractor ESHS Management Plan. The plan shall integrate the emergency response plans of the Contractor and all other Subcontractors. The Emergency Response Plan shall detail the Contractor's procedures, including detailed communication arrangements, for dealing with all emergencies that could affect the Site. The plan shall address items such as injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue.

2.1.86. The Contractor shall ensure that the Emergency Response Plan is prepared to deal with emergencies arising out of, but not limited to:

a) Fire and explosion;

b) Collapse of lifting appliances and transport equipment.

c) Collapse of building, sheds or structure etc.

d) Gas leakage or spillage of dangerous goods or chemicals;

e) Bomb threatening, Criminal or Terrorist attack;

f) Drowning of workers; and

g) Landslides getting workers buried, floods, earthquake, storms and other natural calamities etc.

The above list is not exhaustive and other emergencies can also be included.

2.1.87. Arrangement shall be made for emergency medical treatment and evacuation of the victim in the event of an accident or dangerous incident occurring, the chain of command and the responsible persons of the Contractor with their telephone numbers and addresses for quick communication shall be adequately publicized and conspicuously displayed in the workplace.

2.1.88. The Contractor shall require to tie-up with the hospitals and fire stations located in the neighbourhood for attending to the casualties promptly and emergency vehicle kept on standby duty during the working hours for the purpose.

2.1.89. The Contractor shall conduct an onsite emergency mock drill once in every month for all his workers and his sub-Contractor's workers.

2.1.90. It shall be the responsibility of the Contractor to keep the Local Law and Order Authorities informed and seek urgent help to mitigate the consequences of an emergency. Prompt communication to the Employer and Engineer, through telephonically initially and followed by a written report, shall be made by the Contractor.

Experts/Agencies for Environment, Social, Health & Safety Services

2.1.91. The Contractors may utilise the services of experts/agencies empanelled for the purpose of training, audit and any other ESHS services with prior approval of the Engineer. This approval can be withdrawn by the Engineer at any time if the quality of output of the agency is found not satisfactory.

3. LABOUR PROTECTION

General

3.1.1. The Contractor shall comply in full of the project Workplace Policy as described in Attachment-2 [Work Place Policy on HIV/AIDS, Prevention & Control] and Attachment -3 [Covid 19 policy].

Engagement of Staff and Labour

3.1.2. The Contractor shall ensure that the employees deployed by him in the premises of the Employer are physically and mentally fit and do not have any criminal record.

Payment of Minimum Wages

3.1.3. The Contractor shall ensure payment of at least the minimum wages as prescribed and applicable from time to time under the Minimum Wages Act, 1948 in the presence of an authorised representative of the Engineer and shall maintain proper records of their timely disbursement. These records shall be preserved for a period of at least 3 years and made available even after the Contract is over for any verification by the statutory authorities.

Conditions of Labour

3.1.4. The Contractor shall observe conditions of labour that are no less favourable than those established for the relevant trade or industry.

3.1.5. During the work, the Contractor shall afford all employees all basic rights enumerated in the conventions of the International Labour Organisation, including freedom of association, right to freedom from forced labour, and right to freedom from discrimination based on race, colour, sex, religion, political opinion and social origin.

3.1.6. The Contractor shall ensure coverage of his employees under the Employees Provident Fund and Miscellaneous Provisions Act, 1952 and the Employees State Insurance Act, 1948 via independent code numbers allotted to them by the Central Provident Fund Organisation and Employees State Insurance Corporation respectively.

3.1.7. The Contractor shall insure all his employees under Group Personal Accident Insurance scheme through a recognised and registered insurance company.

Labour Laws

3.1.8. The Contractor shall ensure that all his employees and the Subcontractors obey applicable following laws and regulations, including those concerning safety at work.

a) Minimum Wages Act, 1948;

b) Payment of Wages Act, 1936;

c) Equal Remuneration Act, 1976;

d) Employees Provident Fund and Miscellaneous Provisions Act, 1952;

e) Payment of Gratuity Act, 1972;

f) Employees State Insurance Act, 1948;

g) Payment of Bonus Act, 1965;

h) Maternity Benefit Act, 1951;

i) Industrial Disputes Act, 1947;

j) Trade Unions Act, 1926;

k) Child Labour (Prohibition and Regulation) Act, 1986;

l) Building and Other Construction Workers (Regulation of Employment of Service) Act, 1996;

m) Haryana Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2005;

n) Building and Other Construction Workers Welfare Cess Act, 1996;

o) Building and Other Construction Workers Welfare Cess Rules, 1998;

p) The Contract Labour (Regulation and Abolition) Act, 1970;

q) Inter State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979;

r) Haryana Major Accident, Hazard Control Rules, 2009;

s) Workmen's Compensation Act. 1923;

t) Factories Act, 1948;

u) Mines Act, 1952; and

3.1.9. The Contractor shall comply with all other statutory requirements, rules, regulations and notifications in relation to employment of his staff and workers that may be issued from time to time by the concerned government authorities.

Working Hours

3.1.10. No work shall be carried out beyond the statutory limit given under BOCWA, 1996.

3.1.11. No work shall be carried out outside the normal working hours stated in the Contract unless otherwise:

a) The Engineer gives his consent in writing for additional work; and

b) The work is unavoidable or necessary for the protection of life or property or forthe safety of the Works, in which case the Contractor shall immediately inform the Engineer.

4. SAFETY GENERAL

General

4.1.1. The following standards whichever is more stringent shall be applicable:

a) The BOCW Acts 1996 and the Haryana BOCW Rules 2005 framed there under;

b) Other relevant National Legislations & IS Codes.

Housekeeping

4.1.2. General Housekeeping shall be carried out by the Contractor and ensured always at the Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and Toilets/Urinals.

4.1.3. Full height fence, barriers, barricades etc. shall be erected around the Site to prevent the surrounding from excavated soil, rubbish etc., which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Engineer. These shall be maintained in one line and level.

4.1.4. The Contractor shall ensure that all his sub-Contractors maintain the site reasonably clean through provisions related to housekeeping. All surplus earth and debris are removed/disposed of from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. to avoid dust or odour impact shall be covered while moving. The tyres of the trucks leaving the site shall be cleaned with water, wherever the possibility of spillage on carriageways meant for regular road traffic exists

4.1.5. Water logging or bentonite/polymer spillage on roads shall not be allowed. If bentonite/polymer spillage is observed on road endangering the safety of road users, the Contractor shall be penalized as per Clause 7. [Financial Deduction/Withholding].

4.1.6. No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.

4.1.7. Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.

4.1.8. Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored/stacked in an orderly and safe manner.

Working at Height

4.1.9. Working at height means work in any place, including a place at or below ground level.

4.1.10. The Contractor shall ensure that work at height is properly planned, appropriately supervised, and carried out in a safe manner and without any appreciable risk. Appropriate care shall be taken during bad weather.

4.1.11. Adequate protection in the form of working platform with railing, toe board, safe access, safety net, roof ladder etc. shall be provided. Where fall hazards cannot be eliminated, use fall-arrest systems while erecting, modifying, and dismantling scaffolds.

4.1.12. A trained and certified person shall check working platform, railing, toe board, safe access, safety net, roof ladder etc. after erection and once in a week. A certificate shall be tagged on this

equipment.

4.1.13. Employees involved in the erection, dismantling, moving, repairing, etc., of scaffolding and also workers who perform work on a scaffold shall receive training from a competent person. The purpose of the training is to recognize any hazards associated with the work.

4.1.14. When the height of a scaffold exceeds three times of the smallest width of the base, secure it to the building or structure at every other lift and every 9.0 m horizontally. The scaffold and scaffold working platform with handrails approximately 1.0 m high, mid rails, and toe boards, all secured rigidly by both ties and braces to prevent movement. Working platforms should be completely decked with safety planks, manufactured scaffold decking, or metallic planks.

4.1.15. Only metal frame working scaffold is permitted. Steel stairs are used as a means of raising and lowering the metal frame working scaffold, except for special cases. It is prohibited to directly raise and lower the framework with limbs or to use only ladder.

4.1.16. The Contractor shall ensure that following areas are clearly indicated:

a) where a workplace contains an area in which, owing to the nature of the work, there is a risk of any person at work;

b) Falling a distance; or

c) Being struck by a falling object:

4.1.17. The Contractor shall ensure that work equipment exposed to conditions causing deterioration, which is liable to result in dangerous situations, is inspected at suitable intervals and after any exception occurrence jeopardizing the safety of work/equipment.

4.1.18. In relation to work at height involved in construction work;

a) The top guard-rail or other similar means of protection shall be at least 1100 mm above the edge from which any person is liable to fall;

b) Toe-boards shall be suitable and sufficient to prevent the fall of any person, or any material or object, from any place of work; and

c) Any intermediate guardrail or similar means of protection shall be positioned sothat any gap between it and other means of protection does not exceed 550 mm.

4.1.19. Requirements for all Working Platforms:

a) Every working platform requires a firm & stable supporting structure for holding it;

b) A working platform shall possess a suitable surface and be so constructed that the surface of the working platform has no gap through which a person/material/object could fall;

c) A working platform and any supporting structure shall not be loaded to give rise to a risk of collapse or to any deformation, which could affect its safe use;

d) When altered or modified, it should be so altered or modified as to ensure that it

e) remains stable;

f) A working platform shall be of sufficient dimension to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area having regard to the work being carried out there;

g) Depending on the complexity of the scaffolding selected, a responsible person shall draw up an assembly, use and dismantling plan;

h) A copy of the plan, including any instructions it may contain, shall be kept available for the use of persons concerned in the assembly, use, dismantling or alteration of scaffolding until it has been dismantled; and

i) While a scaffold is not available for use, including during its assembly, dismantling or

alteration, it shall be marked with general warning signs in accordance with and be suitably delineated by physical means preventing access to the danger zone.

4.1.20. Requirements for collective safeguards for arresting falls:

a) Collective safeguard is a safety net, airbag or other collective safeguard for arresting falls;

b) A safeguard shall be used only if:

i) A risk assessment has demonstrated that the work activity can (so far as is reasonably practicable) be performed safely while using it and without affecting its effectiveness;

ii) The use of other safer work equipment is not reasonably practicable; and

iii) A sufficient number of available persons have received adequate training specific to the safeguard, including rescue procedures.

4.1.21. Requirements for personal fall protection systems:

a) A personal fall protection system shall be used only if a risk assessment hasdemonstrated that;

i) The work can (so far as be reasonably practicable) be performed safely while using that system; and

ii) The use of other safer work equipment is not reasonably practicable.

The user and a sufficient number of available persons have received adequate training specific to the operations envisaged, including rescue procedures; and

b) A personal fall protection system designed for use with an anchor shall be securely attached to at least one anchor, and each anchor and the means of attachment thereto shall be suitable and of sufficient strength and stability to supporting any foreseeable loading.

4.1.22. Requirements for Ladders:

a) Every Contractor shall ensure that a ladder is used for work at height only if a risk assessment has demonstrated that the use of more suitable work equipment is not justified because of the low risk;

b) The short duration of use;

c) Existing features on the Site, which he cannot alter;

d) Only metal ladders shall be allowed. Bamboo ladders are prohibited;

e) Any surface upon which a ladder rests shall be stable, firm, of sufficient strength and of suitable composition safely to support the ladder so that its rungs or steps remain horizontal, and any loading intended to be placed on it;

f) A ladder shall be so positioned as to ensure its stability during use;

g) No interlocking or extension ladder shall be used unless its sections are prevented from moving relative to each other while in use;

h) Where a ladder or run of ladders raises a vertical distance of 9.0 m or more above its base, there shall, where reasonably practicable, be provided at suitable intervals sufficient safe landing areas or rest platforms;

Overhead Protection

4.1.23. All contractors shall provide overhead protections as per BOCW Act & Haryana BOCW Rules.

Slipping, Tripping, Cutting, and Falling HazardsAs Per Rule 98 of HBOCWR:

a) All places should be free from dust, debris or similar materials;

b) Sharp projections or any protruding nails or similar objects shall be suitably guarded or shall even be avoided to make the place safe to work;

c) Contractor shall not allow workmen to work or use platforms, scaffolds/passageways or any walkways, which has water, or oil or similar substances spilt and has a slipping hazard, unless it is cleaned off or covered or sanded or saw dusted or make it safe with any suitable material;

d) Open side or opening where worker, equipment, vehicle or lifting appliance may fall at a building or outside shall be guarded suitably except in places of free access by reasons of nature of work;

e) Suitable safety net shall be provided at places of material / man falling is possible in accordance with national standards;

f) Reinforcement of Pier and columns shall be secured from the risk of tilting through provisioning of minimum three guy wires ropes anchored to any concrete block/counter weight of sufficient capacity.

Lifting Appliances including Cranes

4.1.24. Lifting appliances means a crane, hoist hydra, derrick, winch, gin pole, sheer legs, jack, hoist drum, slewing machinery, slewing bearing fasteners, lifting machinery sheaves, pulley blocks, hooks or other equipment used for lifting materials, objects or the Workers and lifting gears means ropes, chain slings, shackles, hooks, lifting lugs, wire ropes, lifting eyebolts and eye nuts and other accessories of a lifting appliance.

4.1.25. Each of the lifting appliances and lifting gear including all parts thereof, whether fixed or moveable shall be thoroughly tested and examined by a competent person once at least in every 6 months or after it has undergone any alterations or repairs liable to affect its strength or stability. Within the validity, if the lifting appliances are shifted to a new site, re-examination by the competent person for ensuring its safety shall also be done.

4.1.26. The Contractors shall utilize the services of any competent person as defined in Factories Act, 1948 with the permission of the Engineer.

4.1.27. No machine shall be selected to do any lifting on a specific job until its size and characteristics are considered adequate:

a) The weights, dimensions and lift radii of the heaviest and largest loads;

b) The maximum lift height, the maximum lift radius and the weight of the loads that must be handled at each;

c) The number and frequency of lifts to be made;

d) How long the crane will be required on site;

e) The type of lifting to be done (for example, is precision placement of loads important;

f) The type of carrier required (this depends on ground conditions and machine capacity In its operating quadrants: capacity is normally greatest over the rear, less over the side, and non-existent over the front;

g) Whether loads will have to be walked or carried;

h) Whether loads will have to be suspended for lengthy periods;

i) The site conditions, including the ground where the machine will be set up, access roads and ramps it must travel, space for erection and any obstacles that might impede access or operation.

4.1.28. The Contractor shall ensure that a valid certificate of fitness issued is available for all lifting appliances including synchronized mobile jacks, pre-stressing hydraulic jacks, jacks fitted with

launching girders etc. and the Engineer approval is obtained before inducting to the site. Only after obtaining the approval from the Engineer any lifting appliances and gear shall be used.

4.1.29. The laminated photocopies of fitness certificate issued by competent person, the Engineers approval letter, the operators photo, manufactures load chart and competency certificate shall always be either kept in the operator cabin or pasted on the visible surface of the lifting appliances.

4.1.30. All lifting appliances and loose gears shall be clearly marked for its safe working load and identification by stamping or other suitable means.

4.1.31. The Contractor shall also maintain a register containing a system of identification of all tools and tackles, its date of purchase, safe working load, competent person date of examination etc.

4.1.32. Sufficient lighting arrangement shall be ensured at all lifting operations.

4.1.33. Qualification of operator of lifting appliances etc.: The Contractor shall not employ any person to drive or operate a lifting machine-like crane, hydra etc. whether driven by mechanical power or otherwise or to give signals to work as an operator of a rigger or derricks unless he:

a) Is above 21 years of age and possesses a valid heavy transport vehicle driving license as per Motor Vehicle Act and Rules;

b) Is competent and reliable;

c) Possesses the knowledge of the inherent risks involved in the operation of lifting appliances by undergoing a formal training at any institution of national importance acceptable to the Engineer; and

d) Is medically examined periodically as specified in schedule VII of BOCW Rules.

4.1.34. All hydraulic piping and fittings shall be maintained leak proof.

4.1.35. Only four legged slings shall be allowed which includes master link (ring), intermediate master link (ring) if necessary, chain / wire rope sling, sling hook or other terminal fitting.

4.1.36. Hand spliced slings up to 32mm diameter shall not be used at site for any lifting purpose. The slings used shall confirm to IS 2762: 2009 Wire rope slings and sling leg specification.

4.1.37. No load shall be slewed over public areas without stopping the road traffic first.

4.1.38. Failure to do any of the above shall attract penalty from the Employer as per Clause 7. [Financial Deduction/Withholding].

4.1.39. Automatic safe load indicator (ASLI) to be provided in crane with audible and visible warning system and made functional and calibrated by the manufacturer or its authorized representative every 6 months or after repair of the lifting equipment.

4.1.40. Automatic safe load indicators and data logger in lifting appliances

As stipulated in Rule 123 of HBOCW Rules, every lifting appliances and gears like cranes, hydras etc., if so constructed that the safe working load may be varied by raising or lowering of the jib or otherwise, shall be attached with an automatic indicator of safe working loads approved by Bureau of Indian standards/International certifying bodies which gives a warning to the operator whenever the load being handled exceeds the safe working limit.

a) Provision of functional data logger with alert facility through SMS and web in all cranes shall be mandatory;

b) Cut-out shall be provided which automatically arrests the movements of thelifting parts of every crane if the load exceeds the safe working limit.

4.1.41. The crane should have a substantial/durable safe working load chart which has clearly legible characters in English and Hindi and figures displayed inside the crane and is easily visible to the crane operator.

4.1.42. General Requirements

The sweep area (work area) of the construction machinery shall be always free from obstructions. All hydraulic piping and fittings shall be maintained leak proof. The operator cab shall posses good and safe:

a) Structure, windows and windshield wipers;

b) Drivers chair and footrest;

c) Control handles;

d) Cab instrumentation;

e) Telecommunication;

f) Cab outfitting;

g) Wind indicator with an adjustable set point shall be in a position representative for the wind on the crane. The indicator shall give continuous information regarding constant speeds and gusts.

4.1.43. Mandatory Rigging requirement

a) Rigging shall be done under experienced and qualified rigger only. All Load shall be adequately and safely rigged to prevent any danger;

b) The primary requirement in rigging shall be to assess the weight of load before attempting any lift;

c) All hooks shall be fitted with Master Rings having certificate of fitness from the competent person, so that the hooks are subjected to balanced vertical loading only;

d) Only four legged slings shall be allowed which includes master link (ring), intermediate master link (ring) if necessary, chain / wire rope sling, sling hook or other terminal fitting;

e) Requirements of outriggers

i) All outriggers shall be fully extended and at all tyres are clear of theground;

ii) Heavy duty blocking having large bearing area shall be necessary to prevent sinking of floats;

iii) Provision of heavy steel plates/ high density interconnected wooden logs of required dimension shall be used to uniformly distribute the load;

iv) The crane shall be setup on fully compacted ground;

4.1.44. Pick & carry operation

Prohibition on Use of "Tractor transmission type Pick and Carry Hydra Crane": Tractor transmission type Pick and Carry-1st Generation model is prohibited at HRIDC works. Contractor shall mobilize "Truck transmission type" Pick and Carry (Hydra)Crane– minimum 2nd Generation model only or higher model.

Pick and Carry operation is prohibited at all HRIDC construction sites except for the tailing purpose for lowering of pile cage, erection of radio tower, electrical poles, exhaust structures etc.

4.1.45. Operation of lifting appliances

Every Contractor shall ensure that:

a) The complete lifting operation shall be governed by signals as per established standards;

b) Adequate measures to be taken to ensure that no workers is allowed to stand, pass, rides or sit under the suspended load;

c) No lifting appliances shall be left by the operator while power is on or load is suspended;

d) After completion of the lifting operation, all doors of the appliances shall be closed by the operator and ignition/operation key should be handed over to competent reliever operator or site In-charge;

e) All loads are provided with minimum two tag lines to ensure that the load can be controlled at all times;

f) No close working to any live over head power line is permitted without system of a 'Permit to Work' and prior permission of the engineer shall be obtained before performing such operation;

g) Danger zone shall be identified and cordoned off for all lifting appliances during their operation;

h) All lifting gears & slings shall be stamped or appropriate tags for their identification no & SWL;

i) Knotting/wrapping of chains & slings shall not be allowed at site;

j) Lifting appliances shall not be used for any dragging or pulling purposes. Contract shall refer to 75% capacity load chart for ascertaining the suitability of crane for safe lifting of load;

k) During tandem lift, available capacity of crane in respect of SWL shall be considered after reduction of 15% for 75% (DIN) load chart respectively. In addition, additional de rating as advised by third party testing and certified agency shall also apply;

l) During hoisting of long material, use of suitable lifting beam is recommended;

m) Only original equipment manufacturer (OEM) supplied/provided load chart shall be used during lifting operation;

n) Before performing any lifting operation, all electronic devices, control levers, hydraulic oil, wind pressure etc. shall be checked and necessary spare parts to be kept in stock to handle any breakdown during time bound lifting operation;

o) Lifting point shall be considered on the I-Girders/U Girder/C Girder/Steel girder/parapet etc. during the casting of the same. Design load calculation for the same should be conducted;

p) All lifting activities shall be stopped in case of high speed wind and similar adverse whether condition or as prescribed by the crane manufacturer; and

q) All cranes shall be provided with fail safe devices to avoid any hoist free fall in case of brake failure.

Launching Operation

4.1.46. As launching operation is one of the riskiest jobs, the Contractor shall take utmost precaution at all stages like; planning, establishing casing yard, casting segments, transporting segments, fabrication and erection of launching girders, launching of segments, pre-stressing, auto launching of girders and dismantling of launching girders.

4.1.47. The Contractor shall prepare a comprehensive Method Statement for the launching operation, adhering to the ESHS conditions laid down in conditions of contract on the ESHS Management Manual. Reference shall be made to the provisions on working at height. As the entire process of launching must be undertaken at an elevated level the safety of workers and the girder is paramount important. In addition to general precautions, such as trained personnel, PPE, etc. listed in earlier clauses, the following general guidelines shall be adhered to throughout the launching operation:

a) The segments shall rigidly secure to the truck with necessary wooden wedges and necessary red indicators/safety tapes provided so that the vehicle is clearly seen by other road users both in day/night time;

b) Every launching operation shall have a responsible engineer on duty all the time;

c) All the time from erection to dismantling the area between the two piers wherein launching is in progress shall always be barricaded;

d) Auto launching shall be done only after approval from the Engineer. After every auto launching the stability of launching girder shall be ensured;

e) The vertical deflection of launching girder shall be monitored at all critical stages like with/without loads and after every auto launching;

f) A register containing all important operational details from erection to dismantling of launching girders shall be maintained and made available to the Engineer whenever called for;

g) Driver shall also have undergone proper medical examination as per sub-Clause-5.2 (Medical Facilities) and checked for influence of alcohol before any kind of lifting operation;

h) Test certificate for all lifting gears including Macalloy Bars shall be maintained at a

i) location closer to the launching girder itself so that it can be referred during all inspections;

j) Proper & safe access stairways shall be maintained for safe ascending /descending of workmen /engineers to or from launchers;

k) Adequate collective and personnel fall protection measures like provision of safety nets while working over live roads/railways, lifeline for anchoring of safety harness, safe means of access on main box girder shall be ensured;

l) Before starting of the launching, valid third party test certificate of the launcher hoist shall be available;

m) Safe and fully deck working platform duly covered from all side shall be ensured for stressing work at front support;

n) Safety checklist for all activities of launching cycle shall be prepared, got approved & implemented;

o) Use of nonstandard locking pins shall attract penalty;

Construction Machinery

4.1.48. Construction machineries may include dumpers and dump trucks, lift trucks and telescopic handlers, piling rigs, vibration hammers, rail welding equipment, mobile elevating work platforms, cranes, tipper lorries, lorry loaders, skip wagons, 360° excavators, 180° backhoe loaders, crawler tractors, scrapers, graders, loading shovels, trenchers, side booms, pavers, planers, chippers, road rollers, locomotives, tankers and bowsers, trailers, hydraulic and mechanical breakers etc.

4.1.49. Every construction equipment shall be in sound mechanical working condition and certified by either competent person under Factories Act or manufacturers' warranty in case of brand new equipment or authorized persons/firms approved by the Engineer before induction to any site.

4.1.50. All vehicles shall be fitted with audible reverse alarms and maintained in good working condition. Reversing shall be done only when there is adequate rear-view visibility or under the directions of a banksman.

4.1.51. **General operating procedures:** Drivers entering site shall be instructed to follow the safe system of work adopted on site. These shall be verbal instructions or, preferably, written instructions showing the relevant site rules, the site layout, delivery areas, speed limits, etc.

a) No passengers shall be carried, unless specific seating has been provided in accordance with the manufacturer's recommendations;

b) Working on gradients beyond any equipment's capability shall not be allowed.

c) Prevention of dumper and dump truck accidents should be managed by providing for adequate lateral clearances, wheel stops at a sufficient distance from the edgesof excavations, spoil

heaps, pits, markers, etc.;

d) No construction material, other than soil shall be carried in excavator buckets;

e) When two or more scrapers are working on the same job, a minimum distance of at least 25m shall be kept between them;

f) Every contractor shall ensure that Competency certificate for driver/operatorsshall be issued by their Plant and Machinery In-charge. The certificate shall be pasted on the machine body in such a way that drivers/operator vision is nothindered;

g) Checklist shall be prepared for all construction machinery and be filled on daily basis by the operator and be counter signed by plant & machinery person;

h) Provision of helper is mandatory for each construction appliances and vehicles during their movement inside and outside of site; and

i) All wood working machines shall be fitted with suitable guards and devices such astop guard, riving knife, push stick, guards for drive belts and chains, and emergency stop switch easily accessible by the operator.

4.1.52. Failure to do any of the above shall attract penalty as per Clause 7. [Financial Deduction/Withholding].

Machine Guarding

4.1.53. The Contractor shall ensure at the site all motors, cog wheels, chains and friction gearing, fly wheels, shafting, dangerous and moving parts of machinery are securely fenced or legged.

4.1.54. Fencing of dangerous parts of machinery shall not be removed while the machinery is in use or in motion and when removed, it shall be replaced as soon as practicable and in any case before the machinery is again brought into use.

Site Electricity

4.1.55. The Contractor shall refer to the applicable guideline "Indian Electricity Rules, 1956" and any amendment thereafter. ESHS requirements are:

a) Graduate Electrical Engineer having Electrical Supervisory CompetencyCertificate;

b) Diploma Electrical Engineer having Electrical Supervisory Competency Certificate;

c) ITI Certificate Holder Electrician with Wiremen Permit; and

d) Assessment of Electrical Load and properly designed power distribution system;

4.1.56. The Contractor shall assess the size and location of the electrical loads and the manner in which they vary with time during the currency of the Contract.

4.1.57. The Contractor shall elaborate as to how the total supply is to be obtained/generated. The details of the source of electricity, earthing requirement, substation/panel boards, distribution system shall be prepared and necessary approval from the Engineer obtained before proceeding of the execution of the job.

4.1.58. The main Contractor shall take consideration, the requirements of the Subcontractors' electric power supply and arrive at the capacity of main source of power supply from diesel generators.

4.1.59. No electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as may give rise to danger.

4.1.60. Adverse or Hazardous Environments:

a) Power supply from public utility service provider is preferable;

b) The Contractor shall provide sufficient ELCBs (maintain sensitivity 30 mA)/ Residual Current Circuit Breakers (RCCBs) for all the equipment (including Potable equipment),

electrical switchboards, distribution panels etc. to prevent electrical shocks to the Workers;

c) Lightening Protection for all structures, gantry, metal portable cabins, silos etc; Lighting ought not to introduce the risk of electric shock. Therefore, 230V supplies should be used for those fittings, which are robustly installed, and well out of reach e.g. flood lighting or high-pressure discharge lamps;

d) No single insulation cable shall be used;

e) Cables shall be selected after full consideration of the condition to which they shall be exposed and the duties for which they are required. Supply cable up to 3.3 kV shall be in accordance with BS 6346:1997;

f) Cables buried directly in the ground shall be of a type incorporating Armor or metal sheath or both;

g) Cabling passing under the walk way and across way for transport and mobile equipment shall be laid in ducts at a minimum depth of 0.6 m;

h) The Contractor shall ensure plugs, socket-outlets, and couplers available in the Site as "splash EM proof" type. The minimum degree of Ingress Protection should be of IP44 in accordance with BS EN 60529;

i) Only plugs and fittings of the weather proof type shall be used and they should be colour coded in accordance with the Internationally recognised standards for example as detailed as follows:

   i) 110 volts: Yellow;

   ii) 240 volts: Blue;

   iii) 415 volts: Red.

j) No loose connections or tapped joints shall be allowed anywhere in the Site, office area, stores and other areas. Penalty as per Clause 7. [Financial Deduction/Withholding] shall be put in case of observation of any tapped joints;

k) All equipment shall have the provision for major switch/cut-off switch in the equipment itself;

l) Isolate exposed high-voltage (over 415 Volts) equipment, such as transformer banks, open switches, and similar equipment with exposed energized parts and prevent unauthorised access;

m) All temporary metal structures like barricade boards, temporary metal containers/shed etc. shall be adequately earthed through suitable means;

n) All the earth pits shall be properly numbered along with display of resistance value and inspection records of the same shall be maintained

4.1.61. Work on or near live conductors

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless-

a) It is unreasonable in all the circumstances for it to be dead;

b) It is reasonable in all the circumstances for him to be at work on or near it while it is live; and

c) Suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

4.1.62. All electrical equipment should be permanently numbered, and a record kept of the date of issue, date of last inspection and recommended inspection period.

4.1.63. Appropriate electrical protection shall be provided for all circuits, against over load, short circuit

and earth fault current.

4.1.64. For supplies to mobile or transportable equipment where operating of the equipment subjects the cable to flexing, the cable shall conform to any of these codes BS 6007/BS 6500/BS 7375.

4.1.65. Flexible cords with a conductor cross sectional area smaller than 1.5 mm2 shall not be used and insulated flexible cable shall conform to BS 6500 and BS 7375.

4.1.66. Power Tools:

The Contractor shall ensure that:

a) Electric tools are properly grounded or/and double insulated;

b) Ground Fault Circuit Interrupters (GFCIs)/Residual Current Circuit Breakers (RCCBs) shall be used with all portable electric tool operated especially outdoors or in wet condition;

c) Only trained employees shall use explosive actuated tools and the tool shall also be

d) unloaded when not in use;

e) Usage of such explosive actuated tools shall be avoided in case of places where explosive/flammable vapours or gases may be present;

f) Explosive actuated tools and their explosives shall be stored separately and be taken out and loaded only before the time of immediate use; and

g) Misfired cartridges of explosive actuated tools must be placed in a container of water and be removed safely from the project.

Illumination

4.1.67. The Contractor shall provide sufficient site lighting, of the right type and at the right place for it to be properly effective as per the relevant national standards & guidelines.

Welding and Cutting

4.1.68. Gas cylinders in use shall be kept upright on a custom-built stand or trolley fitted with a bracket to accommodate the hoses and equipment or otherwise secured. The metal cap shall be kept in place to protect the valve when the cylinder is not connected for use.

4.1.69. Test Certificate for cylinders and Vendor license shall be obtained. Gas Cylinder Act & Rules shall always be followed at workplace.

4.1.70. All gas cylinders shall be fixed with pressure regulator and dial gauges. clamp or clip shall be used to connect hoses firmly in both sides of cylinders and torches.

4.1.71. Non-return valve and flashback arrester shall be fixed at both end of cylinder and torch.

4.1.72. Domestic LPG cylinders shall not be used for gas welding and cutting purpose.

4.1.73. Dry Chemical Pressure (DCP) or CO2 type Fire Extinguisher not less than 5 kg shall be fixed at or near to welding process zone in an easily accessible location. Fire extinguisher should confirm to IS 2190:1992.

4.1.74. Oxygen cylinders and flammable gas cylinders shall be stored separately, at least 6.6 m (20 feet) apart or separated by a fireproof, 1.5 m (5 feet) high partition. Flammable substances shall not be stored within 15m of cylinder storage areas.

4.1.75. Welding grounds and returns should be securely attached to the work by cable lugs, by clamps in the case of stranded conductors, or by bolts for strip conductors. The ground cable will not be attached to equipment or existing installations or apparatus.

4.1.76. All electrical installations shall meet the IS: 5571: 1997 and NFPA 70 for gas cylinder storage area and other hazardous areas.

4.1.77. Use firewatchers if there is a possibility of ignition unobserved by the operator (e.g. on the other side of bulkheads).

4.1.78. Transformer used for electrical arc welding shall be fixed with ammeter and voltmeter and fixed with separate main power switch.

4.1.79. Use a low voltage open circuit relay device if welding with alternating current in constricted or damp places.

4.1.80. The current for Electric arc welding shall not exceed 300 A on a hand welding operation.

Excavation General

4.1.81. References:

a) The Haryana Building and other construction workers (Regulation of Employment of conditions of Service) Rules, 2005;

b) IS: 3764 -1992 (Re-affirmed 1996): Code of Safety for Excavation Work;

c) IS: 4756 -1978 (Reaffirmed 1996): Safety Code for Tunnelling Work;

d) BS 6164: 2011 (Code of practice for health and safety in tunnelling in the construction industry);

e) BS EN 16191: 2014 (Tunnelling Machinery-Safety requirements);

f) IS 4081:2013 Blasting and related drilling operations-code of safety.

4.1.82. The Contractor shall ensure:

a) Where any construction & building worker engaged in excavation is exposed to hazard of falling or sliding material or article from any bank or side of such excavation which is more than 1.5 m above his footing, such worker shall be protected by adequate piling and bracing against such bank or side;

b) Where banks of an excavation are undercut, adequate shoring is provided to support the material or article overhanging such bank;

c) Excavated material is not stored at least 0.65 m from the edge of an open

d) excavation or trench and banks of such excavation or trench are stripped of loose rocks and the banks of such excavation or trench are stripped of loose rocks and other materials which may slide, roll or fall upon a construction building worker working below such bank;

e) Metal ladders and staircases or ramps are provided, as the case may be, for safe access to and egress from excavation where, the depth of such excavation exceeds 1.5 m and such ladders, staircases or ramps comply with the IS 3696 Part 1&2 and other relevant national standards;

f) Trench and excavation is protected "against falling on a person by suitable measures if the depth of such trench or excavation exceeds 1.5m and such protection is an improved protection in accordance with the design and drawing ofa professional engineer, where such depth exceeds 4.0m;

4.1.83. Warning Signs and Notices:

The Contractor shall ensure that suitable warning signs or notices, required for the safety of workers carrying out the work of an excavation, shall be displayed or erected at conspicuous places in Hindi and in a language understood by most of such workers at such excavation work.

Tunnelling Works

4.1.84. The Contractor shall inform in writing to the Chief Inspector of Government of Haryana within 30 days, prior to the commencement of any tunnelling work.

4.1.85. The Contractor shall appoint a responsible person for safe operation for tunnelling work as per

BOCWR.

4.1.86. In addition to general precaution such as display of warning sign/notices, deployment of trained staff, housekeeping, etc., the Contractor shall ensure that:

a) All portable electrical hand tools and inspection lamp used in underground and confined space at an excavation or tunnelling work is operated at a voltage not exceeding 24V;

b) Only flame proof equipment of appropriate type as per IS: 5571:2000 and or another relevant national standard is used inside the tunnel;

c) Petrol or LPG of any other flammable substances are not used, stored inside the tunnel except with prior approval from the Engineer, and no oxy-acetylene gas is used in a compressed air environment in excavation or tunnelling;

d) Adequate number of water outlets provided for fire fighting purpose, an audible fire alarm and adequate number and types of fire extinguishers are provided and maintained;

e) Temperature in any working chamber in an excavation or tunnelling work where workers employed does not exceed 29°C as per BOCWR;

f) All working areas in a free air tunnel are provided with ventilation system as approved by the Chief Inspector of Government of Haryana and the fresh air supplied in such tunnel is not less than 6 m3/min for each worker employed in tunnel and the free air flow movement inside such tunnel is not less than 9.0 m/min;

g) The oxygen level shall not be less than 19.5% in the working environment;

h) The excavated areas are made safe by use of suitably designed and installed steel sets, rock bolts or similar other means;

i) The responsible person referred to in BOCWR examines and inspects the workplaces in a tunnel before the commencement of work in such tunnel, and at regular intervals thereafter, to ensure safety of the Workers in such tunnel;

j) The portal areas of a tunnel with loose soil, or rock, likely to cause injury to a person are adequately protected with supports;

4.1.87. Means of Communication

The Contractor shall ensure that: reliable and effective means of communication such as telephone or walkie-talkie is provided and are maintained in working order for arranging better and effective communication at an excavation.

4.1.88. Permissible Limit of Exposure of Chemicals

The Contractor shall ensure that the responsible person referred to in BOCWR conducts necessary test before the commencement of a tunnelling work for the day and at suitable intervals as fixed by Chief Inspector to ensure that the permissible limits of exposure are not exceeded, and a record of such test is maintained and is made available for inspection to Chief Inspector, on demand.

4.1.89. Rock Fall Prevention (NATM)

The Contractor shall:

a) Draw up a method statement that includes preventive measure to fall of rock, tunnel face watching, evacuation methods from the face, and the construction sequence etc. to ensure that workers are informed.

4.1.90. Evacuation and Training

The Contractor shall ensure that:

a) Implementation of the training for evacuation and fire fighting immediately before the distance reaches about 100m from the portal to the tunnel face; and

b) Implementation of evacuation training by a responsible person appointed in terms of dealing with technical matters.

Blasting and Drilling

4.1.91. The following standards whichever is more stringent shall be applicable:

a) Safety Code for Blasting and Drilling operation IS 4081:2013;

b) Safety Code for tunnelling Work IS 4756-1978;

c) Code of practice for construction of tunnels IS 5878;

d) The Haryana BOCWR ; 2005 and Other Relevant National Legislations & ISCodes; and

e) Code of Practice for the safe use of explosives in the construction industryBS 5607:1988.

4.1.92. The Contractor shall ensure that all blasting operations will only be permitted following consultations with the relevant authorities and subsequent issuing of the permission to blast permits. The Engineer must also give his consent in writing before any blasting operations take place.

4.1.93. The Contractor shall:

a) appoint the manager, the deputy manager and officer in charge of handling explosives to prevent handling accidents;

b) when doing blasting work, the Contractor shall appoint a work supervisor from among those who can take on the blasting work;

c) All blasting shall be conducted under the direct supervision of a Licensed Shot firer.

4.1.94. Handling of explosives- as per Rule 278 HBOCWR;

The Contractor shall ensure at a construction site of a building or other construction work that-

a) All explosives are handled, used or stored in accordance with the instructions and the material data sheet supplied by the manufacturer of such explosives;

b) The use of explosives is carried out in safe manner to avoid injury to any person and under the direct supervision of a responsible person;

c) Before using any explosive, necessary warning and danger signals are erected, at conspicuous places of such use to warn the building workers and the general public of the danger involved in such use.

d) Safety Precautions- as per Rule 279 of HBOCWR;

The Contactor shall ensure at a construction site of a building or other construction work that-

i) Notwithstanding the provisions of rule 278, the following precautions are observed at the places of transporting, handling, storage and use of such explosives, namely-

ii) Prohibition of smoking, naked lights and other sources of ignition in the vicinity where explosives are handled, stored and used;

iii) To keep safe distance and to use non-sparking tools while opening packages containing explosives;

iv) To stop the use of explosives and handling thereof while the weather conditions are not suitable for such use or handling.

v) In addition to the provisions of this chapter, all measures, and precautions

vi) required to be observed for use, handling, storing or transportation of explosives under the rule framed under the Explosives Act, 1884(4 of 1884), are observed.

4.1.95. Risk Assessment and Method Statements

The Contractor shall produce a detailed hazard and risk assessment and an in depth method statement for amongst others the following elements:

a) Type of explosives to be used;

b) Anticipated effects of vibration on nearby structures;

c) Blasting patterns;

d) Delivery of the explosives;

e) Transportation and storage of explosives on site;

f) Drilling and charging of holes;

g) Warning sirens;

h) Measurement of Vibration;

i) Use of blast screens;

j) Ventilation following blasting;

k) Atmosphere monitoring;

l) Procedure for miss-fires;

Material Transportation

4.1.96. The Contractor shall develop the System Procedure/Methods Statement for heavy/big material/machinery transportation such as Rolling Stock, Transformer, and Bridge Main Girder, etc.

4.1.97. The Contractor shall ensure that the person in charge should inspects the safety implementation like properly fixing of wire with vehicle slab bed, condition of vehicle breaks etc. before starting the job and record the accidents and records.

4.1.98. The Contractor shall ensure that every vehicle/moving machinery should have a signal man who has a whistle, a flag or a signal light (in the night) with striking clothes and stands at a safe visible place from a machine operator by means of the proper signal and way determined.

4.1.99. The induction related to moving and parking safely should be given to driver/operator like parking construction vehicles at a specified place with a parking brake and making sure to put a drag.

Foundation Works

4.1.100. The Contractor is required to evaluate the risk in each activity and suggest a control measures of piling works:

a) Covering of bore holes with adequate warning signs;

b) Cage to be lowered by using crane;

c) The auxiliary hook of the rig shall not be used to pull or lower the cage in bore hole;

d) The tremie pipe lowering and lifting after concreting shall be done by using crane;

e) Control measure to arrest polymer spillage from the Site to avoid contaminating the surface drains;

f) An entry restraining fence shall be provided around the pier excavation completion;

g) No man suffering from any chronic disease, alcoholic excess, ear or heart troubles or having a sluggish blood circulation or who has excess of fat should be employed as a diver;

Batching Plant and Casting Yard

4.1.101. The Contractor is required to evaluate the risk in each activity and suggest Control Measures:

a) Adequate space between the casting bed, segment storage area and the adjoining road shall be maintained so that a steel railing could be installed to segregate the gantry crane movement area from the road;

b) All safety precautions stated in Sub-Clause4.8[Construction Machinery], Automatic Safe Load Indicator (ASLI) for crane and gantry shall be complied during erection of gantry crane and other equipment;

c) The aggregate/sand storage area shall be kept under the full coverage of effective water sprinkler to avoid dust generation;

d) The entire batching plant/aggregate storage Area shall be adequately walled of sufficient height, above which the Contractor is required to erect green dust protective net. This is a mandatory requirement to avoid dust in surrounding environment;

e) The batching plant and casting yard required to obtain ''Consent to Establish'' and

f) ''Consent to Operate'' certificate from State Pollution Control Board;

g) The batching plant/casting yard shall be barricaded and made as a compulsory Personal Protective Equipment (PPE) zone;

h) Time office, canteen, drinking water, toilet and rest place shall be suitably located for the easy access to workers. All the facilities shall be properly cleaned and maintained during the entire period of operation;

i) Drainage shall be effectively provided, and waste water shall be disposed after proper treatment; and

j) Manual handling of cement shall be avoided. Whenever it is necessary the workmen shall be given full body protection, hand protection and respiratory protection as a basic measure of ensuring better health.

Form Works

Ensure no attaching equipment to the formwork assembly unless specifically designed for this purpose; and not using a stripping process which may cause damage to the permanent structure.

Concrete Works

a) Concrete pumping equipment, trucks etc. are not to be washed down on site and any waste-water, concrete slurry or other contaminants are to be contained; and

b) These contaminants are not to be discharged into or onto roadways, footpaths, gutters, drainage systems, watercourses or any other surface area that will result in damage to the environment or contravenes environmental legislation.

Pier Casting Works

a) Using crane to hold the pier reinforcement during the time gap between de-staging and placement of shutter; and

b) Location and pier height specific securing arrangement and specific Method Statement for pier more than 9.0 m shall be submitted and approved by the Engineer.

Bridge Erection Works

4.1.102. References:

a) The BOCW Acts and Rules;

b) The Haryana BOCW Rules 2005;

c) Indian Railways Bridge Manual; and

d) Safety Assessment with regard to Steel Bridge Erection Works 1985, Ministry of Health, Labour and Welfare;

4.1.103. General

As bridge erection works are one of the riskiest jobs, the Contractor shall take utmost precaution at all stages like; planning, establishing temporary yard, casting segments, transporting segments, fabrication and operation of erection machinery, if any, launching of segments/lifting of segments, pre-stressing, cutting and welding, auto (or manual) launching and dismantling of erection machineries. For pre-stressed concrete bridges, the Contractor shall further ensure that:

a) a responsible person should be appointed for post-tensioning works testing and inspection of tendon tensioning devices and using material;

b) installation of protective board behind a tensioning jack and keep out behind a jack during tensioning;

c) use of protective glasses, laver gloves, and masks during grouting for safety of the Workers; and

d) fall prevention installation of overall boarding at the bottom of a bridge and installation of funnel type boarding at the side of a bridge during construction in case of RFO (Railway Flyover) or ROB (Road over Bridge) for preventing the flying and fall of materials and tools by safety net, should be ensured.

4.1.104. The Contractors Obligation

The Contractor shall prepare a comprehensive method statement for the bridge erection works, adhering to the ESHS conditions laid down herein. Particular reference shall be made to the provisions on working at height. As the entire process of launching/lifting has to be undertaken at the Site especially during night time, the safety of workers is of paramount important. Daily inspection of scaffold structure and mechanical equipment for the traveller crane should be done.

4.1.105. Basic Consideration under Site Condition:

Erection works over or adjacent roads or highways:

a) The work area should be demarcated properly, and route map and traffic management plan should be developed and implemented with proper signages and

b) caution;

c) The Contractor shall ensure the implementation of proper stop traffic and detour plan;

d) The Contractor shall arrange the proper guide and signs to be followed while working on highway or adjacent roads, railways; and

e) The Contractor should plan and establish all the required measures for the protection of overhead wires and buried utilities.

i) The regular inspection is done for all the installed protection equipment;

ii) The movement restriction site plan to be developed with defined operation path for safe working at site;

iii) watchmen should be appointed who are given training related to all type of traffic management and all signals used for smooth traffic flow and site transportation and works;

iv) The railway schedule is taken in consideration while planning the site works and ensures the safe management system with the details given regarding the kind of works suspended while a train is passing and clarifying the way of opening or closing railway in case of track closure works. For steel truss bridges;

v) The Contractor must install the protective net just after erecting truss upper chord material;

vi) The Contractor must install safety operation path to an end of erected member and a cross point of lateral bracing;

The Contractor may use any of the erection methods. However, following general points will be kept in view and ensured as applicable-

A. The Contractor should develop and confirm the Engineer his Method Statement with details of position of bearing, jacking operation, roller passing etc.;

B. Detailed inspection report related to the movement and condition of superstructure from the place of launching equipment and rollers should be given to the Engineer;

C. The Contractor shall give confirmation of binding situation such as a bolting erection member;

D. The Contractor shall give confirmation of displacement per every erection phase;

E. The Contractor shall give confirmation of fixing situation for bearings;

F. The Contractor must take measures to avoid a fall and lateral buckling of member; and

G. The Contractor shall take measures of fall prevention for main superstructure.

Building and Roof Erection Works

4.1.106. The Contractor shall plan erection sequence and work procedures properly under competent and experienced personnel to ensure the safety of workers and prevent structure failure during erection:

a) Contractor shall develop and confirm with the Engineer his method statement with details;

b) The stability of structural members is to be ensured by means of ties, braces, anchor/fixing bolts, or other suitable means before releasing lifting gear, slings, chains etc;

c) Tag lines must be attached to the ends of components/loads to maintain control during crane lifting operations;

d) Structure stability is to be ensured always. Unattended and incomplete buildings/structures are NOT to be left in an unsafe and hazardous condition, to pose a risk to the safety and health of site personnel or the public;

e) The Workers placing and securing roof battens are to be protected and are to work from an enclosed environment (e.g. scaffolding, deck guardrail or equivalent) and work up from the bottom of the truss/rafter towards and finish at the ridge /peak of the roof framing; and

f) When the spacing of trusses and roof battens exceed 600mm the appropriate procedures are to be considered and applied after conducting a risk assessment to provide the optimum fall protection.

Overhead Contact Wire Works

4.1.107. During starting of works using rack vehicle/moving scaffold/ladder/insulation tower/step ladder, etc., the Contractor's operation in charge shall confirm as follows:

a) The work sequence shall be determined while using Ariel Track vehicle. Communication system between drivers and conductors shall be developed and adopted;

b) A deck which must be used by workers, shall have enough capacity of carry necessary loads for work at a high place with a pre-operation inspection;

c) The workers shall be given the safety protection equipment which has enough capacity to hold necessary loads to prevent any accidental fall with a pre-operation inspection;

d) State of electrical equipment installation and a route of going up and down from ground;

e) The Worker is given required training for electrical works at height and the Worker must use a safety rope, an auxiliary rope, a fall prevention equipment such as a rolip which is a fall arrest device for a fixed rope when they work at high place;

f) The Worker shall fix the grip of an auxiliary ropes at the upper position of their safety ropes and uses special wires or a lift when delivering materials and tools from ground to high place;

g) The Contractor shall ensure that no one lean out of the rail of the track vehicles, or take a foot on the rail; and Shall take all the precautions for self-propellant or roll prevention when bringing the track vehicle to a stop;

h) The installation of medium rail at the place where handrail is more than 85cm high;

i) The training is given to all, for putting on a foot brake when bringing the rolling tower to a stop or working on the deck of the rolling tower suspended;

j) Putting on a foot brake and fixing the insulation tower by an assistant when bringing the insulation tower to a stop or working on its suspension;

4.1.108. While going up and down along an Electric Pole, Power Pylon or a High Steel Structure or working above it, the Contractor shall ensure the safety precautions mentioned below:

a) Use of a safety rope, an auxiliary rope and a fall prevention equipment with using an exclusive scaffold when going up and down along the electric pole;

b) Use of an escort rail, or both a Full Body Harness and an auxiliary rope when going up and down along the power pylon or the high steel structure;

c) While working on a Beam, the Contractor shall ensure the safety precautions mentioned below:

i. Use of a horizontal rope on working consecutively on the beam or painting the beam surface without an auxiliary rope; and

ii. Use of a safety rope and an auxiliary rope when moving on the beam under unavoidable circumstances.

Locomotives and Wagons

4.1.109. Speed limit is determined, and traffic signs of speed limits, lights and related hazards signage and cautions shall be installed at work place.

4.1.110. Person in charge shall be nominated as maintenance officer to inspect and repair temporary rails or track surface situation regularly.

4.1.111. Ensure the installation of an alarm device such as a horn and a buzzer, a head light, and a flood light for the driver's seat.

4.1.112. Training and education shall be given to the driver and the signal man regarding how to send standard signal and operate vehicle diagram and turning off and putting on the brakes while the driver leaves his seat. And making sure to set wheel stoppers when stopping or parking at the slope track.

4.1.113. Each locomotive shall carry an extinguisher for fires

Confined Space Entry

4.1.114. The Contractor must ensure all confined spaces are identified and managed using documented site confined space management methods.

4.1.115. When internal combustion engines are to be used into confined space or excavation or any other workplace where natural or artificial ventilation system is inadequate to keep carbon monoxide below 50ppm, exposure of workers shall be avoided unless suitable measures are taken and provided by the Contractor.

4.1.116. No worker shall be allowed into any confined space or tank or trench or excavation wherein there is given off any dust, fumes/vapours or other impurities which is likely to be injurious or offensive, explosive or poisonous or noxious or gaseous material or other harmful articles unless steps are carried out by the Contractor and certified by the responsible person to be safe.

Fire Protection

4.1.117. The contractor shall ensure that the construction site is provided with—

a) Fire extinguishing equipment sufficient to extinguish any probable fire at such construction site;

b) An adequate water supply at ample pressure as per national standards;

c) Number of trained persons required to operate the fire extinguishing equipment provided; and

d) Is properly maintained and inspected at regular intervals of not less than once in a year by the responsible person and a record of such inspections is maintained.

4.1.118. The extinguishers shall be chosen as per type of fire load and surrounding location.

4.1.119. All construction machinery including crane shall carry a portable fire extinguisher in operator's cabin.

4.1.120. Emergency plan and Fire Evacuation plan in ESHS Management Plan shall be prepared and issued by the Contractor. Mock drills should be held on a monthly basis to ensure the effectiveness of the arrangements and as a part of the programme, the telephone number of the local fire brigade should be prominently displayed near each telephone on site.

4.1.121. Recharging of fire extinguishers and their proper maintenance should be ensured and as a minimum should meet Indian National Standards.

4.1.122. All drivers of vehicles, foreman, supervisors and managers shall be trained on operating the fire extinguishers and firefighting equipment.

Corrosive Substance

As per Rule 100 of HBOCWR, The contractor shall ensure that corrosive substances, including alkalis and acids, shall be stored and used by a person dealing with such substances at a building or other construction work in such a manner that it does not endanger the building worker and suitable protective equipment shall be provided by the contractor to a building worker during handling or use of such substances at a building or other construction work and in case of spillage of such substances on the building worker, immediate remedial measures shall be taken by the contractor.

Demolition

4.1.123. All demolition works be carried out in a controlled manner under the management of experienced and competent supervision.

4.1.124. The concerned department of the Government or local authority is informed, and permission obtained wherever required. Media shall also be informed regarding this concern.

4.1.125. All glass or similar materials or articles in exterior openings are removed before commencing any demolition work and all water, steam, electric; gas and other similar supply lines are disconnected.

4.1.126. No demolition work be performed if the adjacent structure seems to be unsafe unless and until remedial measures life sheet piling, shoring, bracing or similar means be ensured for safety and stability for adjacent structure from collapsing.

4.1.127. Debris/bricks and other materials or articles shall be removed by means of chute, bucket or other safe method.

4.1.128. No person other than the Workers or other persons essential to the operation of demolition work shall be permitted to enter a zone of demolition and the area be provided with substantial barricades.

Permit to Work

4.1.129. The Contractor shall develop work permit system, which is formal written system used to control certain types of work that are potentially hazardous. A work permit is a document, which specifies

the work to be done, and the precautions to be taken.

4.1.130. Work Permits form an essential part of safe systems of work for many construction activities. They allow work to start only after safe procedures have been defined and they provide a clear record that all foreseeable hazards have been considered. Permits to Work are usually required in high-risk areas as identified by the Risk Assessments.

4.1.131. A permit is needed when construction work can only be carried out if normal safeguards are dropped or when new hazards are introduced by the work.

4.1.132. Examples of high-risk activities include but are not limited to:

a) Entry into confined spaces;

b) Hot work;

c) To dig where underground services may be located;

d) Work with heavy moving machinery;

e) Work with radioactive isotopes;

f) Heavy lifting operations and lifting operations closer to live electric power line;

g) Work with using track motor vehicles etc.; and

h) Work under electric facility and overhead electric (OHE) line energized.

4.1.133. The Contractor shall prepare operation manuals above mention and implement training course at any time based on such manuals to the Workers given completion of certificates before the commencement of works.

4.1.134. The permit-to-work system should be fully documented, laying down:

a) How the system works;

b) The jobs it is to be used for;

c) The responsibilities and training of those involved; and

d) How to check its operation.

4.1.135. A work permit authorization form shall be completed with the maximum duration period not exceeding 12 hours or end of shift, which is earlier.

4.1.136. A copy of each permit to work shall be displayed at work place. during its validity, in a conspicuous location in close proximity to the actual works location to which it applies.

Traffic Management and Site Barricading

4.1.137. The basic objective of the following guiding principles is to lay down procedures to be adopted by the Contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen in the all work areas.

4.1.138. The guiding principles to be adopted for safety in construction zone are to:

a) Warn the road user clearly and sufficiently in advance;

b) Provide safe and clearly marked lanes for guiding road users;

c) Provide adequate traffic marshals to regulate the movement of traffic;

d) Provide safe and clearly marked buffer and work zones; and

e) Provide adequate measures that control driver behaviour through construction zones.

4.1.139. In all cases, the Contractor shall employ proper precautions. Wherever operations undertaken are likely to interfere with public traffic, Specific Traffic Management Plans shall be drawn up and implemented by the Contractor in consultation with the approval of Local Police Authorities and/or

the concerned politburo/Civil Authorities and followed to the IRC:SP;55- 2014 (Guidelines on Traffic Management in work zones) & IRC: 67 (Code of Practice for Road Signs).

Working near Railway

4.1.140. The details of Safe work procedure for work near Railway Track is given in **Attachment -5** of this document.

Other Works to be Scrutinized

4.1.141. Other works including, but not be limited to, the works in the Site (the ROW), the works in the Borrow Pit, the works in the Quarry and Works on road shall be included to be scrutinised with respect to the accident prevention.

4.1.142. If blasting is anticipated in excavation in rock, preventive measures against accidents and protective measures against environmental/social impacts shall be of paramount importance.

4.1.143. The Contractor shall include all those items as well as work elements to formulate the preventive and protective measures considering envisaged conditions, situations, and activities of the works which may induce accidents or hazard to environment and/or society.

Personal Protective Equipment

4.1.144. The Contractor shall provide required PPEs to workmen to protect against safety and/or health hazards. Primarily PPEs are required for the following protection:

a) Head protection (Safety helmet with a chin strap);

b) Foot protection (Safety footwear, Gumboot, etc.);

c) Body protection (High visibility clothing (Waistcoat/Jacket), Apron, etc.);

d) Personal fall protection (Full body harness, Rope-grip fall arrester, etc.);

e) Eye protection (Goggles, Welders Glasses, etc.);

f) Hand protection (Gloves, Finger coat, etc.);

g) Respiratory protection. (Nose mask, Self-contained breathing apparatus, etc.); and

h) Hearing protection (Ear plugs, Ear muffs, etc.).

4.1.145. The PPEs and safety appliances provided by the Contractor shall be of the standard as prescribed by Bureau of Indian Standards (BIS). If materials conforming to BIS standards are not available, the Contractor as approved by the Engineer shall procure PPE and safety appliances.

4.1.146. The Contractor shall provide the PPEs which the Contractor deems necessary including; but not be limited to, safety helmets, safety shoes to all the Contractor's Employees including workmen (including those of its sub-contractors). When and Where the Contractor thinks that he needs to provide the Contractor's Employees including workmen' (including those of its sub-contractors) with high visibility clothing as per the following requirement.

a) Hi-visibility jacket covering upper body and meeting the following requirements as per BS EN 471:1994;

b) Background in fluorescent orange-red in colour;

c) Jackets with full-length sleeves with two bands of retro reflective material, which shall be placed at the same height on the garment as those of the torso. The upper band shall encircle the upper part of the sleeves between the elbow and the shoulder; the bottom of the lower band shall not be less than 5cm from the bottom of the sleeve;

d) Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2;

e) Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2;

f) Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back;

g) The bottom strip shall be at a distance of 5cm from the bottom of the vest; and

h) viii) Strips shall be retro reflective and fluorescent.

Safety Helmet Colour Code (Every Helmet should have the LOGO*affixed/painted)	**Person to use**
Hard hat with company Logo (Employees)	Hard hat with reflective tape (Marshals)
White	Employer/Engineer
Grey	All designers, Architect, Consultants, etc.
Violet	Main Contractors (Engineers/Supervisors)
Blue	All subcontractors (Engineers/Supervisors)
Red	Electricians (Both Contractor andSubcontractor)
Green	Safety professionals (Both Contractor and Subcontractor)
Orange	Security guards/Traffic marshals
Yellow	All workmen
White (with "VISITOR" sticker)	Visitors
Safety Shoes (Anyone at the Site incl. Marshals)	
All employees of the contractor including workmen	Traffic marshals

Note: LOGO·

a) Logo shall have its outer dimension 2"X2" and shall be conspicuous
ii) Logo shall be either painted or affixed
iii) No words shall come either on Top / Bottom of Logo

Logo of the corresponding main contracting company for their employees and sub-contracting company for their employees shall only be used.

4.1.147. In addition to the above any other PPEs required for any specific jobs like, welding and cutting, working at height, tunnelling etc. shall also be provided to all workmen and also ensure that all workmen use the PPEs properly while on the job.

4.1.148. The Contactor shall not pay any cash amount in lieu of PPEs to the workers/sub- contractors and expect them to buy and use during work.

4.1.149. The Contactor shall at all-time maintain a minimum of 10% spare PPEs and safety appliances and properly record and show to the Engineer during the inspections. Failing to do so shall invite penalty as per Clause 7. [Financial Deduction/Withholding].

4.1.150. It is always the duty of the Contactor to provide required PPEs for all visitors. Towards this required quantity of PPEs shall be kept always at the security post.

4.1.151. The Contractor shall ensure that safety equipment and protective clothing is available and used on the site at all material times and those measures for the effective enforcement of proper utilisation and necessary replacement of such equipment and clothing shall be incorporated into the Site ESHS Plan.

Visitor at Site

4.1.152. No visitor can enter the Site without the permission. All authorised visitors should report at the site office. The Contractor shall provide visitor's helmet (White helmet with visitor sticker) and other PPEs like Safety Shoe, reflective jacket, respiratory protection etc. as per requirement of the Site. Entry of visitors in underground shall be suitably controlled.

4.1.153. The Contractor shall be fully responsible for safety and health of all visitors within the Site.

Site Security

4.1.154. The Contractor shall be wholly responsible for security on the Site and any other areas being used by him or the Subcontractor's for the purposes of the Contract. The Contractor shall implement and cause the Subcontractor's to implement proper security management procedures in accordance with the approved ESHS Management Plan.

4.1.155. The Contractor shall assign on the Site a security officer (adequately trained person,) and his alternate(s), who shall be primarily responsible for the Contractor's security services and fully cooperate with the Engineer's security organization throughout the Time for Completion. Necessary approval of agency shall be obtained from the Engineer.

4.1.156. The security plan covered by the ESHS Management Plan shall contain the following:

a) Security policy statement and objectives;

b) The Contractor's security organization;

c) Role, responsibility and authority of each member of the security organization;

d) Procedure for enforcement of security regulations;

e) Daily, weekly and monthly security meeting procedures;

f) Sample forms for security reports;

g) Personnel security control procedures;

h) Goods security control procedures;

i) On-site security patrol procedures;

j) Liaison and coordination procedure with local fire/police and other authorities;

k) Liaison and coordination procedure with the Employer and relevant other authorities; and

l) Liaison, coordination and joint security inspection procedure with other Contractors.

4.1.157. Where necessary, the Contractor shall install, modify, maintain and remove the temporary security fences, gates, posts, security lightings and other facilities required for proper security control, in addition to those to be constructed as part of the Works. The Contractor shall operate these facilities to properly control ingress to and egress from the areas under his control throughout the Time for Completion. This control shall apply to every person including the Employer's Personnel.

5. OCCUPATIONAL HEALTH AND WELFARE

Physical Fitness of Workmen

5.1.1. The Contractor shall ensure that his employees/workers subject themselves to such medical examination as required under the law or under the contract provision and keep a record of the same.

5.1.2. The Contractor shall not permit any employee/workers to enter the work area under the influence of alcohol or any drugs.

5.1.3. The Contractor shall maintain the confidential records of medical examination or the physician authorized by the Engineer.

5.1.4. No worker is charged for the medical examination and the cost of such examination is borne by the Contactor employing such worker.

5.1.5. If the Contractor fails to get the medical examination conducted as mentioned above, the Engineer will have the right to get the same conducted through an agency with intimation to the Contractor and deduct the cost and overhead charges from his dues.

Medical Facilities

5.1.6. Occupational Health Centre (First Aid Station)

The Contractor shall ensure at a construction site an occupational health centre, mobile or static is provided and maintained in good order. Services and facilities as per the scale lay down in Schedule IV of HBOCWR. A construction medical officer appointed in an occupational health centre, possess the qualification as laid down in Schedule V Rule no 113 of HBOCWR:

5.1.7. The Contractor shall appoint appropriate full-time staff including one nurse, one dresser- cum-compounder, one sweeper-cum-ward boy with each construction medical officer.

5.1.8. The Contractor shall communicate the complete details including name, qualification and experience of the construction medical officer, to the inspector having jurisdiction under HBOCWR.

5.1.9. Ambulance Room, Ambulance Van and Stretchers:

The Contractor shall ensure at a construction site of a building or other construction work that an ambulance van and room are provided at such construction site or an arrangement is made with a nearby hospital for providing such ambulance van for

transportation of serious cases of accident or sickness of workers to hospital promptly and such ambulance van and room are maintained in good repair and is equipped with standard facilities specified in Schedule VI of Rule 114 & Schedule VII of Rule 115 of HBOCWR.

5.1.10. The Contractor shall provide enough stretchers at each site for use in an emergency.

5.1.11. First Aid Boxes and Emergency Care:

The Contractor shall ensure at construction site one First-aid box for 100 workers for providing first-aid to the workers. Every First-Aid box is distinctly marked "First-Aid" and is equipped with the articles specified in Schedule IX of Rule 119 of HBOCWR. Adequate no. of trained first aid persons shall be available at each work site in each shift.

5.1.12. HIV/AIDS Prevention and Control:

a) The Contractor shall adopt the Employer's "Workplace Policy on HIV/AIDS Prevention and Control for Workers Engaged by Contractors" and implement it. A copy of the policy is given in **Attachment-2 [Workplace Policy on HIV/AIDS Prevention & Control]**; and

b) The Contractor shall prepare and submit the Manual for HIV/AIDS Prevention and Control for his workers in terms of the aforesaid Employer's Policy within 28 days of the date of notification of the Contract.

c) The Contractor shall organize awareness program for labourers on the risks of AIDS and STDs in coordination with Haryana State AIDS Control Ssociety.

5.1.13. COVID -19 Prevention and Control

The Contractor shall ensure that the latest guidelines issued by Ministry of Health and Family Welfare (MoHFW), local government and the district administration are strictly followed at the construction works site. The Workplace Policy on COVID-19 Prevention and Control is given in **Attachment-3 [Workplace Policy on COVID-19 Response].** The Contractor shall undertake a COVID-19 risk assessment of project area and prepare and submit COVID-19 Response and Management Plan.

5.1.14. Prevention of Mosquito Breeding

Measures shall be taken to prevent mosquito breeding on the Site. The measures to be taken shall include:

a) Empty cans, oil drums, packing and other receptacles, which may retain water, shall be deposited at a central collection point and shall be removed from the site regularly;

b) Stagnant water shall be treated at least once every week with oil to prevent mosquito breeding;

c) The Contractor's equipment and other items on the site, which may retain water, shall be stored, covered, or treated in such a manner that water could not be retained; and

d) Water storage tanks shall be provided.

5.1.15. Posters in local language, Hindi and English, which draw attention to the dangers of permitting mosquito breeding, shall be displayed prominently on the Site.

5.1.16. The Contactor at periodic interval shall arrange to prevent mosquito breeding by fumigation/spraying of insecticides, and the ideal larvicide etc.

5.1.17. Alcohol, Smoking and Drugs

The Contactor shall always ensure that no employee is working under the influence of alcohol/drugs which are punishable under BOCWR;

Smoking at public places by any employee is also prohibited as per Government Regulations. The Contractor shall comply with the legal provisions in this regard, such as; Prohibition of Smoking in Public Places Rules, 2008. He shall be solely responsible for any penalty or punitive action by the government authorities because violations of the provisions contained in these rules by him or his representatives or his employees or his Subcontractors. Requisite notice boards, posters, etc., shall be put by him, as per the Rules.

Occupational Noise

5.1.18. The Contractor shall comply with the codes, regulations and standards regarding noise pollution and control as notified and amended by Central Government and State Government from time to time on the Site including but not necessarily limited to:

a) Chapter VII, Part -I, Schedule-I of Haryana BOCWR 2005;

b) Noise Pollution (Regulation and Control) Rules, 2000;

c) Environment (Protection) Act, 1986;

d) Environment (Protection) Amendment Rules, 2000; and

e) Central Motor Vehicles Rules, 1989;

f) Notification on Control of Noise from DG Sets, 2002.

Welfare Measures for Workers

5.1.19. Latrine and Urinal Accommodation:

a) Latrine and urinals shall be provided as per Chapter VI, Part – II of Rule 80 of Haryana BOCWR and shall also comply with the requirements of public health authorities; and

b) When women are employed, separate latrine and urinals accommodation shall be provided.

5.1.20. Moving Sites:

a) In case of works like track laying, the zone of work is constantly moving. In such cases, mobile toilets with proper facility to drain the sludge shall be provided at reasonably accessible distance; and

b) In case the Contactor fails to provide required number of urinals and latrines or fails to maintain it as per the requirements of Public Health Laws, the Engineer shall have the right to provide/maintain through renowned external agencies at the cost of the Contactor.

5.1.21. Canteen

In every workplace wherein not less than 250 workers are employed, the Contractor shall provide an adequate canteen conforming to Chapter VI, Part – II of Rule 81 of Haryana BOCWR

5.1.22. Drinking Water.

As per Section 32 of BOCWA, the Contractor shall make in every site, effective arrangements to provide sufficient supply of wholesome drinking water. Quality of the drinking water shall conform to the requirements of national standards on Public Health Laws. While locating these drinking water facilities due care shall be taken so that these are easily accessible from the place of work for all workers at all location of the Site. All such points shall be legible marked "Drinking Water" in a language understood by most of the workmen employed.

5.1.23. Crèche

In every workplace where in more than 50 female workers are ordinarily employed, there shall be provided and maintained a suitable room for use of children under age of 6 years, conforming to the provisions of Section 35 of BOCWA.

5.1.24. Labour Accommodation Camps

Labour camp management plan shall be prepared and approved by Engineer. Where workers are based some distance from their normal place of residence, the Contractor shall provide them with suitable and safe accommodation free of charge and shall take all necessary precautions to protect their health and welfare. The accommodation shall conform to the requirements of Section 34 of BOCWA and include but not be limited to the further measures specified hereunder.

5.1.25. All accommodation camps shall be provided always with a sufficient supply of clean drinking water (of potable quality according to national legal standards), in suitable and easily accessible locations:

5.1.26. The quality of drinking water shall be tested once a fortnight as prescribed in IS 10500:2012and immediate remedial action shall be taken if quality falls below the standard. Test results shall be provided to the Engineer at least monthly.

5.1.27. The Contractor shall provide all accommodation camps with clean and properly equipped and staffed kitchen and canteen facilities to supply meals for workers.

5.1.28. The Contractor shall provide sufficient toilet and bathroom facilities for the numbers of workers accommodated in each camp. Separate accommodation and toilet/bathroom facilities shall be provided for men and women and all facilities shall be kept in full working order always and cleaned and re-equipped daily.

5.1.29. The Contractor shall provide a laundry facility at the Labour Accommodation Camps.

6. ENVIRONMENT AND SOCIAL MANAGEMENT

General Conduct of the Works

6.1.1. The purpose and objective of these guidelines is to outline how the project will avoid, minimise or mitigate effects on the environment and surrounding area. These guidelines detail the implementation of measures in accordance with environmental and social commitments of HRIDC. These guidelines will be 'live' guidelines that will be reviewed and updated at regular intervals throughout the project life cycle. These guidelines will ensure that the development is compliant with current Environmental and Social legislations and will guide and assist the Contractor in exploring all reasonable and feasible means for reducing construction related Environmental and Social impacts.

6.1.2. The Contractor shall comply with the Environment and Social Management Plan (ESMP) given in the Environmental and Social Impact Assessment (ESIA) report available on HRIDC portal for information disclosure and will note and implement any requirements therein, in addition to those found in this specification.

6.1.3. The Contractor is required to build good public relations before the commencement of the Works particularly with the local level representatives such as the Gram Panchayat, by informing the expected impacts by the Works and their schedule and dispute resolution mechanism known as GRM set by the Employer.

Environmental Legislation

6.1.4. The Contractor shall always comply with all relevant National and State legislations regarding environmental protection, pollution prevention and control, waste management and other relevant environmental matters, including but not necessarily limited to, the following with their latest amendments:

a) The Environment (Protection) Act, 1986 and Rules 1986

b) The Indian Wildlife (Protection) Act, 1972;

c) The Forest (Conservation) Act, 1980 &Rules;

d) Punjab Land Preservation Act, 1900;

e) The Noise Pollution (Regulation and Control) Rules, 2000;

f) Notification on Control of Noise from Diesel Generator (DG) sets, 2002;

g) The Air (Prevention and Control of Pollution) Act, 1981and Rules 1981;

h) The Water (Prevention and Control of Pollution) Act, 1974 and Rules 1974;

i) Guidelines to control and regulate ground water extraction in India, 24th September2020, Central Ground Water Authority;

j) The Solid Management Rules, 2016;

k) The Construction and Demolition Waste Management Rules, 2016;

l) The Hazardous and Other Wastes (Management and Transboundary Movement)Rules, 2016;

m) The Bio-medical Waste Management Rules, 2016;

n) Plastic Waste Management Rules, 2016;

o) E-Waste (Management) Rules 2016;

p) The Batteries (Management and Handling) Rules, 2001;

q) Manufacture, Storage, and Import of Hazardous Chemical (Amendment) Rules,1989;

r) Ancient Monuments and Archaeological Sites and Remains (Amendment andValidation) Act 2010;

s) Fly ash utilization notification, Sept 1999;

t) Applicable NGT Guidelines issued time to time; and

u) Provisions of Graded Response Action Plan notified by the MoEFCC.

6.1.5. The Contractor shall comply the Environmental and Social Framework (ESF) of Asian Infrastructure Investment Bank (AIIB) February 2016.

6.1.6. If the requirements stated in this document are in conflict or inconsistent with the requirements of applicable laws, the more stringent requirements shall apply.

6.1.7. It is also the Contractor's responsibility to obtain all environment clearances, official approvals, consents, or other authorizations as may be necessary to comply with the relevant statutes, and to pay all related fees and other costs. The Contractor shall obtain all authorizations in a timely manner and submit to the Engineer as the evidence for the regulatory obligations before commencement of any related construction activity. The indicative clearances/permission/permit are presented in Table below and Contractor is required to take any other clearance as required for its construction activities.

Clearance/ Permission/Permit	Relevant Acts/Rules	Concerned Agency
Consent to Establish and Consent to Operate batching plants and casting yards	• The Water (Prevention and Control of Pollution) Act, 1974, and its amendments; • The Air (Prevention and Control of Pollution) Act 1981 and its amendments	Haryana Pollution Control Board
Authorization for generation, handling, storage, and transportation of hazardous waste	Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016	Haryana Pollution Control Board
Permission for extraction of ground water	Central Ground Water Authority guidelines to regulate and control ground water extraction in India, 24th September, 2020	Central Ground Water Authority
Pollution Under Control Certificate	Central Motor and Vehicle Act 1998 Vehicular Exhaust Norms, CPCB 2007	Department of Transport, Government of Haryana
Construction and Demolition Waste Management Plan	Construction & Demolition Waste Management Rules, 2016	Local Authority (Municipal Corporation)
Cutting of trees	Punjab Land Preservation Act, 1900 (PLPA, 1900)	Forest Department, Haryana

Environmentally Friendly Construction Practices

6.1.8. Containment of Air Pollution

a) All construction equipments should be cleaned of visible dirt/mud before exiting the construction sites and streets shall be promptly cleaned by manual sweeping, or by deploying electro – mechanical devices if such material has been dropped;

b) The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. This facility will be provided with efficient drainage, water re-circulation apparatus and silt traps to prevent any excessive buildup of water. Where wheel-washing facility is not possible, the Contractor shall ensure manual cleaning of wheels by wire brushes or similar suitable means;

c) The Contractor shall ensure that vehicles shall have properly fitted side and tailboards. No open load carrying vehicle shall be used for moving potentially dust-producing materials and dust potential material shall not be loaded to a level higher than the side and tail boards, and shall be fitted with cover lids or tarpaulin covers;

d) The Contractor shall place excavated materials in the dumping/disposal areas with suitable slopes designated in the drawings;

e) The Contractor shall place material in a manner that will minimise dust production. Material shall be stabilised each day by watering or other accepted dust suppression techniques;

f) Materials should not be dropped from more than 1.5 m to limit fugitive dust generation;

g) During dry weather especially on windy, water sprinkling must be used daily at every two hours intervals or at any time that it is required for dust control to prevent any dust from blowing and causing nuisance.

h) The Contractor shall provide storage facilities at each construction site in the form of closed containers/bins or wind protected shelters or mat covering or walled or any combination of the above to the satisfaction of the Engineer.;

i) Stockpiles of sand and aggregate greater than 20m3 for use in concrete manufacture shall be enclosed on three sides, with walls extending above the stockpile and two (2) metres beyond the front of the stockpile;

j) Areas within the Site such as construction depots and batching plants, where there is a regular movement of vehicles shall have an approved hard surface that is kept clear of loose surface material;

k) Unless the Engineer has given notice otherwise, the Contractor shall restrict all motorised vehicles on the Site to a maximum speed of 15 kilometres per hour and confine haulage and delivery vehicles to the designated roadways inside the site;

l) The Contractor shall erect hoardings as specified in Engineer requirements securely around all construction work sites during the main construction activity, to contain dust within the site area and also to reduce air turbulence caused by passing traffic. The hoarding shall be safely secured to the ground to prevent from toppling with minimum gap between the base of hoarding and ground surface.

m) Water spray should be used to control dust during breaking of rock/concrete;

n) During tunnel construction the Contractor shall monitor dusts concentration, wind velocity, air capacity of ventilation system every month for and will keep monitoring record including date, method, location, condition, results, and evaluation of results.

6.1.9. Containment of Water Pollution

a) List of sources (surface/ground) to be provided for approval from Engineer;

b) Prior to use of source, written permission to be obtained from authority to use the water in construction activity, and submit a copy to Engineer;

c) During construction only permitted quantity (permission taken) from approved sources to be

used in construction activity;

d) A Drainage system should be constructed during the commencement of the works, drain off all surface water at the site into suitable drains;

e) At construction depots and batching plants temporary drainage works should be maintained, removed, and reinstated as necessary and all other necessary precautions should be taken for avoidance of damage by flooding and silt;

f) At Batching plant Sedimentation tanks or other acceptable measures, of sufficient capacity to trap silt- laden water before discharge into the outlet drain should be provided;

g) The Contractor shall take measures to prevent discharge of oil in land and water bodies. Oil separator/interceptors shall be provided at Batching Plant and Construction Depot location for vehicle maintenance to prevent the release of oils and grease into the drainage system. These shall be cleaned on a regular basis;

h) Open stockpiles of construction materials (e.g. aggregates, sand and fill material) should be covered with tarpaulin or similar fabric during rainy season or at any time of the year when rainstorms are likely. Washout of construction or excavated materials should be diverted to drainage system through appropriate sediment traps;

i) Rainwater pumped out from trenches or foundation excavation should be discharged into storm water drains after obtaining notice of no objection from the Agency controlling the system;

j) The Contractor shall prevent soil particles and debris from entering the wells or water discharge points by use of filters and sedimentation basins as required;

k) The Contractor shall always ensure that all existing stream courses and drains within, and adjacent to the site are kept safe and free from any debris and any excavated materials arising from the Works;

l) The Contractor shall discharge wastewater arising from site offices, canteens or toilet facilities constructed by him into sewers after obtaining prior notice of no objection of agency controlling the system;

m) The volume of oil spill should be calculated as well as storage volume to contain spill within the materials storage containment areas. The procedure shall include measures to contain and mitigate transportation of oil, grease or hazardous materials to the drainage system or any water body;

n) The Contractor shall ensure that earth, bentonite, chemicals and concrete agitator washings etc. are not deposited/drained in the watercourses but are suitably treated and effluents and residue disposed off in a manner approved by local Regulatory Authorities;

o) Construction works should be programmed to minimize soil excavation works in rainy season. If carried out during rains, temporarily exposed slope surfaces should be covered by tarpaulin, and temporary access roads should be protected by crushed stone or gravel, as excavation proceeds.

p) Wastewater from Concrete Batching & Precast Concrete Casting and that generated from the washing down of mixer trucks and drum mixers and similar equipment should wherever practicable be recycled. The discharge of wastewater should be kept to a minimum;

q) The road between the vehicle washing bay and the public road should be paved to reduce vehicle tracking of soil and to prevent site run-off from entering public road drains;

r) Surface run-off should be segregated from the concrete batching plant and casting yard area as much as possible and diverted to the storm water drainage system. Surface run-off contaminated by materials in a concrete batching plant or casting yard must be treated to, within the discharge norms before disposal into storm water drains;

6.1.10. Containment of Noise and Vibration

a) Contractor shall minimize the use of impact devices, such as jackhammers, and pavement breakers instead use concrete crushers or pavement saws;

b) Equip noise producing equipment such as jackhammers and pavement breakers with acoustically attenuating shields or shrouds recommended by the manufacturers thereof, to meet relevant noise limitations;

c) Use hydraulic tools instead of pneumatic impact tools. If pneumatic impact tools and equipment are used, they shall have intake and exhaust mufflers recommended by the manufacturers thereof, to meet relevant noise limitations;

d) Provide mufflers or shield panelling for other equipment, including internal combustion engines, recommended by manufacturers thereof;

e) Employ prefabricated structures instead of assembling on-site;

f) Use electric instead of diesel-powered equipment;

g) Provide enclosures for stationary equipment and barriers around noisy areas;

h) Locate stationary equipment in such a way, so as to minimize noise and vibration impact on community.

i) Keep noisier equipment and activities as far as possible away from noise sensitive locations and nearby buildings.

j) Plant and equipment known to emit noise strongly in one direction should where possible, be oriented in a direction away from noise sensitive receptor.

k) Reduce the number of plant and equipment operating in critical areas close to noise sensitive receptors.

l) Schedule truck loading, unloading, and hauling operations in such a way so as to minimize noise impact near noise sensitive locations and surrounding communities;

m) Plan noisier operations during times of highest ambient noise level, keep noise levels relatively uniform and avoid excessive and impulse noises;

n) Use only well-maintained, regular serviced plant/equipment, and not to be kept idling when not in use;

o) Maintain equipment such that parts of vehicles and loads are secure against vibrations and rattling;

p) Grading of surface irregularities on construction sites to prevent the generation of impact noise and ground vibrations by passing vehicles;

q) If back-up alarms are used on construction equipment, their noise emission level near noise sensitive receptors such as residences, schools, hospitals and similar areas where calmness is essential, should be regulated, especially at night time;

r) Select truck routes for muck disposal so that noise from heavy-duty trucks will have minimal impact on sensitive areas (e.g., residential);

s) Conduct truck loading, unloading and hauling operations in a manner such that noise and vibration are kept to a minimum;

t) Avoid operating truck on streets that pass by schools during school hours;

u) Efforts to be made to bring down the noise levels due to the DG set, outside the premises, within the ambient noise requirements by proper setting and control measures;

v) The Contractor shall ensure that all necessary permissions/ approvals/consent is obtained from relevant authorities before installation and operation of Generator set;

w) A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacture;

x) At all times noise levels of DG sets shall comply the standards set out by CPCB/SPCB;

y) During tunnel operation following measures to be taken:

i) Blasting activities to be so schedule that local people are not disturbed and notify them prior to undertaking such activity;

ii) Operations to be scheduled to coincide when people are busy with their daily tasks so that they would be least likely to be affected. Blasting operation shall not be carried out in night.

iii) Charge mass per delay should be decreased by minimizing the number of blastholes firing on each delay.

iv) Smaller blasthole patterns and longer delays shall be used between dependent charges.

v) A preconstruction survey of nearby structure likely to be adversely affected by the construction activities to be performed and threshold or limiting values to be established that take into account each structure or use's ability to withstand the loads and displacements due to construction vibrations;

vi) An extensive outreach to be conducted in advance in the surrounding villages that could be affected;

vii) Vibration levels shall be monitored in the foundations of nearby buildings during all blasting activities. Blasting activities resulting in peak particle velocity (vibration) levels in excess of appropriate damage criteria as measured in the foundations of nearby structures would be immediately stopped until further precautionary measures are taken to reduce blasting-related vibration impacts.

viii) Work shall not begin again until the steps proposed to stabilize and/or prevent further damage to the designated buildings are approved.

6.1.11. Containment of Waste

a) The Contractor is required to develop, institute and maintain a Waste Management Plan (WMP) during the construction of the project for his works, which may include:

ix) Identification of disposal sites;

x) Identification of quantities to be excavated and disposed off;

xi) Identification of split between waste and inert material;

xii) Identification of amounts intended to be stored temporarily on site location ofsuch storage;

xiii) Identification of intended transport means and route;

xiv) Obtaining permission, where required, for disposal;

b) Such mechanism is intended to ensure that the designated area for the segregation and temporary storage of reusable and recyclable materials are incorporated in the WMP. The WMP shall be prepared and submitted to Engineer for approval.

c) Construction activities are expected to generate a variety of waste such as:

i) General refuse;

ii) Construction Waste including waste from excavated material;

iii) Chemical waste;

iv) Hazardous waste; and

v) Biomedical waste.

All wastes shall be stored at a designated areas and not to be mixed with each other.

General Refuse

a) Each worksite would generate general refuse including paper and food waste which shall be stored in enclosed bins or units.

b) The Contractor shall not burn debris or vegetation or construction waste on the site;

c) The refuse shall be stored and transported in accordance with good practice and disposed at licensed landfills;

d) An authorised waste collector shall be employed by the Contractor to remove general refuse from the site, on a daily basis to minimise odour, pest and litter impacts.

Construction and Demolition (C&D) Waste

e) C&D Waste would mainly arise from the project construction activities and from the demolition of existing structures where necessitated. It will include: material and equipment wrapping packaging material, unusable/surplus concrete/grouting mixes, Damaged/contaminated/surplus construction materials, Wood from formwork and false work, concrete rubble, plastics, metal, glass, asphalt, wood and refuse obtained from demolition of houses.

f) The Contractor shall be responsible for collection, segregation, storage and disposal of C&D as directed or notified by the concerned local authority in consonance with the Construction & Demolition Waste Management Rules, 2016;

g) The Contractor shall ensure that there is no littering or deposition of C&D waste and disposal of C&D waste along the riverbed, natural drainage and wet land is strictly prohibited;

h) The requirement of concrete/RCC/PCC waste disposal, generated from the entire contract shall be either when 15 Tonnes of C&D waste which has been generated or such C&D waste has been stored for 15 days (irrespective of quantity), of the two whichever is earlier;

i) A proper arrangement for record keeping has to be maintained to ensure disposal of C&D waste to C&D waste recycling plant. Contractor shall submit the record of C&D waste disposal to recycling facility, in his Monthly Environment Report;

Hazardous Waste

j) Hazardous waste would mainly arise from the maintenance of equipment. These may include, but not be limited to: Used engine oils, hydraulic fluids, waste fuel, spent mineral oils/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spent solvents/solutions, some of which may be derived, from equipment cleaning activities which shall be disposed off in a manner in compliance with the procedure given in "Hazardous Waste (management, handling and trans-boundary movement) rules, 2016" only to authorized recyclers under intimation to the Employer's Representative ;

k) Chemicals classified as hazardous chemicals under "Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 of Environment (Protection) Act, 1986 shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act;

l) The hazardous waste shall be stored on an impermeable surface with containment bunding to retain leaks, spills and ruptures;

m) All waste collection containers shall be of appropriate size with a closed lid. Each

container will be clearly labelled with a colour code system in local language and English. Original labels of empty containers should be completely covered and the contents of the type of waste stored in the used containers clearly indicated.

Bio medical waste

n) Collection, segregation, storage and disposal of Bio Medical waste shall be in accordance to The Bio-medical Waste Management Rules, 2016;

o) Storage time of waste shall be as less as possible so that waste storage, transportation and disposal is done within 48 hours;

p) The contactor shall ensure Posters/ placards for bio-medical waste segregation shall be installed at the point of generation;

q) Disposal of biomedical waste shall be through a licensed waste collector, duly authorized by MoEFCC or Haryana Pollution Control Board as the case may be. License of the waste collector shall be shown to the Employer's Representative on demand and staff handling the biomedical waste shall be provided with PPEs;

Storage and Segregation of Waste

a) Collection and storage points of appropriate size containers shall be established around all construction work sites, with a 'display board' showing quantity and nature of waste;

b) All waste shall be stored in different coloured bins as per table below:

Storage of Waste

Type of Waste	**Colour**
Wet/Organic/ Bio-Degradable Waste	Green Bins with lids
Dry/Recyclable waste (excluding Bio-medical waste/ hazardous waste)	Blue
Bio-Medical waste	Red with lids
E-Waste	Black
Hazardous Waste	Brown
COVID Waste	Yellow

6.1.12. Housekeeping

a) The Contractor along with his sub-Contractors shall maintain the site, labour camps, stores and offices reasonably clean, keep free from obstruction and properly store any construction equipment, tools, and materials.

b) Full height fence, barriers etc. will be installed at the site in order to preserve the surrounding area from excavated soil, rubbish etc which may cause inconvenience to public.

c) The Contractor's through daily pre-work meeting (tool box talk), safety meeting etc. will impart the necessary education to labour on housekeeping. Other staff such as supervisors and engineers working at the site will also be educated on the necessity of good housekeeping;

d) The Contractor shall ensure the availability of dustbins in Labour Camps at required place and ensue regular cleaning of rooms, kitchens, toilet blocks and dustbins.

e) Proper access and stacking shall be ensured at the Stores. A list will display daily stock of materials.

f) Everyone shall be responsible to maintain housekeeping of their work station.

g) To keep the area free of litter and garbage, specific locations shall be designated for consuming food and snacks to prevent random disposal of waste.

h) Drip pans of suitable size shall be used to collect oil leakages and spills while plants/equipment/machinery maintenance.

i) The Contractor shall make available Material Supply Data sheet (MSDS) for material/chemicals/substances used, for which these are available to the Engineer when requested;

j) Such material/chemicals/substances used shall be treated, handled, stored, transported and disposed off, by the Contractor, in a manner specified in the MSDS.

6.1.13. Landscape, Greenery and Aesthetics

a) As far as is reasonably practicable, the Contractor shall maintain ecological balance by preventing deforestation and defacing of natural landscape. In respect of ecological balance, the Contractor shall observe the following instructions.

i) Prevent any avoidable destruction, scarring or defacing of natural surroundings in the vicinity of work;

ii) Any damage shall be repaired, replanted or otherwise corrected at Contractor's expense.

iii) Directional shielding for light used for illumination shall be used to prevent from striking adjacent areas, where feasible;

b) Tree Felling

i) All trees and shrubs, which are not specifically required to be cleared or removed for construction purposes, shall be preserved and protected from any damage by use of protective barriers or other methods approved by Engineer;.

ii) The Contractor shall not fell, remove or dispose of any tree or forest produce in any land handed over to him for the construction of works and facilities related to project except with the previous permission obtained from the Forest Department;

iii) Trees shall not be used for anchorage.

6.1.14. Energy Management

a) The Contractor shall use energy efficient pumps and motors. The efficiency shall be measured during installation and also periodically;

b) The Contractor should rigorously follow the maintenance regime of his DG sets;

c) The Contractor shall maximize the use of energy efficient luminaries such as LED's, metal halide lamps and ensure optimum illumination levels to save energy.

d) The Contractor shall make provision of Earth Leakage Circuit Breakers (ELCBS) to prevent loss of excessive earth currents which are unsafe;

e) The Contractor shall plan in advance and select locations to receive and store material such that these are at the least distance from place of use;

f) The Contractor shall design site offices for maximum daylight and minimum heat gain.

6.1.15. Archaeological And Historic Resources

a) If any archeological and historic structure is likely to be affected, a resource protection plan shall be prepared by the Contractor in consultation with the Archaeological Survey of India (ASI) to

identify and assess construction effects and seeks ways to avoid, minimize or mitigate adverse effects on such monuments;

b) The Contractor shall stop work immediately and notify the Engineer if, during construction, an archaeological or burial site is discovered. The work will not recommence until approval of the Engineer is obtained for the same.

6.1.16. Fly Ash

MoEFCC fly ash notification dated September 1999 and its subsequent amendments makes it mandatory for use of fly ash-based products in construction activities located within 300Km from coal or lignite based thermal power plants. The Contractor shall use fly ash as a percentage substitution of cement, in concrete for certain structures and works as prescribed in the latest amendment. The Contractor shall provide details of usage of such products to Engineer and shall maintain a detailed record of usage of Fly Ash.

Environmental Monitoring

6.1.17. Baseline Study: Before commencement of actual construction work, all items and parameters as specified in ESHS manual shall be monitored once as the baseline of the environmental condition prior to the construction and compared with the monitored values during the construction period;

6.1.18. Qualification of Monitoring Agency: Monitoring shall be conducted by MoEFCC approved or NABL accredited laboratory and approved by the Engineer;

6.1.19. Enforcement of the Monitoring: Monitoring plan shall be proposed in the Contractor's ESHS Management Plan and must be approved by the Engineer before commencement of the monitoring. If the monitoring results are more than baseline and standards, cause analyses and necessary counter measures shall beproposed to the Engineer in the monitoring reports;

6.1.20. Parameters, Location and Frequency of the Monitoring: Environmental Monitoring parameters, locations and frequency is given in following table.

Parameters, Standards, Location and Frequency of Monitoring

Parameters	Sampling Standards	Location	Frequency
Air (PM_{10}, $PM_{2.5}$)	CPCB (2011) Guidelines for the Measurement of Ambient Air Pollutants, Manual Sampling & Analyses	One representative location within each construction yard and batching plant	Monthly
		Closest residential or commercial area (one location) within 100m from each active construction site or representative locations approved by theEngineer	Monthly
Noise Day Time (6 AM – 10PM)	CPCB (2015) Protocol for Ambient Level Noise	One representative location within each construction yard and batching plant	Weekly

Parameters	Sampling Standards	Location	Frequency
L_{max}, L_{min}, L_{eq}, L_{10}, L_{90}, L_{50} **Night Time** (10PM – 6AM) L_{max}, L_{min}, L_{eq}, L_{10}, L_{90},L_{50}	Monitoring	Closest residential or commercial area (one location) within 100m from each active construction site or representative locations approved by the Engineer	Weekly
Vibration (in mm/s orVdB)	IS 14884 (2000)	During complaints or as directed by employer.	
Drinking/GW (pH, Total Alkalinity, Electrical Conductivity, Total Dissolved Solids, Fluoride, Arsenic, Nitrate, Iron, Lead, Cadmium, E-coli)	IS 3025 (2008) & IS 10500 (2012)	**Drinking water**: construction yard, batching plant andlabour camps	Quarterly (April, July, October, January)
		Groundwater: one representative tube/bore well in the adjacent residential area or within 100m from each active construction site	Quarterly (April, July, October, January)
Surface Water pH, Total Dissolved Solids, Fluoride, Arsenic, Iron, Lead, E-coli	IS 3025 (2008) & IS 2296 (1982) & CPCB (2012) Guide Manual Water and Wastewater Analysis	Upstream and downstream of the river/stream if any. Any natural water course (ex. Pond etc.) located or within 100 m of each a) construction yard, b) labour camp, and c) active construction site	Quarterly (April, July, October, January)

Parameters	Sampling Standards	Location	Frequency
Waste	Not available but fully complying with monitoring the quantities of wastes specified by the Solid Management Rules 2016 & the Construction and Demolition Waste Management Rules 2016	Each construction yard and construction site	Quarterly (April, July, October, January)
Hazardous waste	Not available but typed reporting (not handwriting) fully complying with monitoring the quantities of wastes specified by the Hazardous and Other Wastes (Managementand Transboundary Movement) Rules 2016,	Each construction yard and active construction site	Quarterly (April, July, October, January)
Complaints if any		All Works' related locations	Weekly

Complaint Response Process

6.1.21. Enquiries, complaints and requests for information can be expected from a wide range of individuals and organisations both private and government. Most complaints are likely to be received by HRIDC, although the site offices are also likely to be contacted;

6.1.22. The objective of complaint process is to ensure that public and agency complaints are addressed and resolved consistently and expeditiously;

6.1.23. The Contractor's Project Manager will be notified immediately on receipt of complaint that may relate to environmental impacts. The Project Manager will immediately inform the Engineer;

6.1.24. Field investigation shall determine whether the complaint has merit, and if so, action shall be taken to address the complaint;

6.1.25. The outcome of the investigation and the action taken shall be documented on a complaint Performa prepared by the Contractor and submitted for notice by the Engineer in advance of the works;

6.1.26. Where possible, a formal response to each complaint received shall be prepared by the Contractor within seven days to notify the concerned person(s) that action has been taken.

Social Legal Requirement

6.1.27. The Contractor shall always comply with all relevant national and state legislations regarding social safeguard including but not necessarily limited to, the following with their latest amendments

a) National Policy for the Empowerment of Women, 2001;

b) The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013;

c) The Protection of Children from Sexual Offences Act, 2012;

d) The Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome (Prevention and Control) Act, 2017;

e) Child Labour (Prohibition & Regulation) Act 1986

Some of the key International instruments for the protection of women include the following:

a) United Nations General Assembly, Resolution 52/86 on Crime Prevention and Criminal Justice Measures to Eliminate Violence Against Women, 2 February1998;

b) United Nations Security Council Resolution 1325 on Women, Peace and Security, 31 October 2000;

c) Environmental and Social Framework (ESF) of Asian Infrastructure Investment Bank (AIIB) February 2016

Gender equality

6.1.28. The Contractor is responsible for providing equal opportunities to both genders and end gender related discrimination, if any. The ESHS Committee will proactively identify cases of gender discrimination with key focus on the following topics:

a) Gender based violence, including sexual harassment at the workplace;

b) Disparity in benefits provided;

c) Termination on account of pregnancy.

6.1.29. The Contractor shall enhance female workforce participation and maintain sex -disaggregated data for periodic reporting.

6.1.30. The Contractor shall ensure that women workers are paid at par with male workers

6.1.31. If women workers are deployed at site then day crèche facilities shall be provided to facilitate the women with infant working on site.

Labour Requirements

6.1.32. The contractor shall use unskilled labour drawn from local communities to avoid any additional stress on the existing facilities (medical services, power, water supply etc.)

6.1.33. The recruitment of women and members of vulnerable groups shall be prioritized

6.1.34. The Contractor shall provide training to build the skills of locally recruited labour.

6.1.35. All staff, skilled and unskilled labours employed on a site shall be required to sign Code of Conduct that shall ensure compliance with the ESHS provision of civil works and consultancy contracts.

Cultural and Religious Issues

6.1.36. Disturbance from construction works to the cultural and religious sites, and Contractors lack of knowledge on cultural issues cause social disturbances. The Contractor shall

a) Communicate to the public through community consultation, informing the peers and newspaper announcements regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restriction;

b) Not block access to cultural and religious sites and sites of importance for livelihood activities, wherever possible;

c) Need to take mitigation measures while working near religious place/ educational institutions close to the construction sites;

d) Provide freedom to construction workers to observe their cultural and religious practices;

e) Monitor and be responsible for the behaviour of construction workers especially migrant workers towards the community. The workers must be debriefed well regarding local aspects and need to follow good behaviours, and informed regarding unexpected behaviours at the time of employing;

f) Provision of cultural sensitization training for migrant labours regarding engagement with local community;

g) Resolve cultural issues in consultation with local leaders and Project Manager;

h) Establish a mechanism that allows local people to raise grievances (directly and

i) indirectly) arising from the construction process;

j) Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social and security matters.

Guidelines for Addressing GBV in Projects

6.1.37. The Contractor's ESHS Plan shall include implementation of Gender Based Violence (GBV), Sexual Exploitation and Abuse (SEA) and Sexual Harassment (SH) Prevention and Response Action Plan. This action plan shall describe Code of Conduct (CoC), mechanism to address such incidents, assess the project scenario and potential risks of GBV/SEA/SH, training plan for workers on GBV/SEA/SH and awareness programme amongst workers regarding socially, culturally appropriate behaviour that would ensure that the project community and women in particular are safe, secured, and not vulnerable to abuse. A sample GVB/SEA/SH action plan is given in Table below.

Table - GBV/SEA/SH Prevention Action Plan

Objective	Activity	Responsibility
Assess Potential Risk of GBV	Rapid assessment of worksite, project footprint (e.g. community structure, local self-governance, national regulations, history of incidence), type of workers (local or migrant) for possible GBV risk.	As part of the social impact assessment (to be updatedat the time of construction).
Inclusive development	• Engage women in project planning and implementation • Incorporate women's feedback in project design and construction schedule • Organize systematic consultations with women to ensure continuous feedback on projects and identify any gender-	

Objective	Activity	Responsibility
	sensitive adverse impacts	
Training – women	• Sensitization of women on GBV and women's rights to avoid/avert such incidents • Sensitization of women on actions to be taken in case of GBV	
Training – men	• Sensitization of male workers on GBV and women's rights to avoid/avert such incidents • Sensitization of male workers on actions to be taken in case of GBV • Sensitization of male workers on appropriate socially and culturally acceptable behaviour towards women • Training of managers on • methods of dealing with cases of GBV	
Awareness generation	• Distribution of leaflets propagating gender-appropriate behaviour • Signing of self-declaration format on commitment towards gender-sensitive behaviour	

6.1.38. The Contractor shall constitute an appropriate Grievance Redress Mechanism (GRM) for

addressing grievances at worksite. Grievances of workers will be first brought to the attention of supervisor at site. Grievances not redressed by the supervisor within 7 days will be brought to the Grievance Redress Committee (GRC). The composition of GRC will have representatives from workers, women representative, ESHS staff of the Contractor ESHS staff of GC. The main responsibilities of the GRC are to: (i) provide support to workers on problems arising at worksite, (ii) record workers grievances, categorise, prioritize grievances and resolve them, (iii) immediately inform the Engineer of serious cases and (iv) report to workers on development regarding their grievances and decisions of GRC. The panel of the GRC will function without any prejudice or fear of retaliation. The well-being of the panel members will be protected by HRIDC. A format for record of complaints is given in General Instruction: ESHS/GI/008. The GRC will redress the grievances within 14 days.

6.1.39. This project has zero tolerance of any form of:

a) **Gender-based violence (GBV)**, that is perpetrated against a person's will and that is based on socially ascribed gender-related differences between people.

b) **Sexual exploitation and abuse (SEA**) which is attempted abuse of a position of vulnerability, differential power, or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another.

c) **Sexual harassment (SH**) which is unwelcome sexual advances, requests for sexualfavors, and other unwanted verbal or physical conduct of a sexual nature.

6.1.40. Any incidence of GBV, SEA or SH should be reported to the Grievance Redress Committee (GRC). The panel of the GRC should take appropriate gender-sensitive actions to verify authenticity of the incident with due consideration to the safety, security, and dignity of the offended person. The investigation should be concluded within three days of receiving the report or as reasonably possible. Depending on the severity of the incident, the panel may report the case to appropriate authorities.

Following the investigation, the GRC shall recommend appropriate actions to the company which may include but not limited to:

a) Informal warning

b) Formal warning

c) Additional training

d) Loss of up to one week's salary

e) Suspension of employment (without payment of salary), for a minimum period of one month up to a maximum of six months

f) Termination of employment

6.1.41. The affected person will be provided with appropriate support (e.g. psychological counselling, medical support and any other support as needed).

6.1.42. A self-declaration format for adherence to gender-sensitive behaviour should be signed by all contractors, subcontractors, employees, and senior managers, engaged by the Project to avoid GBV/SEA/SH at worksite. A self-declaration format is given in below:

6.1.43. Commitment Statement for all Project Workers

(to be translated into local language or explained in a manner that is appropriate for general understanding of the signee)

I, (name of person), acknowledge that preventing Gender-Based Violence (GBV), Sexual exploitation and abuse (SEA) and Sexual harassment (SH) is essential, and that preventing it is my responsibility. At [Company], GBV activities constitute acts of gross misconduct and are therefore grounds for sanctions, penalties or potential termination of employment. All forms of GBV are

unacceptable, be it on the worksite, the worksite surroundings, at workers' camps, or in the community. Prosecution of those who commit GBV may be pursued if appropriate.

I agree that while working on the [Project], I will:

- Cooperate with any relevant investigations.
- Treat women, children (definition of "child" shall be as specified in Child Labour (Prohibition and Regulation) Act, 1986) and men with respect regardless of race; color; language; religion; political or other opinion; national, ethnic or social origin; sexual orientation or gender identity; disability; birth or other status.
- Not use language or behaviour towards women, children or men that is inappropriate, harassing, abusive, sexually provocative, demeaning or culturally inappropriate.
- Not request or engage in sexual favors - for instance, making promises or favorable treatment dependent on sexual acts, in or outside the work site.
- Refrain from abusive and violent behaviour, in the workplace, labor camp or surrounding communities.
- Attend and actively partake in training courses related to HIV/AIDS, GBV, SEA and SH as requested by my employer.
- Report through the grievance redress mechanism or to my manager any suspected or actual GBV by a fellow worker, whether in my company or not, or any breaches of this Code of Conduct.

[Company] recognizes that false accusations of sexual harassment can have serious effects on innocent persons. If, after the investigation, it is found that the complainant has maliciously or recklessly made a false accusation, the complainant will be subject to appropriate sanctions. In such a case, the company will also take appropriate action to restore the reputation of the accused.

I understand that it is my responsibility to use common sense and avoid actions or behaviours

that could be construed as GBV or breach this Self-declaration format. I do hereby acknowledge that I have read the foregoing Self-declaration format, do agree to comply with the standards contained therein and understand my roles and responsibilities to prevent and respond to GBV. I understand that any action inconsistent with this Self-declaration format or failure to act, as mandated by this Self-declaration format may result in disciplinary action and may affect my ongoing employment.

I have familiarized myself with the contents of this Self-declaration format. By my signature below, I acknowledge, understand, accept and agree to comply with the information contained in the Self-declaration format provided to me.

I hereby confirm I have read and understand the Self-declaration format.
Name (Employee)

Signature
Date

7. FINANCIAL DEDUCTION/WITHHOLDING

Financial deductions from Contractor on occurrences of an incident.

7.1.1. Table No. 1 below indicates ESHS incidents and the corresponding deductions to be made from the Contractor under Sub-Clauses 20.1 [Employer's Claims], Sub-Clauses 14.3 [Application for Interim Payment], Sub-Clauses 14.6 [Issue of Interim Payment Certificates] and Sub-Clauses 14.7 [Payment] of the General Conditions of Contract.

7.1.2. The affected part of the Works shall remain suspended until all necessary investigations are completed as prescribed in Clause 2. [ESHS Management], Sub-Clause 2.15 Accident Report and Investigation and as per the related local laws of the state.

7.1.3. Upon submission of the Contractor's Request for Inspection (RFI),a joint inspection of the affected part of the Works shall be carried out by the Engineer and the Contractor. On receipt of the Engineer's Consent (Notice of No Objection: NONO), the Contractor may resume the work.

7.1.4. The Contractor shall not be entitled to any extension of time or to the payment of any cost or profit due to any suspension in accordance with this Sub-Clause 8.5 [Extension of time for Completion]

7.1.5. The maximum amount of delay damages set out in Sub-Clause 8.8 [Delay Damages] of the General Conditions of Contract shall not be applicable where the cause of delay to completion is suspension of part of the Works due to the Contractor's non-compliance as described in this clause 7.1.

Table No. 1: Incidents

Sl. No.	Incident		Financial deductions from the Contractor in Indian Rupees
1.	Injury and Incidence reporting	i) Fatal accidents	i) Rs.1,000,000 for first fatality and Rs.1500,000 for every subsequent fatality.
		ii) Injury accident	ii) Rs.300,000 for first grievously injured person and Rs.500,000 for every subsequent grievously injured person (Grievous Injury as defined by Workmen's Compensation Act)
		iii) Abnormal delay in reporting accidents or willful suppression of information about any accidents / dangerous occurrence as per Sub-Clause 2.15.	iii) Rs.1,00,000 for first violation and Rs.2,00,000 for subsequent violations

Withholding and deduction of payments from Contractor

7.1.6. The Engineer may issue a notice to the Contractor in accordance with Sub-Clause 3.5 [Engineer's Instruction] of the General Conditions of Contract to rectify any unsafe act or condition (including but not limited to error, default or omission) upon discovery of same on the Site by the Engineer, in a form of Nonconformity Report.

7.1.7. Table No. 2 below indicates Contractor's non-conformances from the ESHS requirements of the Contract and the corresponding amounts to be withheld and deducted by the Engineer from payment due to the Contractor under Sub-Clause 14.3 [Application for Interim Payment], Sub-Clause14.6 [Issue of Interim Payment Certificates(IPC)] and Sub-Clause 14.7 [Payment] of the General Conditions of Contract.

7.1.8. The Engineer shall have the right to withhold and deduct charges for any other unsafe act

7.1.9. and/or condition depending upon the gravity of the situation on a case-to-case basis. The charge shall be comparable to that, which is the closest to the unsafe act/condition, indicated in Table 2.

7.1.10. Except as may be required otherwise by the Laws of the Republic of India, upon receipt of the Engineer's notification concerning an unsafe act or condition as described in Table No. 2, the Contractor shall promptly comply with such notification, investigate the cause of the unsafe act or condition and as soon as possible (but no later than 7 days, or within such other period from receipt of the Engineer's notification as may be approved by the Engineer), submit to the Engineer for review full details of the proposed correction, prevention and any other measures (hereinafter referred to as the "measures") to be taken by the Contractor to rectify and close-out the matter and to prevent re-occurrence. Such measures shall be to the satisfaction of the Engineer.

7.1.11. The Engineer is entitled to withhold amounts from the Contractor's payment until the Engineer has verified the Contractor's measures, submitted to the Engineer for review as above, and accepted them after a joint inspection in response to the RFI for the same.

7.1.12. Should the Contractor default in implementing any measures within the time previously agreed between the Contractor and the Engineer or the Contractor makes subsequent violations as specified in Table No. 2, the Engineer shall be entitled to the deduction to be recovered from the Contractor under Sub-Clause 20.1 [Employer's Claims] of the General Conditions of Contract. Such deductions shall be made via the certification and payment process provided for in the Contract, including Sub-Clauses 14.3 [Application for Interim Payment], Sub-Clause 14.6 [Issue of Interim Payment Certificates] and Sub-Clause 14.7 [Payment] of the General Conditions of Contract without limiting to the unsafe acts and or conditions mentioned above in Table 2.

7.1.13. The release or deduction of amount shall happen in the next payment process.

Suspension of work

7.1.14. The Engineer may issue a notice to the Contractor in accordance with Sub-Clauses 3.5 [Engineer's Instruction] and Sub-Clause 8.9 [Suspension of Work] of the General Conditions of Contract to suspend the progress of part of the Works in a form of Nonconformity Report, if in the Engineer's opinion such work is non-compliant with the ESHS requirements of the Contract. Such notification shall include details of the cause of the suspension. During such suspension, the Contractor shall protect, store and secure such part of the Works against any deterioration, loss or damage.

7.1.15. The Contractor shall not proceed with the affected Works until its measures are accepted by the Engineer.

7.1.16. Suspension of part of the Works as described in Sub-Clause 7.3.1 above and withholding of the amount from the Contractor's payment Sub-Clause 7.2 above shall continue together or independently until the Engineer has verified the Contractor's correction and close-out of any such non-conformity.

7.1.17. The Contractor shall not be entitled to any extension of time or to the payment of any cost or profit due to any suspension in accordance with the Sub-Clause 7.2.

7.1.18. The maximum amount of delay damages set out in Sub-Clause 8.8 [Delay Damages] of the Conditions of Contract shall not be applicable where the cause of delay to completion is suspension of part of the Works due to the Contractor's non-complianceas described in this Clause 7.

Table No. 2: Unsafe Acts/Conditions

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
1.	ESHS Management Policy & Plan	1) ESHS Policy Non-compliance of Sub-Clause2.4.1 (Per Month)	Rs.25,000 per month
		2) ESHS plan: a) Delay in submission (Sub-Clause 2.4.2.) b) Not updated as per employer's instruction as per Sub-Clause 2.4.4. c) Copies not provided to all required supervisors / engineers (Sub-Clause 2.4.5)	Rs.50,000 per month.
2.	ESHS Organization	i) Not filling up the vacancies created due to ESHS personnel before leaving the Contractor (Sub-Clause 2.6.4.) ii) ESHS organization not provided with required Audio-visual and other equipment as per General Instruction ESHS/GI/ 001 (Clause 8. Attachment-4)	i) Rs.200,000 per month. ii) Rs.50,000 per month
3.	ESHS Committee	i) Failed to formulate or conduct ESHS Committee meeting for any month (Sub-Clause 2.8.1) ii) The Contractor and Subcontractor representatives not attending ESHS Committee meetings (Sub-Clause 2.8.6.) iii) Failed to conduct Site inspection before conducting ESHS Committee meeting (Sub-Clause 2.11.7 (a).) iv) Failed to send Agenda to Employer in time or ESHS Committee Minutes of Meeting (Sub-Clauses 2.8.4 &	Deduction of amount i) Rs.100,000 per violation ii) Rs.5,000 per member not attending the meeting For item iii) & iv) Rs.25,000 per violation

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		2.8.7.)	
4.	ID Card	i) Non-adherence of Clause 2.9.	Rs. 1,000/- per ID card per month
5.	ESHS Training	i) Not complying to the requirements as mentioned in Sub-Clause 2.10.1, 2.10.2, 2.10.3	Deduction of Rs.1,00,000 per violation
6.	ESHS Inspection	i) Not complying to the requirements as mentioned in Clause 2.11.	Rs.1,00,000 per violation
7.	ESHS Audit	Internal Audit, MARS & External Audit i) Not conducted as per ESHS Plan (Sub-Clauses 2.12.6) ii) Report not sent to Employer (Sub-Clause 2.12.9) iii) Corrective action not taken for any month (Sub-Clause 2.12.9)	Rs.1,00,000 per violation
8.	ESHS Communication	i) Important days to be observed for ESHS awareness as furnished by employer not observed (Sub-Clause 2.13.2) ii) Posters as directed by Employer not printed and displayed (Sub-Clause 2.13.2)	i) Rs.10,000 per violation and ii) 50,000 per month
9.	ESHS Submittals	Non-compliance of Clause 2.14	Rs.1,00,000 per month
10.	Traffic Management	a) Non-compliance of Sub-Clause4.2.9	Rs.25,000 per single violation .
11.	Emergency Preparedness Plan	Non-compliance of Clause 2.16	Rs.1,00,000 per month
12.	Permit to work	Non-compliance of Clause 4.28	Rs.1,00,000 per violation.
13.	OccupationalHealth	Non-compliance of Clause 5.1 & 5.2	Rs. 50,000 per month.

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
14.	Labour Welfare Measures	Non-compliance of Clause 5.4	Rs.50,000 per month .
15.	Environmental Management	i) Containment of air pollution (Sub-Clause 6.3.1) ii) Containment of water pollution (Sub-Clause 6.3.2) iii) Containment of noise pollution (Sub-Clause 6.3.3) iv) Containment of waste pollution (Sub-Clause 6.3.4) v) Preservation of trees (Sub-Clause 6.3.6 (b)) vi) Environment monitoring (Sub-Clause 6.4) vii) Non-adherence to statutory agencies (SPCB, CPCB NGT etc.) environment management guidelines	Rs.50,000 per violation Actual penalty imposed by statutory agency
16	Housekeeping (Clause 4.2)	i) Surrounding areas of drinking water tanks / taps not hygienically cleaned / maintained ii) Office, stores, toilet / urinals not properly cleaned and maintained. iii) Required garbage bins at appropriate places not provided / not cleaned. iv) Stairways, gangways, passageways blocked. v) Lumber with protruding nails left as such vi) Openings unprotected vii) Excavated earth not removed within a reasonable time. viii) Truck carrying excavated earth	Rs.50,000 per violation.

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		not covered/tyres not cleaned. ix) After close of work Vehicles / equipment not parked at designated place x) Unused surplus cables / steel scraps lying scattered xi) Wooden scraps, empty wooden cable drums lying scattered xii) Water stagnation leading to mosquito breeding	
17.	Working at Height / Ladders and Scaffolds	Non-compliance of Clause 4.3.	Rs.50,000 per violation
18.	Lifting Appliances and Gear	Non-compliance of Clause 4.6	Rs.50,000 per violation
19.	Launching Operation	Non-compliance of Clause 4.7	Rs.50,000 per violation
20.	Site Electricity	Non-compliance of Clause 4.10	Rs.10,000 per violation.
21.	Power Tools (Sub-Clause 4.10.13)		
22.	Welding and Cutting (Clause 4.12)	i) Wrong colour coding of cylinder. ii) Cylinders not stored in upright position. iii) Flash back arrester, non-return valve and regulator not present or not in working condition. iv) Fail to put cylinders in a cylinder trolley. v) Damaged hose and fail to use hose clamps vi) Using domestic LPG cylinders vii) Fail to store cylinder 6.6m away from fire prone materials viii) Fire extinguisher not placed in	Rs. 10,000 per violation.

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		the vicinity during operation Voltmeter and Ammeter not working. ix) Non-availability of separate switch in the transformer x) Improper grounding and return path. xi) Damaged and bare openings in the welding cable. xii) Damaged holder xiii) Fire extinguisher not placed in the vicinity during operation	
23.	Fire Precaution (Clause 4.27)	i) Smoking and open flames in fire prone area ii) Using more than 24V portable electrical appliances in the fire prone area iii) Not proper ventilation in cylinder storage area. iv) Absence of fire extinguishers v) Fire extinguishers not refilled once in a year. vi) Fire extinguisher placed in a not easily accessible location	Rs. 10,000 per violation.
24.	Excavation, Tunneling and Confined Space (Clauses 4.13, 4.14, 4.26)	Non-compliance	Rs. 10,000 per violation
25.	Batching plant and Casting yard	Non-compliance of Clause 4.18	Rs. 10,000 per violation.
26.	Personal Protection Equipment	Non-compliance of Clause 4.34. Items of attention are as under – i) Not having ii) Not wearing (or) using and kept	Rs. 200 per person per violation.

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		it elsewhere iii) Using damaged one iv) Using wrong type v) Using wrong colour helmet or helmet without logo vi) Using for other operation (e.g. Using safety helmet for storingmaterials or carrying water from one place to other)	
27.	Working near Railway	Non-compliance of Clause 4.32.	Rs. 1,00,000 per violation

8. ATTACHMENT

Attachment -1 Contents of ESHS Management Plan

1.0 General

1.1 The Contractor shall prepare an Environment, Social, Health and Safety (ESHS) Management Plan, which provides measures to protect the Environment, Health and Safety of workers and the public.

1.2 The Contractor's ESHS Management Plan shall be based on Environment, Social, Health and Safety considerations submitted with the Tender and shall have the content shown in the following section [Contents of ESHS Management Plan].

1.3 The Contractor shall submit his ESHS Management Plan for review by the Engineer within 28 days after the Commencement Date and shall amend the ESHS Management Plan to address any comments made by the Engineer and submit a Final ESHS Management Plan within 14 days of receipt of comments.

1.4 The Final ESHS Management Plan shall be binding on the Contractor for the duration of the Contract.

2.0 Content of ESHS Management Plan

2.1 The Contractor's ESHS Management Plan shall cover the following aspects:

Site ESHS Management Plan	
Contract No.	
Contractor Name	
Project Name	
1	Project Highlights i) Title of the content; ii) Contract number; iii) Brief scope of work; iv) Location map/key plan; v) Period of the project;
2	ESHS Management Policy with senior management responsibility;
3	Site organization chart Chart indicating reporting of ESHS Management personnel, appointment, duties, and responsibilities
4	Roles &responsibility Individual responsibility of the i) The Contractor's representative

	ii) ESHS Manager iii) Environment manager iv) Social expert v) Chief accident prevention officer vi) Construction manager vii) Construction Supervisors viii) ESHS Committee members ix) ESHS in charge x) Site engineers xi) First line supervisors xii) Subcontractors
5	ESHS Site Committee xiii) Details - Chairman, secretary, members, and employer's representative xiv) Procedures for effective conduct of meeting
6	ESHS Training
7	Subcontractor Safety and Health procedures for Subcontractors;
8	ESHS Inspection and audit
10	Accident, diseases investigation reporting procedures
11	Health, First Aid, and emergencies measures
12	Staff and labour welfare measures at site
13	Policy for identifying hazards and risks with risk assessment and mitigation procedures
14	Safe Work Procedures e.g. i) Excavation ii) Structural steel erection iii) Form works iv) Concrete placement v) Work at height vi) Switch-over works vii) Floor, wall openings and stairways viii) Welding, cutting and bracing ix) Lifting appliances x) Electrical equipment

	xi) Mechanical equipment xii) Fire prevention xiii) Hazardous chemicals and solvent xiv) Lighting xv) Abrasive blasting
15	Work permit system
16	List of standard job specific PPEs to be used in the site
17	Maintenance of regime for construction equipment and machinery
18	Traffic management
19	Housekeeping
20	i) Environmental and Social Management ii) Applicable National and State legislation and regulations iii) Specific procedures for achieving environmental and social performance requirements as given in the Employer's requirements on Environment. iv) Details on air monitoring and noise monitoring control plan which details mitigation measures / corrective action / preventive action and monitoring schedule. v) The ESHS Management Plan must contain procedures on prevention and control of water pollution, storage, handling and disposal of waste, including municipal, C&D, plastic, bio-medical, chemical and hazardous wastes, reuse/recycle of waste, selling to authorised recyclers and records thereof, preservation of landscape disturbed due to construction, housekeeping/Environmental sanitation and traffic management as required under the contract. vi) Procedures for recording environmental complaints and response process. vii) HIV prevention and control plan viii) Gender Based Violence (GBV) and sexual Exploitation and Abuse (SEA) prevention and response plan ix) COVID-19 Response and management plan
21	Visitors and security arrangement
22	Disciplinary Procedures
23	Safety and Health promotion and awareness;
24	Safety and Health equipment and Safety and Health of the Contractor's construction and office equipment;

Note: -The Environment, Social, Health and Safety (ESHS) Management Plan shall beincorporated in

the relevant sections.

3.0 Training

3.1 The Contractor shall describe the training program and content he will provide for workers and staff to:

a) Raise awareness of the role and importance of Environment, Social, Health and Safety matters; the potential negative impacts of construction work in general and the ways in which impacts can be prevented; and the expected constructionimpacts and long-term environmental and social benefits of the applicable project;

b) Disseminate the philosophy and approach of the ESHS Management Planthroughout the workforce, and explain the roles of all parties in implementing the ESHS Management Plan; and

c) Inform all employees of the Environment, Social, Health and Safety activitiesthey are required to comply with when conducting their work, and the penaltiesfor non-compliance.

3.2 Training to raise the awareness and capacity of the Subcontractors and their employees shall also be incorporated where necessary.

3.3 The Contractor shall prepare the following plans to supplement the ESHS Management Plan:

a) Emergency Response Plan; and

b) Fire Evacuation Plan.

Attachment -2 Workplace Policy (on HIV/AIDS Prevention & Control)

Haryana Rail Infrastructure Development Corporation Limited (HRIDC) recognizes HIV/AIDS as a developmental challenge and realizes the need to respond to it by implementing regular HIV/AIDS prevention programmes and creating a non- discriminatory work environment for HIV infected workmen engaged by Contractors. For the purpose of making conscientious, sensitive and compassionate decision in addressing the realities of HIV/AIDS, HRIDC has established these guidelines based on ILO code of practice on HIV/AIDS.

- Creating awareness through professional agency using IEC (Information, Education and Communication) package specially designed for migrant workers.
- Institutional capacity building by training the project implementation team, Environmental, Social, Health & Safety (ESHS) Managers, establishing linkages for deficient diagnosis and treatment of the affected workers, effective monitoring of implementation and documentation for further learning.
- Establishing peer educators by selecting them in consultation with Contractors and training them through professional agencies so that they become focal point for any information, education and awareness campaigns among the workmen throughout the contract period.
- Promotion of social marketing of condom

Attachment -3 Work Place Policy on COVID-19 Prevention and Control

It is likely that Corona virus Disease 2019 (COVID-19) will continue to occur in the community in the foreseeable future. It is therefore necessary to have a plan/policy in place to prevent the spread of this virus within the workplace. In order to reduce the risk of infection, Haryana Rail Infrastructure Development Corporation Limited (HRIDC) recommends to the Contractor to consider the following measures:

a) The Contractor shall ensure that the latest guidelines issued by Ministry of Health and Family Welfare (MoHFW), local government and the district administration are strictly followed at the construction works site.

b) On day 0, before resuming the work on sites post lockdown period, mandatory medical check-up will be arranged for all workers.

c) The workers coming from outside shall observe home-quarantine for at least 14 days as per the guidelines issued by MoHFW.

d) Only medically fit workers will be deployed at site and medical assistance will be arranged for unfit workers.

e) A unique photo identity card with serial number will be issued to all the workers and their family members staying at site.

f) All the essential items will be made available to them at site only. If necessary, they can go out wearing face masks, after informing the supervisor.

g) No outside worker will be allowed to stay at site without following proper procedure and instructions.

h) Start time on site will be staggered to avoid congestion at the entry gates.

i) As in most cases, workers reside at the Sites, hence no travel arrangements are required for them.

j) The workers staying outside (which are always nearby) shall reach the site either by walking or by their individual mode of transport (bicycle, two-wheeler etc.).

k) During attendance, training and other sessions, social distancing guidelines will be followed along with provision of no-touch attendance.

l) All workers may be advised to take care of their own health and look out for respiratory symptoms/fever and, if feeling unwell, shall leave the workplace immediately after informing their reporting officers.

m) They shall observe home-quarantine as per the guidelines issued by MoHFW and shall immediately inform the nearest health centre or call 011-23978046.

n) Workers shall not shake hands when greeting others and while working on the site.

o) Mandatorily wear face masks while working on site. While not wearing masks, cover your mouth and nose with tissues if you cough/sneeze or do so in the crook of your arm at your elbow.

p) Avoid large gatherings or meetings. Maintain at least 1 metre (3 feet) distance from persons, especially with those having flu-like symptoms, during interaction.

q) Not more than 2/4 persons (depending on size) shall be allowed to travel in lifts or hoists.

r) Use of the staircase for climbing shall be encouraged.

s) Workers shall clean hands frequently by washing them with soap and water for at least 40 seconds.

t) Workers shall not share their belongings like food, water bottles, utensils, mobile phones

etc. with others.

u) The utensils shall be washed properly post use at designated places.

v) Post work, workers shall change their clothes before leaving the site and clothing shall not be shook out.

w) Avoid touching your eyes, nose, or mouth with unwashed hands.

Attachment -4 Reference for ESHS Activities

General Instruction: ESHS/GI/001

Minimum Requirements of ESHS Monitoring and Audio-Visual Equipment's

a) Every Contractor shall provide the following audio-visual aids for conducting weekly review, monthly safety committee and other post review meeting of all fatal and major incidences effectively. This audio-visual equipment is a must for conducting periodical in-house safety presentations in the training programs; and

b) In addition to the above, portable hand held Type I or Type II digital sound level meter (SLM) and portable hand held digital Lux meter are also to be provided.

c) The minimum requirement of the quantity to be provided in ESHS management Plan and approved by the Engineer.

Sl. No	ESHS Monitoring and Audio-Visual Equipment details
1.	Portable hand-held Type I or Type II Digital Sound Level Meter (SLM)
2.	Portable hand-held Digital Lux Meter
3.	Laptop computer with standard configuration including multimedia facilities
4.	Colour printer
5.	Computer projector with screen
6.	Overhead projector
7.	Smartphone for taking photos and recording of video
8.	Portable loudspeaker (for tool-box talk and emergency purpose)
9.	Communication facility like mobile phone, walky-talky etc.
10.	Accident investigation Kit containing the following:
a)	Chalk piece for marking
b)	Measuring tape for measuring Flexible tape – 2m length Metal Foot long scale and Metal tape – 30m
c)	Equipment tags
d)	Multipurpose Flash light
e)	Barrier tape
f)	Accident investigation Forms and checklists
g)	Enough Paper for witness recording and other noting
h)	Emergency Phone Numbers list

General Instruction: ESHS/GI/002

Topics for ESHS Orientation Trainings for Workmen for First Day at Work

1) **Hazard Identification Procedure**

Hazards on site:

- Falls;
- Earthing work;
- Electricity;
- Machinery;
- Handling materials;
- Transport;
- Site housekeeping;
- Fire;
- Safety of nearby located structures;
- Works close to railway tracks or roads.

2) **Personal Protective Equipment**

- What is available?
- How to obtain it?
- Correct use and care.

3) **Health**

- Site welfare facilities;
- Potential health hazards;
- First Aid/Cardiopulmonary Resuscitation (CPR). /Automated External defibrillator(AED)

4) **Duties of the Contractor**

- Brief outline of the responsibilities of the Contractor by law;
- Details of the Contractor's accident prevention policy;
- The Employer SHE Management Manual (if any);
- Building and other Constructions Welfare Law.

5) **Employee's Duties**

- Brief outline of responsibilities of employee under law
- Explanation of how new employees fit into the Contractor's plan for accident prevention (induction and orientation).

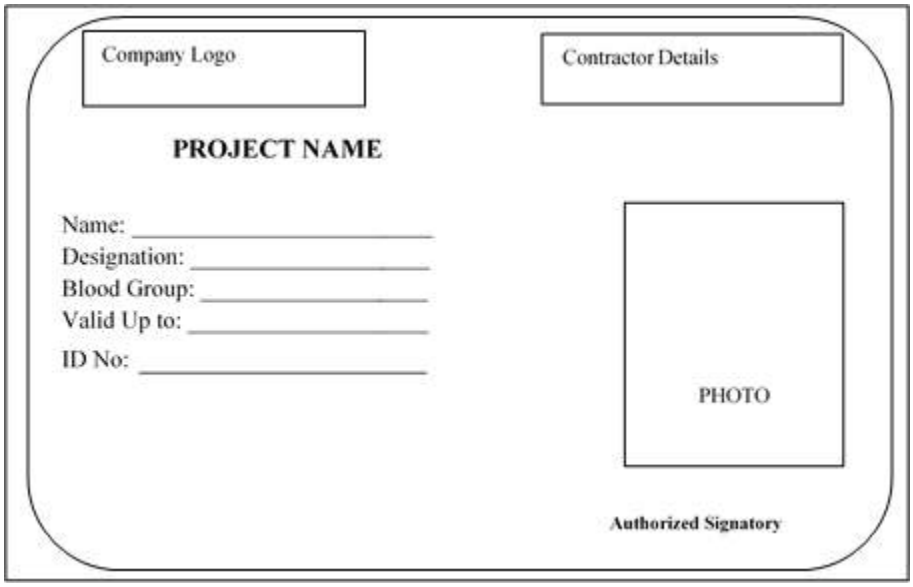
6) **Environment And Social**

- Contractor's Environment Policy
- Key legal requirements
- Avoidance of Nuisance
- Environmental Sanitation

- Dust Control Measures
- Water Pollution and Control
- Occupational noise mitigation
- Waste Management and Disposal
- Gender Based Violence and Sexual Exploitation and abuse (GBV/SEA)
- HIV/AIDS prevention
- Grievance Redressal Mechanism for GBV/SEA

General Instruction: ESHS/GI/003

ID CARD FORMAT (85 mm x 55mm) FRONT SIDE OF ID CARD:



General Instruction: ESHS/GI/004 [ESHS Training Matrix]

ESHS Supervisors	ESHS Manager	Medical Officer	Clerical Staff	Security Officers	Transportation Drivers	Electrical workers	Mechanical Workers	Steel Workers	Station Building Workers	Material Handlers	Machinery Operators	Construction Foreman	Construction Supervisors	Construction Managers	Planning Engineer	Quality Manager	Sr. Construction Managers	Contractor Representative	Types of Training
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	ESHS orientation
		*												*	*	*	*	*	ESHS leadership
*	*	*										*	*	*	*	*	*	*	ESHS plan
*	*												*	*		*	*	*	ESHS improvement plan
*	*												*	*	*	*	*	*	Management of change
*	*												*	*	*		*	*	ESHS audit and inspection
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	ESHS emergency response & preparedness
*	*	*		*									*	*	*	*	*	*	Incident/Accident investigation & reporting
*	*											*	*	*	*	*	*	*	ESHS communication
*	*													*	*		*	*	ESHS promotion & incentives
*	*			*	*						*		*	*		*	*	*	Traffic management
*	*			*						*		*	*	*	*	*	*	*	Hazard identification & risk analysis & Aspect Impact
*	*			*				*	*	*		*	*	*		*	*	*	Permit to work system
*	*													*	*	*	*	*	Confined space entry
*	*	*		*				*	*	*				*		*	*	*	Scaffolding
*	*	*	*	*	*	*	*	*	*		*		*	*		*	*	*	Waste management
*	*											*	*	*			*	*	Environment monitoring
*	*	*										*	*	*		*	*	*	Labour welfare measures
*	*											*	*	*		*	*	*	Behavior Based Safety Management (BBSM)
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	Industrial First Aid and CPR
*	*		*	*	*	*	*	*	*	*	*	*	*						Fire fighting
*	*					*	*	*		*	*	*	*	*			*		Rigging
*	*											*	*	*					Wire rope inspection
*	*											*	*	*					Crane inspection
*	*											*	*	*					Electrical/Mechanical isolation
*	*											*	*						Explosive handling and control
*	*					*	*	*	*			*	*						Heavy lifting operation
*	*							*				*	*						Welding, cutting and bracing
*	*								*			*	*						Power actuated hand tool
*	*					*	*	*	*			*	*						Roofing work
*	*							*				*	*						Steelerection work
*	*					*	*	*	*			*	*						Scaffold erection/dismantling

General Instruction: ESHS/GI/005

ESHS Training Details for Managers and Supervisors

1. The Law and Safety	**2. Policy and Administration**
Statutory requirement Appropriate regulations Duties of employee	Effect of incentive on accident prevention ESHS Policy Industrial relations Safety Officer: duties, aims, objectives
3. Safety and the Supervisor	**4. Principles of Accident Prevention**
Safety and efficient production Accidents affect morale and public relations	Attitudes of management, supervision and operations Methods of achieving safe operations Accident and injury causes
5. Site Inspection	**6. Human Behaviour**
The role of management Hazard Identification Procedure Records results Follow-up procedures Feedback	Motivating agencies Individual behaviour Environmental effects Techniques of persuasion
7. Site housekeeping	**8. Health**
Site organization Relationship of site housekeeping to accident occurrence Site access Equipment storage Material stacking Materials handling	Medical examination Hazard to health on site Sanitation and welfare Protective clothing First Aid/CPR
9. Personal Protective Equipment	**10. Electricity**
Eye, face, hands, feet and legs Respiratory protective equipment Protection against ionizing radiation	Appreciation of electrical hazards Power tools Arc welding Low voltage system Lighting and power system on sites ELCB, RRCB, Grounding/Ground fault circuit interrupters (GFCIs)
11. Oxygen and Acetylene Equipment	**12. Equipment**

Cylinder storage and maintenance Condition and maintenance of valves, regulators, and gauges Condition and maintenance of hoses and fittings Pressures	Accidents related to moving parts of machinery Appreciation of principles of guarding Importance of regular maintenance
13. Transportation Transport to and from site Hazard connected with site transport Competent drivers Dumpers Tipping trucks Movement near excavations	**14. Excavations** Method of shoring Precautions while shoring Precautions at edge of excavations Removal of shoring Sheet steel piling
15. Working platforms, Ladders, and Scaffolding	**16. Cranes and other Lifting Machines**
Hazards connected with the use of ladders Maintenance and inspection Type of scaffold Overloading Work on roofs Fragile material Openings in walls and floors Use of Full Body Harness and nets	Licensing, certification and training required for operation of cranes Slinging Methods Signalling Access to crane(s) Maintenance and examination Ground conditions Hazards and accident prevention methods connected with the use of different types of cranes/heavy equipment Crane Lift Plan for all lifts
17. Lifting Tackle	**18. Fire Prevention and Control**
Slings - single and multi-legged Safe working loads (SWLs) Safety hooks and eyebolts Cause of failure Maintenance and examination	Principle causes determining fire Understanding fire chemistry Firefighting equipment Firefighting training
19. Communications	
Effective methods of communication (interest to non-English speaking workers) Method and preparation of reports Safety committees Safety meeting	

20. **Environment and Social**

Environment Policy

Regulatory requirements

- Central
- State
- Judicial
- Environmental requirements of funding agency

Overview of Environmental issues at construction sites and funding agency's requirements.

Avoidance of nuisance

Environmental sanitation

Dust control measures

Overview of impact of construction on Climate change

Contractual requirements to reduce construction related impacts

Monitoring of environmental parameters and their significance

Waste Management

Occupational Noise and its mitigation

Health impacts of construction industry

Resource minimization

ISO requirement (as applicable)

Gender Based Violence and Sexual Exploitation and abuse (GBV/SEA)

HIV/AIDS prevention

Grievance Redressal Mechanism for GBV/SEA

General Instruction: ESHS/GI/006

WEEK/DAYS TO BE OBSERVED FOR CREATING ESHS AWARENESS

1st Monday to Sunday of January	Road Safety Week (Subjected to confirmation from Ministry of Road Transport, Govt. of India every year.)
16th February	Kyoto Protocol Day
March	Red Cross Month
4th March	National Safety Day
22ndMarch	World Water Day
7th April	World Health Day
14th April	Fire Safety Day
18th to 22nd April	Earth Week
20th April	Earth Day
20th April	Noise Awareness Day
28th April	ILO World Day for Safety and Health at Work Day
1st to 7th May	Emergency Preparedness Week
5th June	World Environmental Day
12th June	World Day against Child Labours
21st June	World Yoga Day
9th July	Occupational Health Day
17th October	World Trauma Day
1st December	World AIDS Day

General Instruction: ESHS/GI/007

Minimum Requirements of ESHS Communication Posters/Signage/Video:

a) Every Contractor shall prepare a ESHS Communication Plan as a part of site specific ESHS Management Plan and shall include the following minimum requirement of Posters/Signage/Video as applicable. In case readymade posters are available in any of the category from National Safety Council or any other safety related organizations they may procure the same and display it. In case the same is not available, then the Contractors shall make necessary arrangements to get the posters designed and printed on their own. All posters shall each be in Hindi, English and the regional language; and

b) All the above is to be detailed in the Contractor's ESHS Management Plan and he shall obtain the Engineer's prior consent for the numbers, contents, locations, etc.

Table No.: 1 - Minimum No. of Posters

Sl. No	ESHS Poster Title	Minimum No. of concepts in each title	No. of Posters/Signage/Video
1.	Safety Culture	5	Each 10
2.	Daily Safety Oath	1English, 1 Hindi	Each 50
3. a)	Signage to display the messages like PPE ZONE, NO PPE ZONE, HARD HAT AREA etc.	2 types of sizes made up of metal sheet to be mounted at different locations	Each 25
b)	Helmet	5	Each 25
c)	Shoe	5	Each 25
d)	Goggles & Ear Protection	5	Each 25
e)	Full Body Harness	5	Each 25
f)	Hi-Vi Jacket	5	Each 25
4.	Emergency Management Plan	5	Each 25
5.	Working at Heights	10	Each 25
a)	Ladder, Stairway, Scaffold - Signage to display the messages like SAFE, UNSAFE, FIT FOR USE,	5 types of sizes made up of metal sheet to be mounted at different locations	Each 25

Sl. No	ESHS Poster Title	Minimum No. of concepts in each title	No. of Posters/Signage/Video
	AVOID USE etc.		

6.	Site Electricity	5	Each 25
7.	Crane Safety	5	Each 25
8.	Slings	5	Each 25
9.	Rigging Procedures	5	Each 25
10.	Excavation	5	Each 25
11.	Occupational Health (Mosquito Control, HIV/AIDS awareness, Dust Control, Noise Control, No Smoking/Spitting, etc.)	10	Each 25
12.	First – Aid	3	Each 25
13.	Labour Welfare Measures (Payment of Minimum Wages, Avoidance of Child labour, signing in the Muster Roll, in case of accidents- what to do? Etc.	5	Each 25
14.	Importance of "Safety Handbook"	1	25
15.	Traffic Safety (Speed limit, safe crossing and working within barricaded area etc.)	5	Each 25
16.	Environmental Monitoring (Spillage of Muck, hazardous material, Improper drainage, water spray for dust containment etc.)	5	Each 25
17.	Video in Hindi on PPE usage – 15 minutes duration	1	-

Note 1: Items mentioned under 17 is video. Items under 3 (a) and 5 (a) are metal signage boards and all other items are posters.

Note 2: The above minimum numbers are for guidance only. The actual number will depend on the project's specific requirements. The Contractor shall propose and obtain Engineer's prior consent to the final numbers, locations, etc.

Table No.: 2 – Size of Posters/Signage

Sl. No	Item	Size
1.	Posters – Standard	17"x22" –135 GSM 4 Colour Printing

2.	Posters – Special (Wherever required)	17"x22" card laminated FA Poster
3.	Posters - Mega size (Wherever required)	32"x40" Flex FA Poster
4.	First-Aid Booklet	6"x4"
5.	Safety Handbook	6"x4"
6.	Signage	Small: 12"x6" Big: 24"x12"
7.	Road Traffic Sign Boards	Strictly as per Indian Road Congress (IRC) specifications

Table No.: 3 – Safety Signage Colour (as per IS: 9457)

Sl. No	Type of signage	Colour
1	Mandatory	Blue
2	Danger	Yellow
3	Prohibitory	Red
4	Safe conditions	Green

General Instruction: ESHS/GI/008

Environment, Social Formats/Checklist

1. Weekly Environmental Inspection Summary

1.0 Major issues of non-conformity in the past week are:

	Issue	Reason
I.	Air (Specify)	
II.	Water (Specify)	
III.	Noise (Specify)	
IV.	Water (Specify)	
V.	Storage (Specify)	
VI.	Housekeeping (Specify)	
VII.	Roads (Specify)	

2.0 Over the last week have been able to implement environmental management requirement as per contract

Yes ☐ ☐ No if not yes reasons are:

(i)

(ii)

(iii)

3.0 Following issues have not been resolved for more than past two weeks

(i)

(ii)

(iii)

4.0 Support/Clarification from Employer's Representative required in the following:

(i)

(ii)

(iii)

5.0 Complaint received in the past week:

From	Action Taken	Reasons for Delay
(i) Public		
(ii) Client		
(iii)Statutory Agency		

Auditor: Project Manager

Contact Number: Contractor:

Environmental Manager	**Project Manager**	**Document No.:**

2. Weekly Environmental Inspection

Report No.:	Inspection Date:	Inspected by:
Inspection Area:		
Participants:		

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
1.0	**Air Pollution**				
1.1	Dust (approach roads, adjacent road, working area, cement handling etc.)	☐ Satisfactory ☐ Site Dusty ☐ Sprinkling carried out as required ☐ Excavated soil removed within 2 days			
1.2	Generators	☐ Satisfactory ☐ Maintenance regime followed ☐ Black smoke ☐ Leaking oil ☐ Drip pans not available			
1.3	Vehicles	☐ Satisfactory ☐ PUC certificate available ☐ Black smoke ☐ Wheel washed/cleaned ☐ Leaking oil ☐ Side of vehicle clean of mud ☐ Material transported in closed manner			
1.4	Air monitoring	☐ Carried out as per contract ☐ Results reported as per contract			

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
		☐ Remedial measures in place where required			
2.0	**Water Pollution**				
2.1	Site Drains	☐ Drainage system functional ☐ No Contamination ☐ Not blocked by debris/ garbage ☐ No indications of Oil spilled in drains ☐ Storage of chemical waste not nearby			
2.2	Adjacent Drains	☐ Not damaged ☐ No signs of pouring bentonite ☐ No signs of pouring Chemicals ☐ Signs of discharging Silt/ debris			
2.3	Separator Tanks	☐ Tank not full of silt ☐ Tank regularly emptied			
3.0	**NOISE POLLUTION**				
3.1	Noise control measures	☐ All powered mechanical equipment's are sound reduced ☐ Acoustic / enclosures constructed in areas of excessive noise ☐ Equipment located and directed away from noise receptors			
3.2	Generators provided with acoustic enclosures	☐ Effective ☐ Not effective ☐ Not provide			
3.3	Noise Monitoring	☐ Carried out as per contract ☐ Not exceeded baseline values ☐ Remedial measures in place ☐ Results evaluated statistically for inclusion in Monthly report			

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
4.0	**WASTE MANAGEMENT**				
4.1	Waste Identified	□ Chemical Flammable Corrosive Construction related/ oil/ Filters/ Batteries □ Hazardous □ Other (Specify)			
4.2	Storage Containers & Bins	□ Adequate number and properly place □ Proper quality □ Emptied regularly □ Labelling proper □ No spillage on container □ surface noticed			
4.3	Storage Containers & Bins	□ Pollutants (e.g. waste chemical), not dumped in bins □ Recyclable (e.g. metal) not dumped in garbage bins			
4.4	Oil Waste	□ Drip pans available □ No oil stains on ground □ Spill absorption material available □ Waste oil poured in to designated waste drums □ Used oil filters not dumped in garbage bins			
4.5	Excavated soil	□ Storage satisfactory/ properly secured □ Dumping in authorized areas □ No interference with nearby drainage			
5.0	**STORAGE**				
5.1	Diesel Storage	□ Extensive diesel spillage on ground not visible □ Drip pans used when pumping diesel □ Pipes / connectors/ pumps not leaking			

S.No.	Item	Observation	Remarks	Action	
				By Date	**By Whom**
		☐ Not located close to storm water drains ☐ Transfer arrangement satisfactory			
6.0	**AESTHETICS & CLEANLINESS**				
6.1	Housekeeping & Hygiene	☐ Designated storage area for materials ☐ Scraps/brickbats/rubbish scattered at site ☐ Proper space for handling waste ☐ Area Clean and dry ☐ Stagnant water treated weekly ☐ Proper stacking of drums ☐ Barricades are clean, in line, firmly secured and proper earthling ☐ Water not allowed to accumulate in work area for any reason			
7.0	**Roads**				
7.1	Access Roads	☐ Satisfactory Maintenance ☐ In urgent need of Maintenance			
7.2	Public Roads used by Contractor	☐ Satisfactory maintenance ☐ Repair not carried out			

3. Air and Noise Monitoring Report Format

Air Monitoring Report

Parameter:
Unit :

CPCB Standard Value:

Location	Monitoring Date	Measured Value	Base line value if any

Noise Monitoring Report
Day Time

Location	Category of Area/Zone	National Standard (Day time) Leq dB(A)	Baseline value (Day time), Leq dB(A)	Noise levels (Day time) Leq dB(A)

Night Time

Location	Category of Area/Zone	National Standard (Night time) Leq dB(A)	Baseline value (Night time), Leq dB(A)	Noise levels (Night time) Leq dB(A)

4. Monthly Waste Management Record

S.No	Waste Type	Unit	Quantity Generated		Quantity Disposed off		Adopted/Proposed disposal method
			For the month	Till date	For the month	Till date	
1	**Construction and Demolition Waste**						
	a. Concrete waste	MT					
	b.Demolition Waste	MT					
	c. Bentonite/Polymer mixed soil	CUM					
	d. Good earth	CUM					
2	**Hazardous Waste**						
	a. Waste oil	Litres					
	b. Oil filters	Nos					
	c. Air filters,	Nos					
	d. Cartridges etc.	Nos					
	e. Other (if any)						
3	**Recyclable waste**						
	Paper, plastic, wood, bottles, rubber etc.	Kg					
4	**Bio-degradable waste**						
	Food waste, vegetable waste etc	Kg					
5	**Metal Scrap**	Ton					
6	**E -Waste**	Nos/ Ton					
7	**Miscellaneous (any other)**						

Prepared by:	**Reviewed by: (Environment Manager)**	**Approved by: (Project Manager)**

5. Water Consumption Details

S. No	Source of Water	Quantity Consumed for the month (KL)	Quantity Consumed till date (KL)
1	Ground Water Extracted		
2	Municipal Supply		
3	Water Tanker		
4	Water bottles		
Total (A)			
Breakup of Raw Water Consumption Detail			
S. No.	**Particular**	**Quantity Consumed for the month (KL)**	**Quantity Consumed till date (KL)**
1	**Raw Water**		
	a. Consumed in RO Plant		
	b. Sprinkling		
	c. Wheel washing		
	d. Domestic purpose like drinking, toilets, labour camps, office cleaning		
	e. Curing		
	f. Stone cutting		
	g. TM washing		
	h. Any other use		
	Total (B)		
2	**R O treated water**		
	Total (C)		
3	**R O Reject Water**		
	Total (D)		

Prepared by: **Reviewed by:** **Approved by:**
Environment Manager **Project Manager**

6. Details on Fly Ash (If Applicable)

The Employer shall give his consent to the civil Contractor for using Fly Ash in concrete or brick works. The Contractor shall record all relevant details on the consumption of Fly Ash from the data of initial consumption to date of final use.

Fly Ash utilization in tonnes in Building Materials and Products for the FY-
Contract No. :
Name of Contractor :
Details regarding utilization of fly ash in road/flyover construction projects:

S. No.	Item of work	Total quantity of material used (tonnes)	Quantity of Fly ash used (tones)	Quantity of Soil/Earth any other material used (tones)	% fly ash used against total quantity of material used	Source of fly ash
Remarks:						

Prepared by: **Reviewed by:** **Approved by:**
Environment Manager **Project Manager**

7. Material Consumption Details

S.No.	Particular	Unit	Quantity Consumed	
			For the month	Till date
1	Concrete	CUM		
2	Cement	MT		
3	Sand	MT		
4	Coarse Aggregate	MT		
5	Reinforcement	MT		
6	Admixtures	Litres		
7	Diesel	Litres		
8	Electricity	kWh		

Prepared by:	Checked by: (Environment Manager)

8. Records of Complaints

S.No	Nature of Complaints	Date of Complaints Received	Impact Location	Name of Complainant	Address of Complainant	Remarks	Status		
							Solved	On going	Pending

General Instruction: ESHS/GI/009

MARS Audit Rating

Contractor No.:	Contractor:	
Audit No.:	Date:	
For the month of:		
Audit team	Contractor representatives	HRIDC/GC Representatives
Headed by:		
Assisted by:		

Contract No.:		**Contractor:**	
For the month of:			
Audit date:			
Sl. No.	**Section**	**% score attained By Contractor**	**% Score given By HRIDC-GC**
1	ESHS Administration		
2	ESHS Training and ESHS Communication		
3	ESHS Inspection and Audit		
4	Hazard Identification, Risk Assessment and Emergency Preparedness		
5	Reporting of Accidents and Dangerous Occurrences and investigations		
6	Housekeeping		
7	Working at Height		
8	Lifting Operations and Gears		
9	Construction Machinery / Hand tools and power tools		
10	Site Electricity		
11	Fire prevention		
12	Welding & Cutting		
13	Excavations and Trenching		
14	Tunnelling and Confined Space operations		
15	Traffic management		
16	Personal Protective Equipment		
17	Industrial Health & Hygiene and Lighting & Ventilation		
18	Welfare amenities		
19	Environmental management		
20	Batching Plant and Casting Yard		
Overall audited score attained			

Team Head / Contractor Name:	**Designation**	**Signature**	**Date**
Team Head / HRIDC/GC Name:	**Designation**	**Signature**	**Date**

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

1.0 ESHS Administration

1.1 ESHS Organisation	A	B	C
Adequacy of ESHS personnel	10		
Is ESHS personal professionally qualified	10		
Employer's approval for each ESHS personal	10		
Intimation of ESHS personals vacancy to Employer	10		
ESHS personal lies with the main contractor	10		
Sub total	50		

1.1a ESHS Organisation	A	B	C
ESHS manpower from outsourcing agency	10		
ESHS personals reports to ESHS manager	10		
ESHS manager reports to Project Manager	10		
Facilities and equipment gave to the ESHS personnel	10		
ESHS personnel can stop any unsafe act	10		
Sub total	50		

1.2 ESHS Committee	A	B	C
Is site and construction ESHS Committee formed	10		
Does PM Chairman of ESHS Committee	10		
Committee members under gone monthly inspection	10		
Does site ESHS committee meet at least monthly with 21 days time gap	10		
Are Incident Reports discussed	10		
Sub total	50		

1.3 Construction ESHS Committee	A	B	C
Does construction ESHS committee meet at least weekly	10		
Do all sub contractors attend	10		
Is agenda cover all the points	10		
Minutes of the meeting send to all committee members	10		
Minutes displayed in the notice board	10		
Sub total	50		

1.4 ID card and first day at work	A	B	C
Is ID card issued to all persons	10		
Is ID card as per standard	10		
Authority signed all ID cards	10		
All worker undergone orientation training	10		
ESHS hand book issued to all personnel	10		
Sub total	50		

1.5 Designer's role	A	B	C
Whether designers were informed about clause 5.0 of Conditions of Contract on ESHS	10		
Whether designers provide ESHS risk at the drawing itself.	10		
Whether hierarchy of risk control is indicated by the designer	10		
Participation of designer in monthly SCM	10		
Detailed supplementary information about ESHS risk of the design given by designer.	10		
Sub total	50		

1.6 ESHS submittals to Employer	A	B	C
Daily reporting of workmen	10		
Monthly ESHS report	10		
ESHS committee meeting minutes	10		
ESHS inspection report	10		
Monthly internal ESHS audit score report	10		
Sub total	50		

1.6a ESHS submittals to Employer	A	B	C
External ESHS audit report	10		
Electrical safety audit report	10		
Air monitoring report	10		
Noise monitoring report	10		
Accident, Incident and dangerous occurrence reporting	10		
Sub total	50		

1.7 Visitors to site	A	B	C
Visitor got the permission from Employer	10		
Contractor have visitor PPEs	10		
Responsible accompanied with visitor	10		
Does visitor entering hazardous area	10		
Visitor register maintain at site office	10		
Sub total	50		

	A	B	C
Sub total			

Contractor's Observations:	Employer's Observations:

Section Scores	450			Section % Score	100		

A – Total score B – To be Awarded by contractor C – To be awarded by Employer

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
2.0 ESHS Training and ESHS Communication								
2.1 Training Policy	**A**	**B**	**C**	**2.2 Induction Training**	**A**	**B**	**C**
Is training policy in ESHS Plan	10			Does training take place in first week	10		
Is policy implemented	10			Induction Handout	10		
Does it includes sub contractors	10			Project related syllabus	10		
Is training policy published	10			Management participation	10		
Does PM understand training policy	10			Attendance records kept	10		
Sub total	**50**			**Sub total**	**50**		
2.3 Toolbox Talks	**A**	**B**	**C**	**2.4 Supervisor Training**	**A**	**B**	**C**
Are they held at least weekly	10			Is there a recognized programme	10		
Presented by supervisor/safety officer	10			Project related	10		
System monitored by management	10			Senior management participation	10		
Employee involvement	10			Achievement test	10		
Attendance records kept	10			Attendance records kept	10		
Sub total	**50**			**Sub total**	**50**		
2.5 Follow up training	**A**	**B**	**C**	**2.6 Driver/Plant Operator Training**	**A**	**B**	**C**
Is follow up training organized	10			Does Driver/PO training take place	10		
Does it take place after six months	10			Are all drivers undergone for defensive training at IDTR.	10		
Is syllabus project related	10			Are all Drivers and Operators certificated	10		
Attendance records kept	10			Are records kept	10		
Workers participation towards training	10			Are all Drivers Operators retained	10		
Sub total	**50**			**Sub total**	**50**		
2.7 Promotional activities	**A**	**B**	**C**	**2.8 ESHS posters**	**A**	**B**	**C**
Is there a safety promotional programme	10			Are posters adequate no's	10		
Are any incentive schemes used	10			Are posters separately numbered	10		
Are subcontractors included in promotion	10			Are posters cover all topics	10		
Had any worker rewarded so far.	10			Are safety posters visible on site	10		
Management's participation towards this	10			Are posters maintaining regularly	10		
Sub total	**50**			**Sub total**	**50**		
2.9 ESHS Signage	**A**	**B**	**C**	**2.10 Important days to be observed**	**A**	**B**	**C**
Is signage in correct colours	10						
Adequate number of signs	10						
Suitable positioning of signs	10						
Signs in Hindi and English	10						
Are signage maintaining regularly	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
3.0 ESHS Inspection and Audit							
3.1 Planned General Inspection	**A**	**B**	**C**	**3.2 Routine Inspection**	**A**	**B**	**C**
Monthly contractor and subcontractors' site ESHS committee inspection	10			Operator Daily Inspection of plant and equipment	10		
Weekly ESHS inspection by supervisors	10			Monthly Inspection of electrical hand tools	10		
Daily ESHS inspection by site ESHS team	10			Quarterly Inspection of temporary electrical systems	10		
Employer's and contractor's representative involved in this ESHS inspection	10			Weekly Inspection of scaffold by scaffolding supervisor	10		
Records maintenance	10			Half-yearly inspection of lifting appliances and gears by competent person	10		
Sub total	50			Sub total	50		
3.3 Specific Inspection	**A**	**B**	**C**	**3.4 ESHS Inspection**	**A**	**B**	**C**
Before a heavy lifting operation	10			Is Contractor prepare checklist for all activity	10		
Before & after entry into confined space	10			Checklist mentioned in contractor ESHS plan	10		
Before & after a welding & gas cutting	10			All inspection reports registered	10		
Before concreting formwork	10			Inspection reports sent to Employer	10		
All high-risk processes inspected by competent supervisor	10			Planned and Routine Inspection used for discussion in ESHS Committee Meeting	10		
Sub total	50			Sub total	50		
3.5 MARS	**A**	**B**	**C**	**3.6 Electrical safety audit**	**A**	**B**	**C**
Performed once in a month	10			Covered all areas	10		
Project Manager accompanied this audit	10			Performed once in a month	10		
Conducted at least 7 days prior to Monthly ESHS Committee meeting	10			Team comprising of senior ESHS (Elect) engineer	10		
Audit Report will be sent to Employer	10			Audit Report will be sent to Employer	10		
Corrective actions taken	10			Corrective actions taken	10		
Sub total	50			Sub total	50		
3.7 External Audit (General)	**A**	**B**	**C**	**3.8 External Audit**	**A**	**B**	**C**
Conducted by external agencies	10			Contents and coverage	10		
Auditors ISO qualified and competent	10			Available documents	10		
Approval of the Employer	10			Qualification of audit team members	10		
Audit report as per ISOMLO standard	10			Had checklist prepared	10		
Conducted on a quarterly basis	10			Status of NCR of edernal audit	10		
Sub total	50			Sub total	50		
3.9 Audit Report	**A**	**B**	**C**		**A**	**B**	**C**
Audit report as per ISOMLO standard	10						
Audit conformity / non-conformity report to the Employer	10						
Report contents and coverage	10						
Corrective action by contractors	10						
Initial audit for checking the adequacy of implementation	10						
Sub total	50			Sub total			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

A – Total score B – To be Awarded by contractor C – To be awarded by Employer

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
4.0 Hazard Identification, Risk Assessment and Emergency Preparedness								
4.1 Policy for Identifying Hazards	**A**	**B**	**C**	**4.2 Risk Assessment**	**A**	**B**	**C**
Procedure for identifying hazards	10			Are risk assessment carried out	10		
Is there a list of significant hazards	10			Is there a formal process	10		
Procedure for Risk Assessment	10			Are worksheets used	10		
Whether any schedule or hierarchy made	10			Are records kept in site office	10		
Ranking of hazards	10			Whether control measures are planned	10		
Sub total	**50**			**Sub total**	**50**		
4.3 Method Statements	**A**	**B**	**C**	**4.4 Permit to work in use**	**A**	**B**	**C**
Are Method Statements produced	10			Is there a procedure for Permits to work	10		
Dot hey contain clear instruction	10			Issued by Authorized person	10		
Are they given to work supervisors	10			Issued for defined period	10		
Is correct information given to workers	10			Workers instructed	10		
Step by step description of task	10			Are records kept of Permits issue	10		
Sub total	**50**			**Sub total**	**50**		
4.5 Emergency Preparedness Plan	**A**	**B**	**C**	**4.6 Emergency control centre**	**A**	**B**	**C**
Is there description within Safety Plan	10			Available of first-aid box	10		
Is it up to date	10			Public addressing system	10		
Is it well published	10			Emergency phone numbers	10		
Does Project Manager have copy	10			Emergency alarm	10		
Exercise within past three months	10			Employees name list	10		
Sub total	**50**			**Sub total**	**50**		
4.7 Communication system	**A**	**B**	**C**	**4.8 Plan Details**	**A**	**B**	**C**
Public addressing system	10			Details of emergency co-ordinator	10		
Emergency power supply	10			Designated personnel with Tel. Nos.	10		
Mobile phone in Emergency care centre	10			Are telephone numbers up to date	10		
Warning boards	10			Emergency response team identified	10		
Records maintained for usage and maintenance of communication systems	10			Functions of Team identified	10		
	50			**Sub total**	**50**		
4.9 Requirements	**A**	**B**	**C**	**4.10 First Aid**	**A**	**B**	**C**
Link to Police	10			Is First Aid included in Safety Plan	10		
Link to Fire Services	10			Are adequate no. of First aiders appointed	10		
Link to Ambulance and Hospital	10			Record keep of qualification	10		
Communication to employees	10			First aid boxes supplied	10		
Displayed on Notice Boards	10			First aid boxes properly equipped	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
5.0 Reporting of Accidents and Dangerous Occurrences and Accident Investigations							
5.1 Reporting to Employer	**A**	**B**	**C**	**5.2 Reporting to Govt. organisation**	**A**	**B**	**C**
Verbal information	10			Reporting to Regional Labour Commissioner	10		
Written information within 24 hrs	10			Reporting to welfare board	10		
Delay in reporting	10			Reporting to director general	10		
Are all accidents identified and recorded	10			Reporting to police station	10		
Are AFR rates calculated	10			Reporting to District Magistrate	10		
Sub total	50			**Sub total**	50		
5.3 Incident Reporting	**A**	**B**	**C**	**5.4 Follow up Action**	**A**	**B**	**C**
Is there a proper reporting procedure	10			Does Senior Manger review all reports	10		
Is the procedure communicated to all	10			Is result of investigation published	10		
Are reports available for inspection	10			Are workers advised of remedial action	10		
Do reports accurately describe incident	10			Are failure in Management recognized	10		
Is standardised form used	10			Whether statistics report prepared	10		
Sub total	50			**Sub total**	50		
5.5 Procedure for investigation	**A**	**B**	**C**	**5.6 Incident Investigation**	**A**	**B**	**C**
Made Photographs and sketches	10			Are witness statement taken	10		
Examine involved equipment	10			Is the chain of events identified	10		
Interviewed the eye-witnesses	10			Is specific sub contractor identified	10		
Consulted expert opinion	10			Investigation kit available	10		
Environmental conditions	10			Investigation report made available to Employer	10		
Sub total	50			**Sub total**	50		
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
Contractor's Observations:				Employer's Observations:			
Section Scores	300			**Section % Score**	100		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

6.0 Housekeeping

6.1 Procedure	A	B	C
Is it mentioned in ESHS plan	10		
Responsibility classified	10		
Housekeeping round the clock	10		
Reporting of housekeeping personals to ESHS Manager	10		
Housekeeping persons provided no. / badge	10		
Sub total	**50**		

6.2 Organisation	A	B	C
Adequacy of housekeeping personnel	10		
Is housekeeping personnel trained	10		
Employer's approval for housekeeping personnel	10		
Intimation of vacancy to Employer	10		
Persons provided with suitable logistics / aid	10		
Sub total	**50**		

6.3 Housekeeping squad	A	B	C
Housekeeping plan	10		
Member list	10		
Job allocation and time allocation	10		
Periodicity of housekeeping	10		
Documentation of housekeeping	10		
Sub total	**50**		

6.4 Barricades	A	B	C
Dimension of the board	10		
HRIDC logo	10		
Sequential Numbering	10		
Availability of protruding parts	10		
Regular cleaning and painting	10		
Sub total	**50**		

6.5 Access / Egress way	A	B	C
Free from debris	10		
Unprotected opening	10		
Free from obstructions	10		
Slippery condition	10		
Spillage of water or oil	10		
Sub total	**50**		

6.6 Dustbins	A	B	C
Lumbar with protruding nails	10		
Unprotected projection	10		
Scattered unused materials	10		
Spill of bentonite	10		
Fencing and guarding of equipments	10		
Sub total	**50**		

6.7 Housekeeping at worksites	A	B	C
Lumbar with protruding nails	10		
Unprotected projection	10		
Scattered unused materials	10		
Fencing and guarding of equipments	10		
Stacking and storing of materials	10		
Sub total	**50**		

6.8 Housekeeping at roads	A	B	C
Tyre cleaning of vehicles	10		
Parking of construction vehicles at road	10		
Water logging or bentonite spill on road	10		
Roads kept clean	10		
Position of barricades lying at roads	10		
Sub total	**50**		

6.9 Storage of cylinders	A	B	C
Full / empty separated	10		
Gases separated	10		
Protected from weather	10		
Contents labelled	10		
MSDS available for each gas	10		
Sub total	**50**		

	A	B	C
Sub total			

Contractor's Observations:	Employer's Observations:

Section Scores	450			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
7.0 Working at Height								
7.1 Organisation and planning	**A**	**B**	**C**	**7.2 Fragile surface**	**A**	**B**	**C**
Adequate number of trained personnel	10			Suitable working platform	10		
Supervision	10			Guard rails	10		
Planning emergency and rescue	10			Crawling boards	10		
Work permit system	10			Warning notice	10		
Refresher training	10			Work permit system to work	10		
Sub total	**50**			**Sub total**	**50**		
7.3a Scaffolding	**A**	**B**	**C**	**7.3b Scaffolding**	**A**	**B**	**C**
Is scaffolding included in ESHS Plan	10			Scaffolds constructed for correct use	10		
Are scaffolding erected and dismantled by competent workmen	10			Are scaffolds constructed of sound material without patent defect	10		
Are records kept of inspections	10			No unsuitable material	10		
Security fixed or buttressed	10			Working platforms fully boarded	10		
Working platforms free from rubbish	10			Guardrails and mid rails fitted	10		
Sub total	**50**			**Sub total**	**50**		
7.3c Scaffolding	**A**	**B**	**C**	**7.4a Ladders**	**A**	**B**	**C**
Secure ladder access provided	10			Are ladders specified in Safety Plan	10		
Toe board provided	10			Is there a system for checking ladders	10		
'Safe for Use' board erected	10			Are records kept of weekly checks	10		
Availability of base plate	10			Using of Bamboo ladders	10		
Free from rust / corrosion / debris	10			Painting of ladders	10		
Sub total	**50**			**Sub total**	**50**		
7.4b Ladders	**A**	**B**	**C**	**7.5 Guardrails**	**A**	**B**	**C**
Safety procedure followed	10			Present at all working platforms	10		
Rubber bush in aluminium ladder	10			Securely attached	10		
Landing properly	10			Sound material	10		
Climbing procedure	10			Designed as per standard	10		
Rungs at proper intervals	10			Maintained properly	10		
Sub total	**50**			**Sub total**	**50**		
7.6 Harnesses	**A**	**B**	**C**	**7.7 Safety net**	**A**	**B**	**C**
Is use of harnesses specified in ESHS Plan	10			Approved type	10		
Are harnesses of full body type	10			Good construction	10		
Are secure anchorage points used	10			Adequate number to issue	10		
Has instruction on correct use been given	10			Testing	10		
Maintenance and inspection	10			Maintenance	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
8.0 Lifting Operations and Gears								
8.1 Certification	**A**	**B**	**C**	**8.2 ASLI / Other Indicators**	**A**	**B**	**C**
Procedure is available in ESHS Plan	10			Free from damage	10		
Fitness / Test Certificates available	10			In operable conditions	10		
Daily inspection records maintained	10			Overload device tested	10		
Load chart for lifting appliances	10			Overload device operable	10		
Employer's approval for lifting appliances	10			Bypass key made available to I/C	10		
Sub total	**50**			**Sub total**	**50**		
8.3 Wire Ropes	**A**	**B**	**C**	**8.4 Safety Hooks**	**A**	**B**	**C**
Free from damage	10			Free from damage	10		
Lubricated	10			Safety latch fitted	10		
Correctly anchored	10			Safety latch in operable condition	10		
Splicing method	10			Other form of hook closure	10		
Inspection & Testing	10			Test certificates	10		
Sub total	**50**			**Sub total**	**50**		
8.5 Slings, Chains & Shackles	**A**	**B**	**C**	**8.6 Outriggers (Mobile Cranes)**	**A**	**B**	**C**
Properly stored when not in use	10			Outriggers locked in position	10		
In good condition without defects	10			Jacks in good condition	10		
Market with safe working load	10			Jacks firmly supported	10		
Bulldog clips correct fit/number	10			Wheels clear/not supporting load	10		
Correctly used	10			Chassis level	10		
Sub total	**50**			**Sub total**	**50**		
8.7 Operator and Operator cabin	**A**	**B**	**C**	**8.8 Rigging requirement**	**A**	**B**	**C**
Licence for HMV	10			Rigger qualification & experience	10		
Competent & skilled	10			Load assessment	10		
Medical fitness certificate	10			Type of slings to be used	10		
Portable fire extinguisher	10			Hocks & lifting assessment	10		
Defensive driving at IDTR	10			Overhead power line	10		
Sub total	**50**			**Sub total**	**50**		
8.9 Alarms & signals	**A**	**B**	**C**	**8.10 Accessories & controls**	**A**	**B**	**C**
Overload alarm	10			Side & rear view mirror	10		
Over hoist alarm	10			Clutch & brake	10		
Reverse horn	10			Swing & Extension control	10		
Pressure indicators	10			Illumination	10		
Outrigger extension alarm	10			Maintenance	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

9.0 Construction Machinery / Hand tools and power tools

9.1 Machinery Fencing	A	B	C
All moving parts effectively guarded	10		
Fencing not removed	10		
Is procedure in ESHS Plan	10		
Warning board	10		
Emergency stop switch	10		
Sub total	50		

9.2 Maintenance	A	B	C
All maintenance properly maintained	10		
No maintenance whilst M/c in motion	10		
Records of maintenance kept	10		
Work Permit System	10		
Use of 'Lock Out and Tag Out' (LOTO)	10		
Sub total	50		

9.3 Air Receivers	A	B	C
Fitted with pressure relief valve	10		
Annual test carried out	10		
All couplers with safety chains/wired	10		
Condition of hoses	10		
Noise level under permissible limit	10		
Sub total	50		

9.4 Wood working machines	A	B	C
Top guard fitted	10		
Working space	10		
Guards to protect all drive belts	10		
Emergency stop switch	10		
Push stick used	10		
Sub total	50		

9.5 Grinding machine	A	B	C
Appropriate guards fitted	10		
Correct size wheel/disc fitted	10		
Spindle speed marked on M/s	10		
Name plate for equipment specification	10		
Test and maintenance	10		
Sub total	50		

9.6 General	A	B	C
Is procedure in ESHS plan	10		
All operator medically fir and above 21 yrs	10		
Unauthorized riding on plant	10		
Inspection and maintenance record	10		
Portable fire extinguisher	10		
Sub total	50		

9.7 Safe Operating Procedure	A	B	C
Available for all machines	10		
Available in the working area	10		
Operator trained	10		
Operator know the same	10		
Updated regularly	10		
Sub total	50		

9.8 Requirements	A	B	C
Manufacturer specification	10		
Control switch	10		
GFCI / RCCB and other safety devices	10		
IP 44 plugs, sockets & connectors	10		
Guarding	10		
Sub total	50		

9.9 Maintenance and Inspection	A	B	C
Daily inspection	10		
Lubrication	10		
Pneumatic and hydraulic pressure	10		
Record maintenance	10		
Label displayed in the equipment itself.	10		
Sub total	50		

9.10 PPE	A	B	C
Ear protection	10		
Hand Protection	10		
Eye protection	10		
Apron	10		
Nose / face mask	10		
Sub total	50		

Contractor's Observations:	Employer's Observations:

Section Scores	500			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
10.0 Site Electricity								
10.1 Power assessment	**A**	**B**	**C**	**10.2 Distribution Panels**	**A**	**B**	**C**
Load calculation for power requirement	10			Panel secure box to IP 44	10		
Employer's approval for execution of the job	10			All cables enter box through glands	10		
Is small capacity diesel generator present	10			ELCB or RCCB/ GFCI fitted	10		
Noise from diesel generator	10			Proper earth connection and earth pit	10		
Sub-contractor's power requirement by main contractor	10			Warning signs in appropriate position	10		
Sub total	**50**			**Sub total**	**50**		
10.3 Cables	**A**	**B**	**C**	**10.4 Work on site**	**A**	**B**	**C**
All cables free from damage	10			Site electricity covered in the ESHS Plan	10		
Cables lying on the ground / water	10			Name posted on Main Distribution Board	10		
Cable joints made by IP 44 connectors	10			Single line & Schematic diagram submitted	10		
Correct storage when not in use	10			Employer's Approval for execution	10		
Colour coding	10			GFCI provided	10		
Sub total	**50**			**Sub total**	**50**		
10.5 Electrical professional	**A**	**B**	**C**	**10.6 Earth Pit**	**A**	**B**	**C**
Sufficient numbers	10			As per standard	10		
Professionally qualified	10			Wet condition	10		
Roles and responsibilities defined	10			Pouring 5 litre water per days	10		
Valid license to electrical persons	10			Earth pipe free from corrosion	10		
Training	10			Earth resistance	10		
Sub total	**50**			**Sub total**	**50**		
10.7 Plugs, Sockets and outlets	**A**	**B**	**C**	**10.8 Voltage / Current**	**A**	**B**	**C**
Are all plugs, sockets and outlets IP 44 type	10			Check voltage / current limit	10		
Colour coding of plugs and sockets	10			Rating clearly marked on all equipments	10		
All cables fitted with IP 44 Plugs	10			Monitored continuously	10		
All equipments connected with plugs	10			Mismatch of cable and equipments ratings	10		
All equipments free from defects	10			Properly earthed	10		
Sub total	**50**			**Sub total**	**50**		
10.9 Maintenance	**A**	**B**	**C**	**10.10 Correct Disc. / Revolutions**	**A**	**B**	**C**
Regular inspections carried out	10			Information plate on tool	10		
Records kept	10			Information on Disc/Cutter	10		
Suitable guards/security fenced	10			Compatibility between Tool and Disc	10		
Faults actioned	10			Operator trained/competent to fit Disc	10		
Record maintaining	10			Safety check on condition	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
11.0 Fire prevention								
11.1 Fire fighting personnel	**A**	**B**	**C**	**11.2 Requirements**	**A**	**B**	**C**
Adequacy of Fire fighting personnel	10			Emergency plan	10		
Professionally qualified	10			Fire excavation plan	10		
Employer's approval	10			Mock drill	10		
Intimation of vacancy to Employer	10			Nearest fire brigade phone numbers	10		
Adequate no of trained persons	10			Reporting of fire accident to Employer	10		
Sub total	**50**			**Sub total**	**50**		
11.3 Combustible material	**A**	**B**	**C**	**11.4 Fire Extinguisher**	**A**	**B**	**C**
Used in site	10			Adequate numbers	10		
Handling of combustible material	10			Appropriate type	10		
Stored in separate place	10			Easily accessible	10		
Spillage of materials	10			Frequency of recharge	10		
Location of burning site	10			Maintenance and inspection	10		
Sub total	**50**			**Sub total**	**50**		
11.5 Fir fighting equipments	**A**	**B**	**C**		**A**	**B**	**C**
Sufficient quantity of water supply	10						
Fire hose and nozzle	10						
Fire alarm	10						
Condition of fire hydrants	10						
Sufficient no. available	10						
Sub total	**50**						
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**250**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

	HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:							
12.0 Welding & Cutting								
12.1 Gas Welding / Cutting	**A**	**B**	**C**	**12.2 storage of cylinders**	**A**	**B**	**C**
Is procedure in ESHS Plan	10			Is procedure in ESHS Plan	10		
Are cylinders in cylinder-trolley	10			Storage in upright position	10		
Are pressure gauges fitted and operable	10			Full/empty segregated	10		
Are flashback arresters fitted	10			Different gases separated	10		
Are non return valves fitted	10			Contents labelled	10		
Sub total	50			**Sub total**	50		
12.3 Condition of cylinders	**A**	**B**	**C**	**12.4 Hose**	**A**	**B**	**C**
No damage by misuse	10			Colour coding	10		
No rust/corrosion	10			Hose clip and clamp	10		
Protected from weather	10			Is it free from leak and damage	10		
Colour coding proper	10			Hose lying on the ground	10		
MSDS available	10			Joints if any	10		
Sub total	50			**Sub total**	50		
12.5 Electric Arc Welding	**A**	**B**	**C**	**12.6 Transformer**	**A**	**B**	**C**
Are welding machines in good order	10			Presence of voltmeter and ammeter	10		
Welding leads free form defect	10			Separate main power switch	10		
Welding return free from defect	10			Ground connection	10		
Electrode holder properly insulated	10			Specification plate or board	10		
Dipping electrode in water when it is hot	10			Protected from weather	10		
Sub total	50			**Sub total**	50		
12.7 Electrical Cable	**A**	**B**	**C**	**12.8 Work Area**	**A**	**B**	**C**
Cable lying on ground / water	10			Area clear of flammable substances	10		
IP 44 cable connectors instead of insulation tape	10			Smoking inside the work area	10		
Damaged and exposed wires	10			Fire extinguisher fitted	10		
Separate earthing connection from work piece to transformer	10			Welding screens available	10		
Electrical protection devices ELCB, RCCB,etc	10			Ventilation and fume extraction	10		
Sub total	50				50		
12.9 PPE for welder, cutter and helper	**A**	**B**	**C**		**A**	**B**	**C**
Face and eye protection	10						
Gauntlet gloves	10						
Safety footwear	10						
Nose mask	10						
Ear muff / plug	10						
Sub total	50			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	450			**Section % Score**	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
13.0 Excavations and Trenching								
13.1 Planning	**A**	**B**	**C**	**13.2 Access/Egress**	**A**	**B**	**C**
Are excavations covered in ESHS Plan	10			Suitable ladders provided	10		
Examined by competent person	10			Ladders properly secured	10		
Records of inspection maintained	10			Alternative ladders available	10		
Underground cable and pipelines	10			Staircase for excavation more 1.5 m depth	10		
Backfilling and removal of trench	10			Guardrail for staircase.	10		
Sub total	**50**			**Sub total**	**50**		
13.3 Shoring	**A**	**B**	**C**	**13.4 Barriers and Warnings**	**A**	**B**	**C**
Shoring as soon as earth is removed	10			Rigid barrier around excavation	10		
Suitable support	10			Suitable warning notices	10		
Regular monitoring	10			Regularly checked by supervisor	10		
Proper repair under taken	10			Warning light & signs	10		
Material stacked properly on removal	10			Emergency exit board	10		
Sub total	**50**			**Sub total**	**50**		
13.5 Soil	**A**	**B**	**C**	**13.6 Underground Services**	**A**	**B**	**C**
Not closer than 1 metre	10			Checks made with Utility providers	10		
Properly stacked	10			Safe digging procedures in use	10		
Excavator clear of personnel	10			Supervision has service plans	10		
Storage of Excavated materials	10			Dewatering procedures	10		
Logistics for excavated soil	10			Line of dewatering	10		
Sub total	**50**			**Sub total**	**50**		
13.7 Undermining Nearby Structures	**A**	**B**	**C**	**13.8 Portable Electrical Equipment**	**A**	**B**	**C**
Survey carried out	10			Are as per standard	10		
Temporary support provided if required	10			Proper repair and condition	10		
Vibration measured	10			Rating voltage more than 24 V	10		
Regular monitoring	10			Double insulation	10		
Sufficient clearance provided	10			Open bare wires	10		
Sub total	**50**			**Sub total**	**50**		
13.9 Ventilation and Illumination	**A**	**B**	**C**	**13.10 Signals & Communication**	**A**	**B**	**C**
Are as per standard	10			Audio, Video signals	10		
Exhaust fan arrangement	10			Walkie-talkie / radio /mobile phones	10		
Temperature management	10			Head protection	10		
Gas monitoring systems	10			Arm protection	10		
Lighting arrangement	10			Leg protection	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
14.0 Tunnelling and Confined Space operations							
14.1 Procedure	**A**	**B**	**C**	**14.2 Equipments**	**A**	**B**	**C**
Procedure in ESHS Plan	10			Gas monitoring equipment	10		
Permit Work system in use	10			Rescue BA equipment	10		
Only properly trained operatives	10			Full body harness for each worker	10		
Existing underground cables and pipelines	10			Tripod and lifeline	10		
Refresher training	10			Resuscitation Equipment	10		
Sub total	**50**			**Sub total**	**50**		
14.3 Access and Egress	**A**	**B**	**C**	**14.4 Procedure**	**A**	**B**	**C**
Proper staircase and lift	10			Inform to Director General before 30 days	10		
Guardrail for staircase	10			Emergency power generator	10		
Staircase made of sound material	10			Watertight bulkhead doors at entrance	10		
Free from defects	10			Reflective jackets for workers	10		
Emergency exit	10			Dewatering procedures	10		
Sub total	**50**			**Sub total**	**50**		
14.5 Warning / Communication systems	**A**	**B**	**C**	**14.6 Electrical equipment**	**A**	**B**	**C**
Telephone / walkie-talkie	10			Flame proof electrical equipment	10		
Emergency Alarm	10			Portable tools more than 24 V	10		
Warning for Exit way and electrical panel boards	10			Double insulation / earthing condition of portable equipment	10		
High visibility waist	10			Transformer used in without compressed air	10		
Warning lights	10			Bare conductor or semi enclosed fuse	10		
Sub total	**50**			**Sub total**	**50**		
14.7 Illumination and Ventilation	**A**	**B**	**C**	**14.8 Compressed air**	**A**	**B**	**C**
Illumination / ventilation levels	10			Adequacy of air supply	10		
Air circulation	10			Emergency power supply	10		
Level of oxygen / other toxic gas	10			Flame proof equipment	10		
Temperature level (not more than 29° C)	10			Available in man-locks and medical-locks	10		
Emergency power supply for luminaries	10			Hoses free from damage	10		
Sub total	**50**			**Sub total**	**50**		
14.9 Fire Prevention	**A**	**B**	**C**	**14.10 Health and Welfare**	**A**	**B**	**C**
Adequate water supply	10			Man-lock and medical-lock	10		
Fire alarm	10			Drinking water	10		
Flammable materials inside work areas	10			Medical officer	10		
Water outlet points	10			First-aid room	10		
Inspection and maintenance	10			Shelter room	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
15.0 Traffic management								
15.1 Traffic marshals	**A**	**B**	**C**	**15.2 Vehicle operators**	**A**	**B**	**C**
Sufficient numbers	10			Driving licence	10		
Professionally qualified or trained	10			Medically fitness	10		
Medically fit	10			Defensive driving training	10		
Driving licence	10			Refresher training	10		
Familiar with traffic signs	10			Fire fighting training	10		
Sub total	**50**			**Sub total**	**50**		
15.3 Traffic control devices	**A**	**B**	**C**	**15.4 Barricades**	**A**	**B**	**C**
Cons	10			Erected around the construction site	10		
Drums	10			Free from defects and protruding parts	10		
Delineators	10			Numbered	10		
Traffic cylinders	10			Painted and maintained in good condition	10		
Traffic signs and barricades	10			Barricade register	10		
Sub total	**50**			**Sub total**	**50**		
15.5 Barricades	**A**	**B**	**C**	**15.6 Regulatory Signs**	**A**	**B**	**C**
Barricade inspector & supervisor appointed	10			Approval from police and traffic authorities	10		
Retro reflective strips shape and size	10			Warning signs	10		
Reflective strips placed at a angle at bottom	10			Red light / flag indicator	10		
Minimum gap between retro reflective strips 1000mm	10			Design as per employer's approval	10		
One red light / blinker per barricade	10			Material made of reflective type.	10		
Sub total	**50**			**Sub total**	**50**		
15.7a Vehicle	**A**	**B**	**C**	**15.7b Vehicle**	**A**	**B**	**C**
Vehicle number and company name	10			Brakes in good working order	10		
Inspection stickers & license plate	10			Are wiper blades in good condition	10		
Seat belts	10			Rear view mirrors	10		
Two reflective triangles on rear side	10			Speedometer	10		
Fog lights (front & rear)	10			Vehicle's horn and reverse alarm	10		
Sub total	**50**			**Sub total**	**50**		
15.8 Heavy motor vehicles	**A**	**B**	**C**	**15.9 Operator cabin**	**A**	**B**	**C**
Automatic safe load indicator	10			Made of fire resistance material	10		
Load chart of the vehicle	10			Protection from vibration	10		
Fitness certificate	10			Weather protection	10		
Manufacturer details	10			Adequate ventilation	10		
Marking of safe working load	10			Suitable fire extinguisher	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
16.0 Personal Protective Equipment								
16.1 Head Protection	**A**	**B**	**C**	**16.2 Foot Protection**	**A**	**B**	**C**
Use enforced	10			Use enforced	10		
As per standard	10			Suitable type	10		
In good condition	10			Toecaps effective	10		
Colour and company logo	10			Fair condition	10		
Available for issue	10			Available for issue	10		
Sub total	**50**			**Sub total**	**50**		
16.3 Eye protection	**A**	**B**	**C**	**16.4 Hearing Protection**	**A**	**B**	**C**
Use enforced	10			Use enforced	10		
As per standard	10			As per standard	10		
Suitable type	10			Suitable type	10		
Good condition	10			Available for issue	10		
Available for issue	10			Noise levels monitored	10		
Sub total	**50**			**Sub total**	**50**		
16.5 Respiratory Protection	**A**	**B**	**C**	**16.6 Protective Gloves**	**A**	**B**	**C**
Use enforced	10			Use enforced	10		
As per standard	10			As per standard	10		
Suitable type	10			Correct type for operation	10		
Good condition	10			Good condition	10		
Available for issue	10			Available for issue	10		
Sub total	**50**			**Sub total**	**50**		
16.7 High-Visible Waist	**A**	**B**	**C**	**16.8 Fall Protection**	**A**	**B**	**C**
Use enforced	10			Use enforced	10		
As per standard	10			As per standard	10		
In good condition	10			In good condition	10		
Warning signs displayed	10			Warning signs displayed	10		
Available for issue	10			Available for issue	10		
Sub total	**50**			**Sub total**	**50**		
16.9 PPE for visitors	**A**	**B**	**C**		**A**	**B**	**C**
Use enforced	10						
10% PPEs for visitors in site office	10						
In good condition	10						
Colour and company logo	10						
Available for issue	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
17.0 Industrial Health & Hygiene and Lighting & Ventilation								
17.1 Medical examination	**A**	**B**	**C**	**17.2 Occupational Health Centre**	**A**	**B**	**C**
All worker under gone	10			Construction medical officer & qualification	10		
Covered all testes as per standard	10			Availability nurse & sweeper	10		
Conducted by qualified person	10			Floor area minimum 15 m^2 with two rooms	10		
Confidential report for all workers	10			Adequate equipment	10		
Frequency of medical test maintained	10			Medical emergency equipments	10		
Sub total	**50**			**Sub total**	**50**		
17.3 First-aid	**A**	**B**	**C**	**17.4 Ambulance van and room**	**A**	**B**	**C**
Equipped with all items as per standard	10			Equipped with all items as per standard	10		
Sufficient numbers	10			Availability and numbers	10		
First-aid room facility	10			Maintained in good repair	10		
First-aider & his qualification	10			Equipped with standard facilities	10		
Register for first-aid	10			Record of all cases of accident & sickness	10		
Sub total	**50**			**Sub total**	**50**		
17.5 Mosquito breeding	**A**	**B**	**C**	**17.6 Alcohol and drugs & HIV / AIDS prevention**	**A**	**B**	**C**
Water retain on the site	10			Employee working under the influence of alcohol / drugs	10		
Periodic interval	10			Smoking at public worksites	10		
Still waters	10			Smoking at public worksites	10		
Posters	10			HIV / AIDS awareness training provided	10		
Usage of insecticides	10			Workers participation / co-operation	10		
Sub total	**50**			**Sub total**	**50**		
17.7 Noises	**A**	**B**	**C**	**17.8 Vibration**	**A**	**B**	**C**
Are procedures for noise evaluation in the Safety Plan	10			Monitoring method	10		
Are noise assessments carried out	10			Frequency of monitoring	10		
Are noise zones identified	10			Vibration limits	10		
Is correct PPE provided	10			Report maintenance	10		
Usage of PPE	10			Control plan	10		
Sub total	**50**			**Sub total**	**50**		
17.9 Radiation	**A**	**B**	**C**		**A**	**B**	**C**
Method statement	10						
Approval from Employer	10						
Use and storage of radioactive substance	10						
Disposal of radioactive substance	10						
Appropriate PPE	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
18.0 Welfare amenities							
18.1 Toilets / Urinals	**A**	**B**	**C**	**18.1a Toilets / Urinals**	**A**	**B**	**C**
Enough no available	10			Is it properly illuminated	10		
Separate for men and women	10			Is it having separate and ample water facility	10		
Access within 500m from worksite	10			Is it having proper drainage system	10		
Is it properly cleaned	10			Water leaking or spillage	10		
Is it washed regularly	10			Records kept and available	10		
Sub total	**50**			**Sub total**	**50**		
18.2 Drinking water	**A**	**B**	**C**	**18.3 Canteen**	**A**	**B**	**C**
Quantity is sufficient	10			Is canteen available	10		
Quality is good	10			Is it neat and clean	10		
Laboratory test done	10			Is the flooring dust free	10		
Access within 200m from worksite	10			Is the cost 'no loss and no gain' basis	10		
Is it 6m away from toilets and urinals	10			Lighting, ventilation and water facility	10		
Sub total	**50**			**Sub total**	**50**		
18.4 Labour Accommodation	**A**	**B**	**C**	**18.5 Creaches**	**A**	**B**	**C**
Cooking, bathing, washing and lavatory facilities	10			Is it free from mosquito and other biological agent	10		
Is it free from mosquito and biological agent	10			In-charge to keep the children.	10		
Is it properly illuminated and ventilated	10			Is it properly illuminated and ventilated	10		
Is it adequate for all	10			Is it adequate for all	10		
Is it neat, clean and hygiene	10			Is it neat, clean and hygiene	10		
Sub total	**50**			**Sub total**	**50**		
18.6 Shelter	**A**	**B**	**C**	**18.7 Illumination**	**A**	**B**	**C**
Adequate to all workers	10			Minimum illumination requirement	10		
Is it properly illuminated and ventilated	10			Minimum 50 lux at work place	10		
Is it neat, clean and hygiene	10			Minimum 30 lux on trolley tracks	10		
Is it free from mosquito and biological agent	10			Minimum 10 lux elsewhere	10		
Drinking water and Toilet facilities	10			Adequate Emergency lighting provided	10		
Sub total	**50**			**Sub total**	**50**		
18.8 Ventilation	**A**	**B**	**C**		**A**	**B**	**C**
Oxygen level less than 19.5	10						
Air circulation of $6m^3$/min for each building Worker employed underground	10						
Free air flow movement in work place	10						
Ventilation system in operation	10						
Maintenance records kept and available	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
19.0 Environmental management								
19.1 Air quality	**A**	**B**	**C**	**19.2 Water quality**	**A**	**B**	**C**
Monitoring by competent person	10			Monitoring by competent person	10		
Monitoring equipment as per standard	10			Monitoring equipment as per standard	10		
Monitoring method	10			Monitoring method	10		
Report to Employer	10			Report to Employer	10		
Control plan	10			Control plan	10		
Sub total	**50**			**Sub total**	**50**		
19.3 Noise monitoring	**A**	**B**	**C**	**19.4 Illumination monitoring**	**A**	**B**	**C**
Monitoring by competent person	10			Monitoring by competent person	10		
Monitoring equipment as per standard	10			Monitoring equipment as per standard	10		
Monitoring method	10			Monitoring method	10		
Report to Employer	10			Report to Employer	10		
Control plan	10			Control plan	10		
Sub total	**50**			**Sub total**	**50**		
19.5 Temperature monitoring	**A**	**B**	**C**	**19.6 Dust control**	**A**	**B**	**C**
Monitoring by competent person	10			Water sprinkler arrangement	10		
Monitoring equipment as per standard	10			Frequency water sprinkler inside the site	10		
Monitoring method	10			Dust screens	10		
Report to Employer	10			Dust level under permissible limit	10		
Control plan	10			Environmental monitoring	10		
Sub total	**50**			**Sub total**	**50**		
19.7 Waste Management	**A**	**B**	**C**	**19.8 Felling of Trees**	**A**	**B**	**C**
Dustbin in construction site	10			Approval from forest department	10		
Temporary dumping area	10			Trees used for anchorage.	10		
Separate dumping pit for disposable and non-disposable wastes	10			Trees exposed or injured by construction equipment	10		
Frequency of removal of waste	10			Protective barriers around tree	10		
Burning of waste	10						
Sub total	**50**			**Sub total**	**40**		
19.10 Energy Management	**A**	**B**	**C**		**A**	**B**	**C**
Uniform illumination	10						
Size and length of cable and wires	10						
Efficient luminaries	10						
Efficient motors and pumps	10						
Efficient air-conditions	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**440**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD..								
Contract No.:	Contractor's Name:							
20.0 Batching Plant and Casting Yard								
20.1 General	**A**	**B**	**C**	**20.2 Layout**	**A**	**B**	**C**
Is procedure in ESHS Plan	10			Plan of layout	10		
All operators medically fit/over 21	10			Drainage system	10		
No unauthorized riding on plant	10			Welfare amenities	10		
Daily inspections / recorded	10			Plan for vehicle moving area	10		
Equipped with all	10			Barrication	10		
Sub total	**50**			**Sub total**	**50**		
20.3 Material Handling & dust protection	**A**	**B**	**C**	**20.4 PPE**	**A**	**B**	**C**
Handling of cement bag	10			Hand protection	10		
Loading and unloading cement	10			Respiratory protection	10		
Handling of launching segments	10			Head protection	10		
Is dust level under permissible limit	10			Foot protection	10		
Environmental monitoring	10			Ear protection	10		
Sub total	**50**			**Sub total**	**50**		
20.5 Traffic management	**A**	**B**	**C**	**20.6 Welfare facilities**	**A**	**B**	**C**
Barricades	10			Toilet	10		
Warning boards	10			Drinking water	10		
Traffic marshals	10			Canteen	10		
Delineators	10			Shelter	10		
Lane warning	10			Labour accommodation	10		
Sub total	**50**			**Sub total**	**50**		
20.7 Fitness certificate	**A**	**B**	**C**		**A**	**B**	**C**
Crane	10						
Hydra and all equipment	10						
Ropes and chains	10						
Hooks and shackles	10						
Rigger & Operator	10						
Sub total	**50**			**Sub total**			
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**350**			**Section % Score**	**100**		

Attachment -5 Safe Work Procedure for Work Near Railway Track

1.0 Safety precautions and measures to be observed during execution of ROB/ RUB/ Viaduct/ any other works in Railway and adjoining areas:

1.1 The Contractor(s) shall not allow any road vehicle belonging to him or his suppliers, etc. to ply in HRIDC/railway land next to the running line. If for execution of certain works viz. earthwork for parallel railway line and supply of ballast for new or existing rail line gauge conversion, etc. road vehicles are necessary to be used in railway/HRIDC land next to the railway line, the Contractor(s) shall apply to the Engineer-in-Charge for permission giving the type and number of individual vehicles, names and license particulars of the drivers, location, duration and timings for such work/movement. The Engineer-in-Charge or his authorized representative will personally counsel, examine and certify the road vehicle drivers, Contractor(s)' flagmen and supervisors and will give written permission giving names of road vehicle drivers, Contractor(s)' flagmen and supervisors to be deployed on the work, location, period and timing of the work. This permission will be subject to be following obligatory conditions:

1.2 Construction Activities and Safety:

a) The 'Methodology of Working' shall be incorporated in GAD and Temporary Arrangement Drawings.

b) The activities of work to be taken up during the railway traffic block/under speedrestriction, etc. should be clearly mentioned in such drawings. If at any stage of execution, any discrepancy is found in the drawing with respect to the site condition affecting safety or some new activity of work is required to be done, the same should be brought to the notice of Railway & HRIDC Engineers and such works should be done only after approval by Railways & HRIDC representative. In such cases, scheme may be modified and, if required, fresh CRS sanction shall have to be obtained.

1.2.1 The works required to be done under traffic block protection, are to be carried out only in the presence of Railway & HRIDC Engineering Officials. The Railway's and HRIDC's Supervisor has to certify safe conditions for passage of trains before resumption of traffic. The works to be done under traffic shall be carried out under the provision of banner flag and protection by Engineering Flagman.

1.2.2 Following important activities of works shall be carried out under supervision of Railway/HRIDC Engineer or his nominated Supervisor:

a) Excavation at foundation/ground level near to railway track

b) Concrete casting and/or masonry work very close to railway track

c) Erection of temporary structures near to running lines.

d) Casting of structures like girder/slab over railway track

e) Stage-prestressing of girders when placed across railway tracks properly supported

f) Launching of precast/pre-assembled girders across railway tracks

g) Any work of lifting, side shifting and slewing of girders over the railway track

h) Dismantling of temporary structures, shuttering, scaffolding, etc. adjacent to and above the railway track. For carrying out activities of casting, erection, launching, handling, and dismantling as listed above, the Contractor's Engineer shall furnish the Construction Programme in advance to HRIDC Supervising Engineer & Engineer representative. No such work should be taken up in absence of the HRIDC Supervising Engineer & Engineer representative. For the activities which are to be done in presence of the HRIDC Engineer and prior intimation shall be given in writing and

acknowledgement obtained from HRIDC's representative.

1.2.3 To ensure 'Safety' during construction activities, HRIDC Site Engineer & Engineer representative may direct the Contractor's Supervisor/Engineer or their nominated representative for safe working procedures/ instructions, notwithstanding the contractual or MOU conditions prevailing between/ among Railways/other Departments like NHAI/Contractors/ Concessionaire.

1.2.4 All the records of Quality Assurance/Quality Control, testing of the materials and satisfactory completion of an activity shall be maintained at site by the Contractor's Engineer and Supervisor. On the basis of these records, HRIDC Site Engineer shall do stage-wise clearance of the works at following stages:

i) Completion of foundation

ii) Completion of substructure

iii) Completion of superstructure

Without such stage clearance, the work in next stage of construction shall not be allowed by the HRIDC Supervisor, unless proper system of check and exercise is followed at the site.

1.2.5 Normally, the high beam PSC girders are designed with wider top flange and shorter bottom flange with very high beam which makes the girder unsuitable during lowering, slewing and launching time.

1.2.6 During launching of girders and subsequent adjustments for placement of bearing, special attention and precautions are required at site to be followed rigorously without resorting to shortcut practice or leaving the work at site to untrained or inexperienced Engineers. Normally, end diaphragms are not cast for the extreme both side girders. These shall be cast minimum 300mm on both sides for all 'I' beam girders to provide temporary supports for ensuring stability.

"OR"

For side adjustments and bearing placements below 'I' section girders, end brackets made of steel angles should be provided for all 'I' beams sequentially to avoid side titling of individual girders. End brackets shall be removed only after placing girders on bearing and casting of diaphragms.

1.2.7 During lowering, the jacks shall be operated duly keeping wooden packing of various thicknesses fixing the amount of lowering to the barest minimum, so that even if the jack fails, the wooden packing will take load and further stability of girder is not endangered.

1.2.8 Temporary crib support staging shall be interlaced with clamps and angles. Adequate base width shall be maintained proportionate to the height of stage, which is very essential for avoiding the oblong effect during launching of girders. During launching by RH girder method, the movement of the PSC girders shall be controlled both from front and rear with sync mechanism having simultaneous operation, so that the speed of the launching is always under the control. Spare hydraulic jacks shall always be kept at site. Lowering of girder shall always be carried out at one end only. Further, other end should be adequately secured by wire ropes, end brackets, etc. Thereafter, the process shall be continued alternately.

1.2.9 As far as possible, launching of girders by temporary staging shall be avoided and launching by heavy capacity cranes, wherever feasible, shall be adopted.

1.2.10 Steel girder launcher if used for launching of PSC girders should be pre-tested for the critical loading (likely to be encountered during actual launching) before deployment on the approaches regarding its strength as well as amount of permissible deflection using

actual test PSC girder as a testing load. Connections at supports shall be inspected and certified prior to actual launching. It shall be adequately secured to the base support system on the pier cap.

1.3 General Construction Safety:

1.3.1 General safety precautions as applicable for civil works shall be adopted in field.

1.3.2 Working near running line: Safe practices at site and at all times non-infringement to moving trains shall be ensured. Road vehicles, material trolleys, dollies with any tendency to roll off towards the running lines to be checked by providing chains, locking arrangements, blocks, etc. shall be ensured and the Site-in-Charge of the Contractor shall be primarily responsible, secondary responsibility being of Contractor's Consultant.

1.3.3 Testing of cranes, lifting jacks and other equipment: All equipment like cranes, lifting jacks shall be tested, duly calibrated and certified prior to the use at construction site.

1.3.4 Routine safety checks, validity of test certificates for load bearing equipment especially for cranes outsourced from third party shall be ensured prior to deployment.

1.3.5 Construction workers at site shall be provided with personal safety gear like reflective vest, helmet, Safety shoes, gloves & eyewear approved as per construction industry standards. For persons working at pier top/girder level, temporary supports, hand railing, protection with help of ropes, slings and temporary railings shall be provided.

2.0 Safety Guidelines and Precautions for working close to Railway tracks

2.1 A large number of men and machinery are deployed by the contractors for track renewals, gauge conversions, doublings, bridge rebuilding etc. It is therefore essential that adequate safety measures are taken for safety of the trains as well as the work force. The following measures should invariably be adopted.

A. The contractor shall not start any work without the presence of HRIDC Engineer at site.

B. Wherever the road vehicles and/or machinery are required to work in the close vicinity of railway line, the work shall be so carried out that there is no infringement to the Railway's schedule of dimensions. For this purpose, the area where road vehicles and/or machinery are required to ply, shall be demarcated and acknowledged by the contractor. Special care shall be taken for turning/ reversal of road vehicles/machinery withoutinfringing the running track. Barricading shall be provided wherever justified and feasibleas per site conditions.

C. The look out and whistle caution orders shall be issued to the trains and speed restrictions imposed where considered necessary. Suitable flagmen/detonators shall be provided where necessary for protection of trains.

D. The supervisor/workmen should be counseled about safety measures. A competency certificate to the contractor's supervisor as per Performa annexed shall be issued by DGM/HRIDC, which will be valid only for the work for which it has been issued.

E. The unloaded ballast/rails/sleepers/other P-Way materials after unloading along track should be kept clear off moving dimensions and stacked as per the specified heights and distance from the running track.

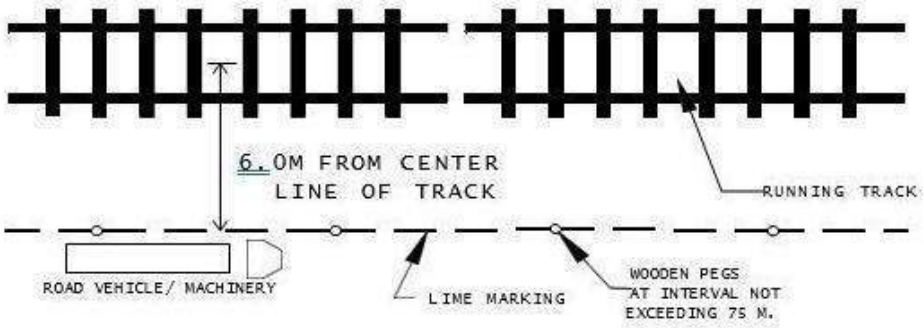
F. Supplementary site-specific instructions, wherever considered necessary shall be issued by the HRIDC's representative.

2.2 PLYING OF ROAD VEHICLES AND WORKING OF MACHINERIES CLOSE TO RUNNING TRACKS

A. Normally, the road vehicles shall be run, or machinery shall be worked so as not to come

closer than 6.0m from centre line of nearest running track.

B. The land strip adjacent to running tracks, where road vehicle is to ply or machinery is to work, shall be demarcated by lime in advance in consultation with the Railway's & HRIDC's Engineer. Wooden pegs at interval not exceeding 75mtr. shall be provided along the line marking as permanent marks. The road vehicles shall ply or machinery shall work so as not to infringe the line of demarcation.



C. If a road vehicle or machinery is to work closer to 6.0m due to site conditions or requirement of work, following precautions shall be observed:

a) In no case the road vehicle shall run or machinery shall work at distance less than 3.5m from centre line of track.

b) Demarcation of land shall be done by bright colored ribbon/nylon cord suspended on 120 cm high wooden/bamboo posts at distance of 3.5 m from centre line of nearest running track.

c) Presence of an authorized HRIDC's representative shall be ensured before plying of vehicle or working of machinery.

d) Railway's Supervisor shall issue suitable caution order to Drivers of approaching train about road vehicles plying or machineries working close to running tracks. The train drivers shall be advised to whistle freely to warn about the approaching train. Whistle boards shall be provided wherever considered necessary.

e) Lookout men shall be posted along the track at a distance of 800m from suchlocations who will carry red flag and whistles to warn the road vehicle/machinery users about the approaching trains.

f) On curves where visibility is poor, additional lookout men shall be posted.

D. If vehicle/machinery is to be worked closer to 3.5m from running track - Under unavoidable conditions, if road vehicles is to ply or machinery is to work closer to 3.5m due to site conditions or requirement of work, following precautions shall be observed:

a) Plying of vehicles or working of machinery closer to 3.5m of running track shall be done only under protection of track. Traffic block shall be imposed wherever considered necessary. The site shall be protected as per provisions of Para No. 806 & 807 of P-Way Manual as case may be.

b) Presence of a Railway's/, HRIDC's Supervisor shall be ensured at worksite.

c) Railway's& HRIDC's Supervisor shall issue suitable caution order to Drivers of approaching train about road vehicles plying or machineries working close to running tracks. The train drivers shall be advised to whistle freely to warn about the approaching train.

E. Precaution to be taken while reversing road vehicle alongside the track

The location where vehicle will take a turn shall be demarcated duly approved by Railway's/HRIDC's representative. The road vehicle driver shall always face the Railway track during the course of turning/reversing his vehicle. Presence of an authorized Railway/HRIDC representative shall be ensured at such location.

F. Road vehicle shall not be allowed to run along the track during night hours generally. In unavoidable situations, however, vehicles shall be allowed to work during night hours only in the presence of an authorized Railway's/HRIDC's representative and whereadequate lighting arrangements are made and where adequate precautions as mentioned earlier have been ensured.

G. Road vehicles/machinery/plant etc. when stabled near running tracks shall be properly secured against any possible roll off and always be manned even during off hours.

2.3 EXECUTION OF WORKS CLOSE TO OR ON RUNNING LINES

A. Any work close to or on running tracks shall be executed under the presence of a HRIDC's Supervisor only.

B. **Precaution to be taken to ensure safety of trains while execution of work close to the running line or on running lines**.

a) Such works shall be planned and necessary drawings particularly with regard to infringement to moving dimensions shall be finalized duly approved by competent authority before execution of work. The work shall be executed only as per approved procedure and drawings.

b) All temporary arrangements required to be made during execution of work shall be made in such a manner that moving dimension do not infringe.

c) Suitable speed restriction shall be imposed, or Traffic block shall be ensured as required.

d) Necessary equipment for safety of trains during emergency shall be kept ready at site.

C. Precaution to be taken to ensure safety of electrical/signal/ telephone cables while excavating near tracks.

a) Particular care shall be taken to mark the locations of buried electrical/signal/telephone cables on the plans jointly with S & T/Electric supervisor and also at site so that these are not damaged during excavation.

b) Copy of the cable plan should be given to the contractor's authorized representative before handing over the site to start the work.

c) Due care shall be taken to ensure that any part of the equipment or machinery or temporary arrangement does not come close to cables while working.

d) Joint procedure order No. 17/2013 issued by Railway Board vide letter No.2003/Tele/RCIL/1 PtIX dated 24.06.2013 shall be followed for undertaking digging work in the vicinity of underground signaling, electrical and telecommunication cables.

D. Precaution to be taken during execution of works requiring traffic blocks.

a) Any work, which infringes the moving dimensions, shall be started only after the traffic block has been imposed.

b) Before closing the work, the track shall be left with the proper track geometry so that the trains run safely.

c) After completion of work the released sleeper and fittings should be properly stacked away from the track to be kept clear of moving dimensions.

d) Block shall be removed only when all the temporary arrangement, machineries, tools,

plants etc. have been kept clear of moving dimensions.

E. Precaution to be taken during execution of works during night:

The work close to running line, generally, shall be carried out only during day hours. At locations, however, where night working is unavoidable, proper lighting arrangement should be made. The engineering indicator boards shall be lighted during night hours as per the provisions of IRPWM. The staff deputed for night working should have taken adequate rest before deploying them in night shift. We can specify duration of night shift from 20.00 hrs to 04.00 hrs. All other safety precautions applicable for daytime work should be strictly observed during night working.

F. Precautions to be taken to ensure safety of workers while working close to running lines:

a) Necessary lookout men with red flags and whistles shall be provided to warn the workmen about the approaching train.

b) Railway's/HRIDC's supervisor shall issue suitable caution order to Drivers of approaching train for whistling to warn the workers about the approaching train. Whistle boards shall be provided wherever considered necessary.

c) A "First aid kit" shall always be kept ready at site

G. Precaution shall be taken for safety of public or passengers, while executing works at locations, used by passengers and public

The worksite shall be suitably demarcated to keep public and passengers away from work area. Necessary signage boards such as "Work in progress. Inconvenience is regretted" etc. shall be provided at appropriate locations to warn the public/ passengers. Adequate lighting arrangement of worksite wherever required shall be done to ensure safety of public/passengers during night.

H. Precaution to be taken before stacking materials alongside the track to ensure that safety of trains is not affected –

The following precautions shall be taken before stacking the materials along the track for stacking of ballast, rails, sleepers etc.

a) The sites for material stacking should be selected in advance in such a manner as to ensure that no part of the material to be stacked is infringing the Standard Moving Dimensions. A plan of proposed stacking locations be made and signed jointly by an authorized HRIDC's/Railway's representative and contractor's representative.

b) The selected locations shall be marked by lime in advance.

c) Presence of an authorized HRIDC's/Railway's representative while unloading and stacking shall be ensured.

d) The material shall be stacked in such a height so as to not to infringe SOD in case of accidental roll off.

I. Precaution for handling of departmental material trains –

Instructions for working of material trains are contained in Chapter VIII of IRPWM which should be brought to the notice of the supervisors and other staff working on the material trains. In addition to this,following precautions should be taken:

a) Issue of 'fit to run' certificate:

As per Para 848 before a material train is allowed to work, the complete rake should be examined by the Carriage and Wagon staff and a 'fit to run' certificate issued tothe Guard.

b) As per Para 849 of IRPWM, a qualified Engineering official should be deputed on the

train to ensure working of the material train as the Guard is not qualified to carry out such duties like Supervising of loading and unloading of materials.

c) As per Para 845 of IRPWM, the material train should not be permitted to work during the period of poor visibility due to fog, storm or any other cause except with the permission of the ADEN/DEN. Working of the material trains carrying labour should not be permitted between sunset and sunrise except in an emergency.

d) While unloading rail panels by the side of the running track, placement of the panels, clear of the maximum moving dimensions should be ensured.

e) Unloading of rail panels should be done by a team of trained staff under the active supervision of competent Supervisor/Officer.

f) Before unloading of rail panels, site should be prepared by way of leveling/removing extra ballast, if any, from the crib and shoulder with the objective to ensure requisite lateral and vertical clearances so as to prevent slippage of rail panels due to vibration during the passage of trains.

g) Reasonably adequate block should be asked and provided for unloading of the material and the work should be done preferably in day light to avoid shortcut in haste which may infringe the safety requirements.

J. Safety aspects to be observed while working in OHE area

a) No electrical work close to running track shall be carried out without permission of HRIDC representative.

b) A minimum distance of 2m has to be maintained between live OHE wire and body part of worker or tools or metallic supports etc.

c) No electric connection etc. can be tapped from OHE.

d) Authorized OHE staff should invariably be present when the relaying work or any major work is carried out.

e) Power block is correctly taken and 'permit to work' is issued.

f) The structure bonds, track bonds, cross bonds, longitudinal rail bonds are not disturbed and if disconnected for the work, they are reconnected properly when the work is completed.

g) The track level is not raised beyond the permissible limit during the work

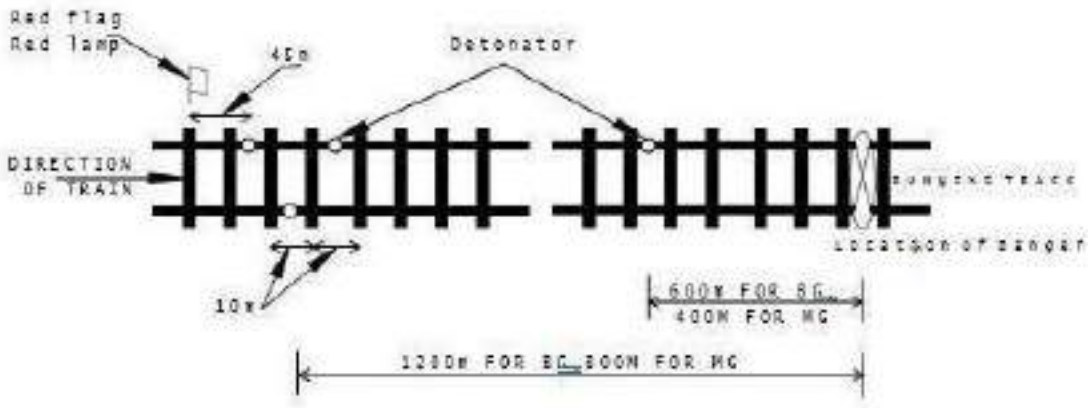
2.4 PROTECTION OF TRACK DURING EMERGENCY

A. Action to be taken when a contractor's supervisor or vehicle operator apprehends any unusual circumstances likely to infringe the track and endanger safe running of trains.

a) At any time if a contractor's supervisor or vehicle operator observes any unusual circumstances likely to infringe the track and apprehend danger to safe running of track, he shall take immediate steps to advise a HRIDC official of such danger and assist him in protection of track.

b) The track shall be protected as under. One person shall immediately plant a red flag (red lamp during night) at the spot and proceed with all haste in the direction of approaching train with a red flag in hand (red lamp during night) and plant a detonator on rail at a distance of 600m from the place of obstruction of BG track (400m for MG track) after which he shall further proceed for not less than 1200m from the place of obstruction from BG track (800m for MG track) and plant three detonators at 10m apart on rails. After this he shall display the red flag (red lamp during night) at a distance of 45m from the detonators.

c) Attempts shall also be made to send an advice to nearest Railway/HRIDC station about the incident immediately.



B. Action to be taken if train is seen approaching to site of danger and there is no time to protect the track as per guidelines mentioned above.

In such a case the detonators shall be planted on rails immediately at distance away from place of danger as far as possible and attention of driver of approaching train shall be invited by whistling, waving the red flag vigorously, gesticulating and shouting.

C. What action shall be taken if more than one track is obstructed.

a) In case of single line protection as above shall be done in both the directions from place of danger.

b) In case of double line or multiple lines, if other tracks are also obstructed, theprotection as above shall be done for other track also.

c) The protection shall be done in that direction and on that track first on which train is likely to arrive first.

d) The Contractor's Supervisors, Operators and lookout men shall be properly explained about the direction of trains on running tracks.

D. Equipment required for protection of track.

Minimum compliment of protection equipment i.e. 10 detonators, 4 red hand flags, 4 red hand lamps, 4 banner flags and whistles etc. shall always be kept ready at worksites for use in case of emergency. HRIDC will arrange to provide detonators, whereas Contractor shall arrange other equipment at his own cost.

E. Arrangement of lookout men and competency required for lookout man to warn labour about approaching train.

a) Contractor will provide lookout men.

b) The lookout men shall be properly trained in warning to staff at worksite about approaching train.

c) Only those lookout men shall be provided at site who have been issued with a competency certificate by the Railway's/HRIDC's Supervisor.

d) In case, it is felt necessary to provide lookout men by HRIDC, the charges for the same as fixed by HRIDC Administration shall be recovered from Contractor.

2.5 Training to Supervisors and Operators of Contractor

The Supervisors and Operators of the contractor proposed to be deployed at wok site, which is close to the running track, shall be imparted mandatory training by the HRIDC at site free of cost about the safety measures to be adopted while working in the vicinity of running track. HRIDC's Engineer-in charge of the work shall decide the scale, extent & adequacy of training. In case training is imparted at a recognized Railway training institute, the charges for the same, as decided by HRIDC, shall be recovered from the Contractor. A competency certificate to this effect to the individual Supervisor/Operator shall be issued as given below,by a HRIDC Officer not below the rank of DGM/HRIDC. No Supervisor/Operator of the Contractor shall work or allowed to work in the vicinity of running track that is not in possession of valid competency certificate.

All the labour, materials, tools, plants etc. except detonators, required for ensuring safe running of trains shall be provided by Contractor at his own cost. Wherever lookout men are provided by HRIDC, charges at the rate of Rs. 1000/- per man day shall be recovered from Contractor.

A sample of training competency certificate is provided below for reference:

Competency Certificate

Certified that Shri …… Supervisor/Operator of M/s. ……has been trained and examined in safety measures to be followed while working in the vicinity of running railway track for the work. His knowledge has been found satisfactory and he is capable of supervising the work safely.

This certificate is valid only for the work mentioned in this certificate only.

Signature and designation of the officer

APPENDIX 14

LIST OF CONTRACT SPARES (INVENTORY ITEMS)

S.No	Description of item	Unit	Required Quantity
1.	Under Ground cable	Kilo- Meter	5 % of the total cable of each type laid subject to a minimum of 1 KM of each type & size and as per satisfaction of Engineer
2.	All other cables & wires other than Underground cables	Meter	5 % of the total cable laid of each type subject to a minimum of 100 Meter of each type & size and as per satisfaction of Engineer
3.	Contact and Catenary wire	Meter	5 % of the total wire used of each type or 2 KM each whichever is more and as per satisfaction of Engineer
4.	All other Equipments/ items used in Electrification work (OHE, PSI, SCADA and General Services work) except Transformers used at substations.	Nos	5 % of the total quantity used in work, subject to a minimum of one Number of each type & size and as per satisfaction of Engineer.

APPENDIX 15
TESTING AND COMMISSIONING

Name of Station: -
Date of Checking -

A. 25 KV Isolator

SN	DESCRIPTION	DETAILS
1	Equipment No.	
2	Location (OHE Mast No.)	
3	Name plate Details: -	
	a) Make	
	b) Serial No.	
	c) Rating	
4	Details of Test conducted: -	
a)	Insulator (Check condition)	
b)	Terminal connectors (check for tightness & condition)	
c)	Contacts (Check for alignment & condition)	
d)	Operation	
	i) Close	
	ii) Open	
e)	Operation Mechanism (Check for alignment & smooth operation)	
f)	Locks (Check whether bolt lock & pad lock fit conveniently when isolator in open or close position)	
g)	Duplicate earth and earth continuity	

h)	Provision of handle earthing	
i)	Isolator resistance (with 2.5 KV megger)	
	a) Pole to pole (open position)	
	b) Pole to earth	
j)	Clearance between male & female contacts (in open position)	
k)	Condition of arcing horn	

Signature of Authorities

Name of Station:
Date of Checking:

B. 25 KV DO Fuse switch

S. No.	Description	Details
1	Make	
2	Maker's S. No.	
3	External Condition	
4	Terminal connection	
5	Contact (Check for alignment & Condition)	
6	Fuse Link (Check Connectivity)	

Signature of Authorities

Name of Station:
Date of Checking:

C. 10 KVA, 25 KV/230V Aux. Transformer

1	Identification No.	
2	Make/ Manufacturing date	
3	Maker's S. No.	
4	External Condition	
5	Oil Level	
6	Dielectric Strength of Oil	
7	Insulation Resistance (2.5 KV megger)	
a	HT-LT	
b	HT-Earth	
c	LT-Earth	
8	Winding Continuity	
9	Condition of Silica gel and breather	
10	Duplicate Earth and earth continuity	
11	Primary winding resistance	
12	Secondary winding resistance	
13	Terminal Connectors (check for tightness)	
14	Arching Horn Gap	
15	Tap Changer Set	

16	Anticlimbing device		
17	Danger/Caution board		
18	AT Mast Implantation (mtr)		
19	Earth resistance (ohm)	Individual	Combined
a	EP-1		
b	EP-2		

Signature of Authorities

D. Switching Post Joint Check list/Test

Name of Sectioning/Sub Sectioning Post:
Date of Checking:

D.1 - 10 KVA, 25 KV/230V Aux. Transformer

1	Identification No.	
2	Make/ Manufacturing date	
3	Maker's S. No.	
4	External Condition	
5	Oil Level	
6	Dielectric Strength of Oil	
7	Insulation Resistance (2.5 KV megger)	
a	HT-LT	
b	HT-Earth	
c	LT-Earth	
8	Winding Continuity	
9	Condition of Silica gel and breather	

10	Duplicate Earth and earth continuity	
11	Primary winding resistance	
12	Secondary winding resistance	
13	Terminal Connectors (check for tightness)	
14	Arching Horn Gap	
15	Tap changer set	
16	Earthing	

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.2- 25 KV DO Fuse switch

S. No.	Description	Details
1	Make	
2	Maker's S. No.	
3	External Condition	

4	Terminal connection	
5	Contact (Check for alignment & Condition)	
6	Fuse Link (Check Connectivity)	

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.3 - BATTERY AND BATTERY CHARGER

S.N.	Description	Details
1	Make	
2	Inter cell & Inter row connectors	
3	Level of Electrolyte	
4	Temperature & specific gravity	
5	Voltage without load	
a)	Of each cell	

b)	Of the battery Set	
6	Stand (Check condition)	
7	Tool boards with thermometer and hydrometer (Check for completeness)	
8	Serial no of batteries	

Signature of Authorities

D.4 - BATTERY CHARGER FOR 110V BATTERY

SN	Description	Remarks
1	Make	
2	Maker's Sl. No.	
3	Switches (Check functioning)	
4	Voltmeter and Ammeter (Check condition)	
5	Fuses (Check rating and continuity)	
6	Wiring and connections (Check correctness)	
7	Earth connection and continuity	

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

VoB

Cell No	Maker's Sr No.	Cell No	Maker's Sr No.	Cell No	Maker's Sr No.	Cell No	Maker's Sr No.
1		15		29		43	
2		16		30		44	
3		17		31		45	
4		18		32		46	
5		19		33		47	
6		20		34		48	
7		21		35		49	
8		22		36		50	
9		23		37		51	
10		24		38		52	
11		25		39		53	
12		26		40		54	
13		27		41		55	
14		28		42			

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.5 - 25KV Interrupter

S.No.	Description	Details of BM's	
1	Identification No.		
2	Type		
3	Make/Year of manufacturing		
4	Maker's S. No.		
5	External Condition (Check Porcelain)		
6	IR value with 5.0 kv megger		
i	Top terminal to Earth		
ii	Top to Bottom terminal		
iii	Bottom terminal to Earth		
7	IR value of Operating mechanism by 500V Megger		
i	Spring charging motor (IR/Res)		
ii	Closing Coil (IR/Res)		
iii	Tripping Coil (IR/Res)		
8	Remote operation from control panel: Open		
	Close		

9	Electrical operation from M/Box: Open	
	Close	
10	Manual operation from M/Box: Open	
	Close	
11	Duplicate earth and earth continuity	
12	Terminal Connections (check for tightness)	
13	Auxiliary contact Block (Check for tightening)	
14	Close Time	
15	Open Time	
16	CRM Value	
17	Operation Control	
18	Interlock with Isolator	
19	Indicator	
20	Visual check of charge spring	

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.6 - Testing for the Control Cables

S.No.	Description	IR value between	Details
1	Control Cable 7*2.5 Sq.mm	Core to Core	
		Core to Earth	
		Continuity	
2	Heating Cable 2*4 Sq.mm	Core to Core	
		Core to Earth	
		Continuity	

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.7 - 25 KV, Double Pole Isolator

SN	DESCRIPTION	DETAILS
1	Equipment No.	
2	Name plate Details: -	
	a) Make	
	b) Serial No.	
	c) Rating	
3	Details of Test conducted: -	
a)	Insulator (Check condition)	
b)	Terminal connectors (check for tightness & condition)	
c)	Contacts (Check for alignment & condition)	
d)	Operation	
	i) Close	
	ii) Open	
e)	Operation Mechanism (Check for alignment & smooth operation)	
f)	Locks (Check whether bolt lock & pad lock fit conveniently when isolator in open or close position)	
g)	Interlocking with Interrupter	
h)	Duplicate earth and earth continuity	
i)	Provision of handle earthing	
j)	Isolator resistance (with 2.5 KV megger)	
	a) Pole to pole (open position)	

	b) Pole to earth	
k)	Clearance between male & female contacts (in open position)	
l)	Condition of arcing horn	

Signature of Authorities

EARTHING ARRANGEMENT (EARTH RESISTANCE)

1. Combined earth resistance: -
   (a) With connection to non-track circuited track –
   (b) Without connection to non-track circuited track –
2. Equipment Earthing
   (c) Equipment Earthing in yard:
   (d) Equipment Earthing inside the control room:
3. Individual earth resistance

SN	Earth Pit Station no.	Resistance in Ohm
1	LA1	
2	LA2	
3	HT1	
4	HT2	
5	HT3	
6	LT1	
7	LT2	
Combined without rail		
Combined with rail		

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.8 - Instruments Used for Testing

S.No.	Equipment Used	Make	I.D. No./S.No.
1	Megger 500V & 5000V		
2	Megger 2500V		
3	Earth Tester		
4	Multimeter		
5	Time Measurements Kit		
6	CRM		

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.9 - Layout & Clearance

1	Location	
2	Chainage	
3	Minimum Height of 25 KV Bus above ground (Min. 3.8M)	
4	Minimum clearance between live and earth part	
5	Compliance with Indian Electricity Rule	
6	Fire Buckets, Fire Extinguisher, First Aid box, respiration chart.	
7	Number Plate	
8	Visual inspection of insulators and bushings	
9	Danger & Caution Board	
10	Remarks	

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.10 - **25 KV Side Bus bar & Connectors**

S.No.	**Description**	
1	External Condition	
2	Tightness of Connection	
3	Condition of Junction Between Connector and Busbar	
4	Busbar & Connectors IR Values (2.5 KV megger) Phase to E	
5	25 KV Post Insulator Top to E	
6	Bimetallic strip	

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D.11 - 10KA/42KV Lightening Arrester

S.No.	Description	Details of LA's	
1	Identification No.		
2	Make		
3	Maker's S. No.		
4	External Condition		
5	Duplicate Earth connection and connectivity		
6	Terminal Connectors (Check for tightness and condition)		
7	IR value with 2.5 KV Megger		
	Top to Bottom		
8	Surge Monitor S. No		
9	Surge Counter Reading		

a	External Condition		
b	Terminal		
10	Disconnect or assembly provided (Yes/No)		

Signature of Authorities

Name of Sectioning/Sub Sectioning Post:

Date of Checking:

D-12 - 25KV Potential Transformer Type-I

S.No.	Description	Details of PT	
1	Identification No.		
2	Make		
3	Maker's S. No.		
4	Rating		
5	External Condition		
6	Earth connection (Duplicate) and connectivity		

7	Check for tightness of terminal connectors & general condition		
8	Winding Continuity		
9	Insulation Resistance between HV & earth with 2.5 KV megger		
a	HV & LV		
b	HV & Earth		
10	Insulation Resistance between LV & earth with 500Vmegger		
11	Secondary Fuse Rating & Continuity		
12	Remarks if any	-	-

Signature of Authorities

E - PTPE Commissioning Report

S.NO.	ITEM CHECKED	STATUS / VALUE
1	Mast location number	
2	Associated TSS/SP	
3	Availability of bonding and earthing	
4	Stagger at must	
5	Make	
6	Makers sr. No.	
7	Height above rail level	
8	Cation boards	
9	Earth resistance value	
10	Availability of earth pit and cover	
11	Condition of arcing horn	
12	Smooth movement of pantograph under PTFE	
13	Gradient of track at PTFE location	
14	Whether curve or tangent track	
15	Distance of nearest signal	

Signature of Authority

<u>NOTE</u>: The above Joint checks are indicative and not exhaustive. Further, all joint test/checks as per checklist of CRS (Latest version) also attached in appendices-II of this chapter, will be conducted jointly before taking-over of Section.

Checklist of CRS: -

1	Name of Gate Keeper				
2	Competency				
3	PME				
4	RC				
5	GWR in Bilingual				
6	Interlocked /				
7	NI (Manned / UM)				
8	Class				
9	TVU				
10	Wire Rope Insulators				
11	Rodding Insulators				
12	Road Warning Signals & Alarming Bells				
13	Height of Booms when lowered				

List of Documents and Testing Report to be kept at station during CRS inspection

Brief description of Item		Stations Name			
	Documents				
1	CRS sanction				
2	ESP				
3	SIP				
4	SWRD				
5	Selection Table				
6	Panel Diagram				
7	Track Bonding Diagram				
8	Cable corage plan				

	IPS & Battery Room				
1	Earthing of IPS (less than 2ohm)				
2	IPS with 55+5 battery bank				
3	Exhaust fan in battery room				
4	Compliance of pre commissioning check list				
	SM Panel Room				
1	Simulation / Panel Test				
2	Filling of duct at ASM office				
3	Earthing of Block				
4	Crank handle wiring				
5	FAT & SAT in case of EI				
	Data logger room				
1	Data logger validation & networking				
2	Diagnostic Panel				
3	ELD				
4	Mineral water plant at SI/HQ				
	Power Supply (DG set / AT Supply)				
1	Nos of sources				
2	DG Set Capacity & Make				
3	Auto start from SM Panel Room				
4	AT Supply with Auto change over				
	Outdoor				
1	Signal – number plates				
2	Signal – X mark on back side				
3	Glued Joints				
4	Earthing of signals & location box				
5	Earthing Cable armours				
6	Cable Route Markers				
7	Painting and writing particulars				
8	AC immunized relays connected with outdoor circuit in RE area				
	Track Circuits				
1	Provision of Choke in RE				
2	QTA2 relays in RE area				

Sl.	Manned Level Crossing Gates	*LC No.*	*LC No.*	*LC No.*	*LC No.*
	Description	*Km*	*Km*	*Km*	*Km*

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Check list for Inspection of Signaling & Telecommunication

	Brief description of item	Stations Name					
	Station						
1	Nos of running Lines.						
2	Send Hump / Overrun on loop lines.						
	Signalling						
1	Type						
2	Standard of Interlocking						
3	Complete Track Circuit of yard						
4	Type of Signal						
	Block working						
1	Up side &						
2	Down Side						
3	Provision of block filter in RE area						
	Telecommunication						
1	OFC with 6 Quad cable						
2	Dismantling of overhead Telecom Alignment						
3	Emergency Socket at every one km.						
4	Emergency Socket at SSP, SP & TSS in RE area.						
	Relay Room						
1	Bunching& lacing of wiring						
2	Tag block covers						
3	Door Close switch proving in data logger						
4	Fire fighting equipment						
5	HMU for LED Signals						
6	Painting and writing particulars						
7	Double Lock arrangement						
8	Earthing for EI as per RDSO guidelines						
9	Air Conditioning Equipment at Junction station.						
10	Flashing of relays more than 3 years old.						
11	AC immunized relays connected with outdoor circuit in RE area						

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45	If manned, Competency certificate for operation of interrupter and isolator is given to manning staff?				
46	Earth Fault Test (providing discharge rod on busbar between LV CB and feeder CV) is done:				
47	Earth Fault Test to be done by providing earthing at farthest end of the sector is done:				

Steel Girder Bridge		Loc	Loc	Loc	Loc
1	Earth pit on both ends :				
2	Earth Values are within prescribed values:				
3	Connection with separate earth pit, Bonding between rail and girder and girder and earth pit provided:				
4	U-Bond between traction rail and gaurd rail at both the ends:				
5	Longitudinal/continuity bonds are provided in traction as well as gaurd rail:				
6	Cross bonds at 100m.				

23	**Buried Rail** : Buried Rail of 13 M length is buried near feeding post gantry fencing coming from secondary side of transformer. It should be connected with all traction rail(s) by 75x8 mm MS flat.				
24	Opposite to TSS/ FP all the traction railsare provided with rail bonds at approximate distances of 300 M, 500 M, 700 M and 1000 M from the TSS/FP.				
25	Cable Trench: It is as per approved drawing based on RDSO. Depth, Width, Depth of Trench is as per RDSO standard.. Execution of cable trench and earthing system are done as per Approved Earthing lay out drawing available at site.				
	Control Room :				
26	Separate earthing for RTU is provided?				
27	All Panels & Battery Charger are commissioned:				
28	Shock Treatment Chart is provided?				
29	Schematic Diagram provided?				
30	Hand gloves are provided?				
31	OHE Key Box is provided?				
32	TPC phone is provided and working?				
33	DoT/BSNL/WLL phone provided and working?				
34	Message register and PN book provided?				
35	Rubber Mat at the front of all control panel provided?				
	Safety Equipment :				
36	First Aid Box with prescribed medicine is provided? Last replenished/sealed date of F.A. Box?				
37	Fire Buckets (Min. 6 nos i.e. 3 sand filled and 3 with water) are provided?				
38	No. and type of Fire Extinguishers provided with next due date?				
	Battery Room :				
39	➢ All the batteries(55 cells, 200AH, 2.1 volts, Total bank Voltage 110Volts) are commissioned and properly numbers?				
40	➢ Specific gravity of the battery has been taken (Typically 1220)				
41	➢ Exhaust fan is provided in battery room?				
42	➢ No sulphation is there on the battery terminal?				
43	➢ Anti-acid tiles on floor with skirting are provided?				
44	➢ voltmeter and hydrometer are provided in battery room?				

	Traction Sub Station (TSS) Name->				
1	Name board for TSS is provided on the fencing facing track?				
2	Provided Caution Boards for staff (Minimum one on each side, near main gate and on control room gate):				
3	Provided Caution Boards for Public (Minimum one on each side of fencing):				
4	25 KV AC Danger Board and protected area boards are provided on the fencing facing track and on the Main Entry?				
	Earthing:				
5	Provided as per approved earthing lay out based on ACTM guide line?				
6	Total number of earth pits (Typically 40):				
7	Earth Pit Covers are with handle				
8	Individual Earth Pit Resistance is less than 10 ohm				
9	Combined earth resistance is less than 0.5 ohm				
10	Earth Pit Boxes are casted?				
11	Earth pit boxes are made as per RDSO drawings?				
12	Earth pit boxes are buried in the ground as per RDSO drawing? Stencilling of all the earth resistance values are done?				
13	Control Panel Room is separately earthed with 50 mm x 6 mm flat in merry- go-round on just above the floor level. Further connected with main earthing network.				
14	All equipment - CT, PT, CT, LA, SPI, DPI, AT, BM, Power Transformer etc are with double earthing. For LA – separate earthing (working of surge counter to be confirmed for ensuring leakage current and number of surge).				
15	Isolator are provided with locking arrangement and flexible earth?				
16	Fencing Earth by at least two bonds?				
17	Minimum 100mm thickness crushed rock is provided?				
18	AT (auxiliary transformer) is commissioned?				
19	Numbering scheme of equipmentsis as per approved drawing?				
20	Number of Transformer provided -				
21	All the protections for tranformer are commissioned:				
22	Primary and Secondary injection testing of all the relays are done:				

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28	No. and type of Fire Extinguishers provided with next due date?						
29	Battery Room :						
	➢ All the batteries are commissioned and properly numbers?						
	➢ Specific gravity of the battery has been taken?						
	➢ Exhaust fan is provided in battery room?						
	➢ No sulphation is there on the battery terminal?						
	➢ Acid-acid tiles on floor with skirting are provided?						
	➢ voltmeter and hydrometer are provided in battery room?						
30	Implantation meeting the minimum requirement as below?						
	➢ Fencing - 3.5 mtr.						
	➢ Main gantry – 4.3 mtr.						
	AT (auxiliary transformer) is commissioned?						
	Inner distance between 2 interrupters is not less than 3 M?						
31	Numbering scheme is as per approved drawing?						
32	Emergency Telephone Socket is provided and working?						
33	If manned, Competency certificate for operation of interrupter and isolator is given to manning staff?						

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2	Caution Board for staff as well as for Public are provided (one on each side)				
3	25 KV AC Danger Board and protected area boards are provided on the fencing facing track and on the entry?				
4	Staff Caution Board is provided on the wall of Control Room?				
5	Number of earth pits provided Typically 8 for D/L, 6 for S/L):				
6	Individual earth value of each earth pit is less than 10ohms?				
7	Combined earth value is less than 2 ohms?				
8	Earth Pit Boxes are casted?				
9	Earth pit boxes are made as per RDSO drawings?				
10	Earth pit boxes are buried in the ground as per RDSO drawing? Stencilling of all the earth resistance values are done?				
11	Buried Rail is provided near SP/SSP as per RDSO SMI?				
12	LAs with discharge counters and two earth bonds are provided?				
13	All the Equipment are connected with two earth bonds?				
14	Equipment earth bonds were made by MS flats with two coats of painting by colour grass green?				
15	Isolator are provided with locking arrangement and flexible earth?				
16	Fencing Earth by at least two bonds?				
17	Minimum 100mm thickness crushed rock is provided?				
	Control Room :				
18	Panel & Battery Charger are commissioned and connected with earth ring by 8 SWG wire?				
19	Shock Treatment Chart is provided?				
20	Schematic Diagram provided?				
21	Hand gloves are provided?				
22	OHE Key Box is provided?				
23	TPC phone is provided and working?				
24	Message register and PN book for operation of interrupters and Isolators is provided?				
25	Ring earth with separate earthing for RTU is provided?				
	Safety Equipment :				
26	First Aid Box with prescribed medicine is provided? Last replenished/sealed date of F.A. Box?				
27	Fire Buckets (4 nos i.e. 2 sand filled and 2 with water near AT) are provided?				

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Sl.	Manned Level Crossing Gates	LC No.	LC No.	LC No.	LC No.
	Description	*Km*	*Km*	*Km*	*Km*
1	Gatemen are trained and counselled regarding precautions and working in Electrified section?				
2	Height of Height gauge from Ground Level is not more than 4.67mtr?				
3	3.67mtr black band marking on the upright is provided?				
4	Danger Board in Bilingual/Trilingual with skull mark is provided?				
5	Height of contact wire on all the lines is not less than 5.50mtr?				
6	Cross bonds are within 5metre from transverse edge of LC?				
7	Distance of nearest OHE mast from transverse edge of LC is not more than 10mtr?				
8	Proper bonding of fencing and gate machine is done?				
9	Public caution notice boards are provided on the uprights of HG (1 per HG)				
10	Staff caution notice board is provided on the cabin:				
11	Electric shock Treatment chart in bilingual/trilingual is provided?				
12	Precautions to be taken in electrified section are included in Gate Working Rules (GWR)?				
13	Insulator are provided in SS wires and Rods?,				

	Unmanned Level Crossing Gates	ULC No.	ULC No.	ULC No.	ULC No.
	Description	*Km*	*Km*	*Km*	*Km*
1	Height of Height gauge from Ground Level is not more than 4.67mtr?				
2	3.67mtr black band marking on the upright is provided?				
3	Danger Board in Bilingual/Trilingual with skull mark is provided?				
4	Height of contact wire on all the lines is not less than 5.50mtr?				
5	Cross bonds are within 5metre from transverse edge of LC?				
6	Distance of nearest OHE mast from transverse edge of LC is not more than 10mtr?				
7	Public caution notice boards on uprights (1 per HG):				

	Switching Stations (SP/SSP) Name->				
1	Name board for SP/SSP is provided on the fencing facing track?				

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	Other Over Line Structure (ROB/FLY OVER etc.)				
1	Static Clearance from bottom of girder to top of catenary is more than 250mm?				
2	Insulated catenary or Contact Catenary is provided under the OLS with minimum 2-3 M on either side from the edge of OLS?				
3	Continuous Protective screen is provided across full span?				
4	Nearby OHE structure is located at least 10 m away from the edge of OLS?				
5	Separate Earth Pit with one bond between Earth Pit and Structural Column an another one between Structural Column and Rail is provided? (EP res. Less than 10 Ω (ind.) & 2 Ω (comb.))				
6	Public Caution Board and 25 KV Danger Board are provided on the protective screen (one each for each track)?				

	PTFE Neutral Section: Location ->	Loc	Loc	Loc	Loc
1	Two Bonds with separate earth pit are provided (EP res. Less than 10 Ω (ind.) & 2 Ω (comb.)):				
2	Caution Boards provided at 500 M , 250 M, DJ OPEN and DJ close :				
3	Conditions –				
4	On tangent Track :				
5	No gradient :				
6	Located at least 200 mtr before stop signal or 400 mtr after stop signal :				
7	Stagger of OHE is be zero :				

13	Public Caution Boards (4 on each PF, 2 on Station bulding, 1 each at Station Entry, Booking Window and waiting rooms:				
14	PF sheds are bonded with earth on at least two places?				
15	Separate earth pit is provided for PF shed if shed length is more than 350 mtr?(EP res. Less than 10 Ω (ind.) & 2 Ω (comb.))				
16	Caution boards are provided to prevent entry over roof of PF shelter, one on each side?				
17	All the Masts/portals on PF bonded with structure bond?				
18	Fencing/Railing on the platform bonded on at least two places, if more than 20 mtr and with separate earth pit also if more than 350 mtr?(EP res. Less than 10 Ω (ind.) & 2 Ω (comb.))				
19	Caution Unwired Turnout / Track ahead boards, Electric Engine Stop boards are provided?				
20	Implantation of OHE Mast/portal is more than 4.75mtr on PF?				
	Foot Over Bridge (FOB) -				
1	Static Clearance from bottom of girder to top of catenary is more than 250mm?				
2	Insulated catenary or Contact Catenary is provided under the FOB with minimum 2-3 M on either side from the edge of FOB.				
3	Continuous Protective screen is provided across full span of FOB?				
4	FOB is bonded with Rail and Separate Earth Pit?(EP res. Less than 10 Ω (ind.) & 2 Ω (comb.))				
5	Public Caution Board and 25 KV Danger Board are provided on the protective screen (one each for each track) and on the ascent of FOB (one on each entry)?				

Name of the Section: _____

	Item Description ↓ Stations Name ->				
1	Appendix 'G' of SWR has been issued as per the current power supply scheme and assurance of the staff regarding the same had been taken?				
2	Electric Traction Working Rule Diagram is provided in front of the Signal panel?				
3	Power Block Register, Power Block Collars, Line Block Collars are provided?				
4	OHE key Box, Hand gloves for isolator operation, Isolator Key Register with List of authorised TRD official who can withdraw key from SM provided?				
5	Electric Shock Treatment Chart in bilingual/ trilingual provided in SM Room?				
6	Sealed First Aid Box with prescribed medicine provided? Sealing and last replenished date?				
7	No. and type of Fire Extinguishers in SM room?				
	Next due date for refilling/testing of F.E?				
8	Competency issued to all SM/ASM for Isolator operation along with Designation of person issuing Competency certificate.				
9	TPC is in place and Working TPC phone provided?				
10	Joint Inspection of traction bonds done in track circuited area by SSE/TRD & SSE/Sig? A register with approved bonding plan is provided at Station?				
11	No.of Bonds provided in yard - (Actually provided/As per bonding plan) (Typical numbers given, Actual shall be as per SIP and yard geometry) :				
	(i) Structure Bond (64 for 4 Lines; 30 for 3 Lines):				
	(ii) L- Bond (250 for 4 Lines, 150 for 3 Lines):				
	(iii) Z-Bond (40 for 4 Lines, 30 for 3 Lines):				
	(iv) IT/IR Bond (30 for 4 Lines; 20 for 3 Lines):				
	(v) C-Bond (40 for 4 Lines; 20 for 3 Lines):				
	(vi) SEJ-Bond (8 for 4 Lines; 6 for 3 Lines):				
	(vii) Special Bonds (20 for FOB & Shed):				
	Platform:				
12	Staff Caution notice boards(1 each for SM/ASM room, Relay room):				

Railway Electrification Broad Checklist

Name of the Section: _____ RKM:_____ TKM: _____

1) Total No. of Stations:-
2) No. of TSS in the Section: - Total - .....; Fully Ready - .....; Back-Charged - .....; Not-Ready - .....
3) No. of SP in the Section: - Total - .....; Not-Ready - ..... ;
4) No. of SSP in the Section: - Total - .....; Not-Ready - ..... ;
5) Max one side Feed Length from TSS:- ..... Km
6) Voltage drop calculations attached if any of the TSS is not fully ready:
7) All the loops and lines are wired :-
8) EIG Sanction Available:
    a) For OHE charging of complete section : -
    b) For TSS which are charged/back-charged :-
    c) For SP/SSP which are ready:-
    d) For AT commissioning :-
9) Compliance of EIG sanction Conditions :-
10) Inspection note of Joint Inspection at SAG level :-
11) Compliance of Joint Inspection note of SAG level :-
12) Joint SED checking with Division done for the complete section:-
13) Joint Tower wagon checking done for the complete section:-
14) Adjustment of all the ATDs in the section done with proper temperature marking:-
15) Bonding is done as per bonding plan in complete section :-
16) Loco Trial has been done in the section :-
17) All the P-Way gangs have been trained and safety equipment are provided:-
18) All the Gate Men have been trained for precautions in Electrified section:-
19) Gate working rules includes precautions to be taken in electrified sections:-

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XXXXXXXX

APPENDIX 15A

SMIS & MIS FOR OHE, PSI AND SCADA ISSUED BY RDSO/RAILWAY BOARD

List of Maintenance Instructions

SMI No.	Rev.	Regarding	Description of the item
TI/MI/0001	**0**	OHE, Insulators	Failure of 25 kV pedestal insulator and to use only solid core support insulator.
TI/MI/0007	**0**	OHE, Insulators	Use of disk insulator in place of 9-T solid core insulators of 25 kV ac OHE.
TI/MI/0008	**0**	OHE, Insulators	Failure of 9-t insulator due to non-provision of double eye distance rod at BWA location.
TI/MI/0018	**3**	OHE, ATD	Winch type regulating equipment.
TI/MI/0026	**2**	Capacitor Bank	Periodical maintenance instruction & trouble shooting guidelines for capacitor bank.
TI/MI/0027	**0**	OHE, Conductor	Development of 107 mm2 silver bearing copper contact wire (silver contents 0.1%).
TI/MI/0028	**2**	OHE, Panto entanglement	Overhead equipments (OHE) on turn out/cross over to avoid panto entanglements.
TI/MI/0029	**3**	OHE, ATD	3:1 Ratio, 3 Pulley type regulating equipment.
TI/MI/0034	**0**	OHE, OOR	Contact wire in out of run OHE.
TI/MI/0035	**1**	OHE, ATD	Provision of pipe on HEX Tie Rod of auto Tensioning Device (ATD).
TI/MI/0036	**0**	Insulated cad. Cupper Catenary	Provision of insulated cadmium Copper catenary wire under over line structure on 25kV ac traction system.
TI/MI/0037	**2**	Contact wire- OHE fittings	Maintenance instruction for OHE contact wire and associated fittings.
TI/MI/0038	**2**	Traction Transformer	Inspection test schedule for traction power transformer.

TI/MI/0039	**1**	Traction Transformer	Schedule of periodic overhauling of traction transformer.
TI/MI/0040	**0**	Pollution measurement, Insulator	Maintenance instructions for measuring the severity of pollution by brush wash method.
TI/MI/0041	**0**	Lightning arrester	Maintenance instructions for lightning arresters.
TI/MI/0042	**0**	OHE, Insulators	Testing of 25 KV porcelain & composite insulators before installation.
TI/MI/0043	**0**	8 wheeler tower wagon	Instruction for 8-wheeler tower wagons covering instructions for DETC & DHTC.
TI/MI/0044	**0**	4 wheeler tower wagon	Special Maintenance Instruction for 4-wheeler tower car.
TI/MI/0044	**0**	Siding electrification	Guidelines for overhead hopper/chute/crane loading/unloading of rakes in electrified sidings.
TI/MI/0045	**0**	OHE, ATD	Maintenance instructions for Gas Auto tensioning device.
TI/MI/0047	**0**	Insulated catenary	Special maintenance instructions for precautions while splicing insulated Cadmium-Cupper catenary wire.
TI/MI/0048	**08/ 13**	Dis connector in lighting arresters	Special maintenance instructions for provision of dis connector assembly to the lightning arresters provided over 25 KV side traction system on Indian Railways.

List of Other Instructions for maintenance

SMI No.	Rev.	Regarding	Description of the item
TI/IN/0001	0	PSI, Control voltage	Instruction for Booster Transformer & return conductors in 25 KV AC traction system.
TI/IN/0002	0	Shunt capacitor	Guidelines for design of fixed compensation for improving power factor at 25 KV, 50 Hz Traction sub-station.
TI/IN/0008	0	Copper cross feeder	Instruction for use of cupper cross feeders at switching station.
TI/IN/0009	0	OHE, Spider	Instruction for splicing of 19/3.99 mm Aluminium conductor (spider).
TI/IN/0011	0	TSS	Guidelines operating procedures of TSS in Mumbai area.
TI/IN/0012	0	Insulators	Instruction for action to be taken for failure prone insulators, insulators suspected to be failure prone and those to retained in service.
TI/IN/0013	0	Composite insulators	Action to be taken by Divn/OHE depots for handling of composite insulators.
TI/IN/0014	0	Use of DRPC	Instructions for use of DRPC on Indian Railways.
TI/IN/0015	0	SS Rope lubrication	Application of lubrication on wire rope used with ATD.
TI/IN/0016	0	Transformer	Guidelines for parallel operation of traction transformer on IR.
TI/IN/0017	0	Protection on parallel operation of transformer	Guidelines on protection scheme with parallel operation of 2x21.6 MVA traction transformer.
TI/IN/0018	0	Panto flash over relay	Application of existing panto flash over relay at TSS for single line section on IR.
TI/IN/0019	0	Harmonics measurement	Instruction for load profile, current & voltage harmonics measurement & recording in 25 KV AC traction sub-station.
TI/IN/0020	0	Replacement of computers at RCC	Instruction for timely replacement & upgradation of computers at RCC of traction SCADA system on IR.
TI/IN/0021	01/10	Data transfer speed of SCADA	Instruction for increasing data transfer sped of the traction SCADA system on IR from 600/1200 bps to min. 9600 bps.
TI/IN/0022	02/10	Relay setting guide lines	Setting guidelines for traction transformer & 25 KV shunt capacitor bank protection relay developed as per RDSO specification no. TI/SPC/ PSI/ PROTCT/6070(09/08) for 25 KV AC TSS.

SMI No.	Rev.	Regarding	Description of the item
TI/IN/0023	02/10	Operating RTU for SCADA	Instructions for operating RTUs with power supply of 110 V DC (in place of 240 V AC) for existing traction SCADA system on IR.
TI/IN/0024	06/10	Feeder CB tripping for 25 KV Traction	Instruction for monitoring & analysis of Feeder Circuit Breaker Tripping for 25 KV AC Traction systems.
TI/IN/0025	08/10	SCADA	Technical Instructions for improving reliability of traction SCADA systems on IR.
TI/IN/0026	09/10	Relay setting guidelines	Protection scheme and relay setting guidelines for 25 KV AC traction sub-station provided with 30 MVA traction transformer.
TI/IN/0027	10/10	Numerical relay maintenance practice	Technical instructions on maintenance practices to be adopted for numerical type microprocessor based protection relay modules for 25 KV AC traction system on Indian Railways.
TI/IN/P&S/0028	12/10	Feeder circuit breaker	Implementation of feeder circuit breaker backup feature in different makes/types of feeder protection modules provided in C & R panels as per old RDSO Spec. No. ETI/PSI/65 (01/97).
TI/IN/0029		Vectorial Delta-I	Technical instructions on important aspects of relay settings of Vectorial Delta-I relays as per RDSO Specification No. TI/SPC/PSI/PROTCT/1982.
TI/IN/0030	05/11	Lightning arresters	Technical instructions related to the installation and commissioning of the 42 KV metal oxide gapless lightning arresters provided on traction systems on Indian Railways.
TI/IN/0031	04/13	Setting up earthing station	Special maintenance instruction for setting up earthing station at switching posts (SSP & SP).
TI/IN/0032	Rev 1	Setting up earthing station	Special maintenance instruction for setting up earthing station at switching posts (SSP & SP).

APPENDIX-16

TYPE TEST FOR SIQNALLINQ ITEMS

In case Employer is fully satisfied with the consolidated report of the assessment, approval shall begiven for type testing of prototype sample.

The type testing of prototype sample shall be undertaken to the satisfaction of Employer.

Type tests shall be carried out on specific items to ensure that they perform their intended functions when subjected to all permutations and combinations of external environment and other factors.

The following tests shall constitute type tests :

Visual inspection tests
Insulation resistance tests
Card level functional and fail safety tests
System level functional and fail safety tests
Computerized testing
EMI/EMC tests
Environmental / Climatic Tests
System Diagnostic Tests
System Software Test
Any other test deemed necessary

Manufacturer shall submit a comprehensive type test plan including procedure, type test formatand expected results. The type test plan shall be finalized in consultation with Employer / ISA / Engineer.
Type tests shall be carried out at manufacturer's premises. Necessary testing equipment andcompetent man power shall be made available by the manufacturer.
Type test shall be carried out by Employer representative / ISA.
Tests which cannot be carried out in house may be referred to independent test house ofrepute.
EMC / EMI tests may not be required if previous independent witness tests have beensuccessfully carried out and reported by document.

Field trials for Siqnallinq items

The field trials shall be conducted to the satisfaction of the Employer.
The field trials shall be held on Indian Railways / HORC as decided by Employer. Employer shall coordinate with IR for this purpose.
The Contractor / Manufacturer shall make all arrangements for conducting field trials. This shallinclude; but not limited to; supply, installation, commissioning and monitoring of the equipment.
The trials shall be monitored in the following manner —

S N	Name of Division /Railway / Section	Name of station	Equipment Model and version no.	Date of installation	No. of failures*	Remarks

* Analysis of cause of failures to be attached.Duration of field trial

SN	Item / Equipment	Initial trial	
		Number of equipment	Duration
1.	EI	01	180 days in parallel and/or standalone mode or a combination thereof as decided by Employer.
2.	BPAC & DAC	01	180 days in parallel and/or standalone mode or a combination thereof as decided by Employer

NOTE:

The number of equipment and duration can be suitably revised, as required, by Employer.
Employer shall decide if field trials and type test can proceed simultaneously or not.

Appendix 17

Policy Circular No. 02/16

NORTHERN RAILWAY
Head Quarter Office,Baroda House,New Delhi.
No. 256-Sig/O/SG/Pt-XV Dated- 22.08.2016
CSTE/Project, CSTE/Project-West, CSTE/Project-HQ, CSTE/Construction, Baroda House, New Delhi.
Sr.DSTEs,
Northern Railway,DRM office,
DLI, FZR, LKO,MB & UMB.
Sub- Guidelines for Signalling Cables Laying on Northern Railway.
Ref- i) RDSO's Letter No. STS/E/Cable Laying Practices dated 31.10.11 & 07/11.03.14
This office letter No. 256-SIG/O/SG/Pt-XII dated 01.12.2011.
ML's DO letter No. 2011/SIG/SF/1/Cable Laying dated 15.11.2011circulated vide this office letter No. 256-SIG/O/SG/Pt-XII dated 29.11.2011.
Railway Board's JPO/Telecom Circular No. 17/2013 issued vide Railway Board letter No. 2003/Tele/RCIL/1/Pt-IX dated 24.06.2013.
RDSO has issued guidelines on Signalling Cable laying under reference (i) & ML's D.O. letter No. 2011/SIG/SF/1/Cable Laying dated 15.11.2011 circulated vide this office letter No. 256-SIG/O/SG/Pt-XII dated 29.11.2011 under reference (iii)**.** Further, Railway Board has issued JPO/Telecom Circular No. 17/2013 (under reference iv) for undertaking digging work in the vicinity of underground Signalling, Electrical and Telecommunication Cables. These guidelines have been discussed and deliberated upon in the HQ office as per the requirement & existing practice of Cable laying on Northern Railway and accordingly, guidelines for Cable laying to be adopted on Northern Railway have been prepared.
The important items for Signal cable laying to be adopted on Northern Railway are as under :-
PI/RRI/EI installations with more than 100 routes :-
Duplicated Power cable arrangement shall be adopted for PI/RRI/EI installation having more than 100 routes for External circuits i.e. 24V DC/ 60V DC External for Track proving & Point detection, 110V AC for Track Feed Battery charger, External 24V DC for Axle Counter, BPAC etc. (Ref- Para No. 3.5.3 of RDSO guideline).
Laying of Signalling cable from Home to Home Signal for PI/RRI/EI installations having more than 100 routes shall be done in RCC duct of 500mm width with removable top cover as per NR Drawing No. NR/Sig/Cable/002 & 003 (Annexure -9 & 10). Beyond Home Signal and upto Distant Signal, Normal trenching as per extant practice shall be continued. (Ref- Para No. 7.3.7 & 7.3.8 of RDSO guideline).

PI/RRI/EI installations with less than 100 routes :- For less than 100 route PI/RRI/EI installations, RCC ducting from Home to Home signal shall be adopted for works sanctioned prior to 2016-17 to the extent possible. Subsequently, from 2017-18 onwards all abstract estimate at PWP level should take care of full implementation of this guideline for all stations irrespective of number of routes. Beyond Home Signal and upto Distant Signal, Normal trenching as per extant practice shall be continued. (Ref- Para No. 7.3.7 & 7.3.8 of RDSO guideline).
Only in Automatic Signalling territory, between Advance Starter of one station and Home

Signal of other station, RCC duct with 300mm width as per NR Drawing No. NR/Sig/Cable/001(Annexure -8) shall be adopted. (Ref- Para 7.3.8 of RDSO guideline). From 2017-18 onwards, all abstract estimate at PWP level should take care of full implementation of this guideline.

In Para No. 7.3.11 of RDSO guideline, RCC duct is to be laid at the depth of 600mm to 1000mm. This para has been modified as "*The RCC duct shall be laid at the depth such that the top of RCC cover is at the depth of Minimum 690 mm below ground level."*

Laying cable in Solid & Rocky soil

In Para 7.4.1 of RDSO guidelines, following has been added as :

"However, before finalising tender schedule for Cable laying in solid/rocky soil area , detailed site survey should be conducted by min. Assistant level Officer, its report to be placed on record & approval taken from JAG level officer executing the work & accordingly quantity and depth of Cable laying in solid/rocky soil area to be finalised."

Para 7.4.3 has been modified as below:-

"In case, sharp edge of rocky ground cannot be prevented with sifted earth, GI pipe of medium grade of ISI mark as per IS: 1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In-charge. Inspection of GI pipe shall be done by RITES. In isolated cases, Rocky ground can be given smooth surface by using either masonry bricks or cement concrete."

Sketch No. NR/SIG/Cable/004 showing Cable Laying in rocky area is enclosed (Annexure-11)

Track Crossing - DWC-HDPE pipe of suitable diameter as per RDSO specification RDSO/SPN/204/2011 shall be used as per NR drawing No. NR/Sig/cable/005 **(Annexure-12).** Diameter of DWC-HDPE pipe shall bedecided by Engineer In-charge. (Ref: Para 8.2 (iii) of RDSO guideline).Inspection of DWC-HDPE pipe shall be done by RITES.

Road Crossing :- GI pipe of medium grade of ISI mark as per IS: 1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In-charge. Inspection of GI pipe shall be done by RITES **(NR drawing No. NR/Sig/cable/006 as Annexure-13, Ref: Para 9.1 of RDSO guideline).**

Cable laying on Bridges/Culverts –

For Cable laying on bridges/culverts with high flood level, reference Para 10.2 ofRDSO guideline, following shall be adopted:-

On approach of Bridges/Culverts, DWC- HDPE pipe of suitable diameter as per RDSO specification RDSO/SPN/204/2011 shall be used. Diameter of DWC-HDPE pipe shall be decided by Engineer In- charge.

On Bridge/Culvert portion, perforated GI pipe of medium grade of ISI mark as per IS:1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In- charge.

At junction point of GI and DWC pipe, a GI bend of 112.5 degree, 1 mtr. Length as per IS 1239 (Part-2): 2011 and overlapping 250mm with DWC pipe shall be used.

Inspection of DWC-HDPE and GI pipe shall be done by RITES. A sketch No. NR/SIG/CABLE/007 showing cable laying on bridges/culverts with high flood level is enclosed **(Annexure-15)**.

Cable laying on Arch bridges :- For Cable laying on Arch bridges, reference Para 10.4 of RDSO guideline following shall be adopted :-

On approach of arch bridge, DWC- HDPE pipe of suitable diameter as per RDSO specification RDSO/SPN/204/2011 shall be used. Diameter of DWC- HDPE pipe shall be decided by Engineer In- charge.
On Bridge portion, perforated GI pipe of medium grade of ISI mark as per IS:1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In-charge.
At junction point of GI and DWC pipe, a GI bend of 112.5 degree, 1 mtr. Length as per IS 1239 (Part-2): 2011 and overlapping 250mm with DWC pipe shall be used.
Inspection of DWC-HDPE and GI pipe shall be done by RITES. A sketch No. NR/SIG/CABLE/008 showing Cable laying on arch bridges is enclosed **(Annexure-18)**.
Cable laying on bridges/culvert with low flood level and metallic bridges shall be asper existing RDSO guidelines.

Planning for Cable route:- A new para 4.7 regarding Planning for cable routehas been incorporated. The details are as below:-

Para 4.7 : The cable trench should be as straight as possible. Cable Route Plan

should be immediately prepared after laying of the cable showing exact location of cables at an interval of every 30 - 40 meters also showing various protective measures provided like RCC duct, DWC pipe, GI pipe, GI trough etc. **After the submission of Cable route plan showing protective works, the payment to the contractor for complete trenching and Cable laying of the station to be released. This should be mentioned as special condition of the contract.**

12. **Laying of different type of cable in same trench** :- It is highlighted that for Laying of different type of cables in the same trench, para 7.2 of RDSO guideline to be followed strictly, particularly Signalling cables must be separated from power cables by a row of bricks between them as mentioned in Para 7.2.2. For this sketch No. SDO/CABLE LAYING/004 showing laying of signalling cable & Telecom/Power cable in same trench as enclosed **(Annexure-7)** should be ensured.

The detailed guidelines for Signal Cable laying (in 47 pages) to be adopted on Northern Railway are enclosed herewith. It is advised that these guidelines are circulated to all field executives to ensure its strict implementation in all future works.

This is issued with the approval of CSTE.

DA/ Guidelines in 47 pages
(Based on "Guideline on Signalling Cable laying" Version 1.1 issued by RDSO vide letter No. STS/E/Cable laying Practices, dated 07/11.03.2014)

22.8.16

(V. K. Pandey)
Dy.C.S.T.E./P&D
for G.M./S&T

Copy to/-

1. **CSTE/CORE,** 1, Nawab Yusuf Road, Civil Lines, Allahabad for kind information & necessary action please.
2. **CMD/RVNL,** Plot No. 25, Ist Fir, B-Block, August Karanti Bhawan, Bhikaja Cama Place, New Delhi for kind information & necessary action please.
3. **CMD/DFCCIL,** 5th Floor, MRTS Building, Pragati Maidan, Metro Station, New Delhi for kind information & necessary action please.
4. **Chief Workshop Manager,** N. Railway, Ghaziabad for kind information please.
5. **Principal/STTC,** Ghaziabad for information please.

GUIDELINES

ON

SIGNALLING CABLE LAYING

TO BE FOLLOWED ON NORTHERN RAILWAY

Number of Pages - 47

(Based on "Guideline on Signalling Cable laying" Version 1.1 issued by RDSO vide letter No. 7STS/E/Cable laying Practices,dated 07/11.03.2014)

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Background

The Signal Engineering Manual (SEM) covers broadly various instructions on laying of signalling cables. Railway Board have also issued guidelines on the subject from time to time. This issue of cable laying practices has also been discussed in many forums like CSTE's Conference, MSG's etc.

On account of multiple faults in the cable and inadequate protection arrangement against short/open circuit faults, failures of point and other signalling gears have taken place on various Zonal Railways. In some of the cases, Railways signalling cables are invariably damaged by JCB & other track machine operated by Engineering Department, which resulted in serious dislocation to train services inviting criticism from different quarters.

Following documents are also considered while preparing this document:-

RDSO guideline on Signalling cable laying issued vide RDSO's Letter No.STS/E/Cable Laying Practices dtd 31.10.11 & 07/11.03.14.

Railway Board's Joint Procedure Order/Telecom Circular No. 17/2013 issuedvide Railway Board letter No. 2003/Tele/RCIL/1/Pt-IX dated 24.06.2013.

Cable Laying Practices adopted on WCR.

Railway Signalling Installation and Quality Handbook.

These guidelines on signalling cable laying containing consolidated instructions on the subject are being issued for uniform adoption on Northern Railways.

General

Railway signalling circuits shall normally be carried on cables. For new works, signalling circuits shall only be carried on cables. In 25 KV AC electrified areas overhead lines shall not be used.

Planning for cables

Cables used for carrying signalling, circuits shall conform to relevant approved specification. The conductors used shall be of annealed copper and of approved size. For this purpose, specification No. IRS:S 63 may be referred.

Power cable used for carrying power supply for signalling circuits shall conform to relevant approved specification. The size of conductor shall be so selected as to suit the electrical load. For this purpose, specification No. IRS:S 63 may be referred.

The Core-wise usage of signalling cable is as given below:-

Core & Cross section	**RDSO Specification**	**Usage**
6 Core × 1.5 mm^2	IRS S 63	Tail Cable
12 Core × 1.5 Sq. mm^2	IRS S 63	Tail Cable/LC Gate/ Main Cable
19 Core × 1.5 Sq. mm^2	IRS S 63	Main Cable
24 Core × 1.5 Sq. mm^2	IRS S 63	Main Cable
30 Core × 1.5 Sq. mm^2	IRS S 63	Main Cable
2 Core × 2.5 Sq. mm^2	IRS S 63	Track circuit lead connections
12 Core × 2.5 Sq. mm^2	IRS S 63	Main/Tail Cable
2 Core × 16 Sq. mm^2	IRS S 63 & IS 1554	Power cable
2 Core × 25 Sq. mm^2	IRS S 63 & IS 1554	Power cable
2 Core × 35 Sq. mm^2	IRS S 63 & IS 1554	Power cable
2 Core × 50 Sq. mm^2	IRS S 63 & IS 1554	Power cable
4/6 Quad Cable (0.9 mm)	IRS TC:30	Axle Counter

A cable core distribution plan is required to be prepared for each installation. Cables for power distribution shall be indicated for each signaling gear. A sketch No. SDO/CABLE LAYING/001 showing typical main cable distribution plan including power cable for field gears for a typical double line (4 lines) PI station is enclosed **(Annexure-4)**.
The distribution of various power supplies for operating signalling gear in yard shall be covered in cable distribution plan. However, following guidelines may be followed:-
In general, following power supplies are required to be distributed on each side of the station:-
110V AC for track feed battery charger etc.
24/60 DC for external for TPR, point detection etc.
24 DC external for electronic equipment like Axle Counter, BPAC etc.

The above power supplies as per the requirement of the station may be extended on each side of station and terminated at all main location boxes/huts.
Duplicated Power cable arrangement shall be adopted for PI/RRI/EI installation having more than 100 routes for External circuits i.e. 24V DC/ 60V DC External for Track proving & Point detection, 110V AC for Track Feed Battery charger, External 24V DC for Axle Counter, BPAC etc. to avoid major signalling breakdown affecting punctuality of train services during any damage/cable becoming faulty. A changeover switch may be provided at either end of the station for extending the alternate power supplyin case of failure.
In RE area, for automatic signalling, IBH, mid-section, level crossing gates and at station where location boxes/huts are more than 2 km power supply may be taken from auxiliary transformer.
In Non-RE area, for automatic signalling, IBH and mid-section level crossing gates, power supply may be extended from stations on either side. The arrangement shall be such that the power supply from one of station can be extended while at same time power supply from other station shall remain isolated.
While planning for cabling on a route, the number of conductors required, for the circuits shall be first determined. Recommended core sizes shall be used.
Adequate spare conductors to a minimum of 20% of the total conductors used shall be provided for in each main cable up to the farthest point zone, beyond this there shall be a minimum of 10% spare conductors of the total conductors used. The spare conductors shall be provided on the outermost layer.
2 numbers of 12 Core dedicated spare cable from home signal to home signal may be laid and terminated in all locations for instant transfer of these dedicated conductors in case of cable failure and cable testing.

Where a number of cables have been laid along a route, the circuits shall be so distributed that cables can be disconnected for maintenance purpose with theleast possible dislocation to traffic. Line wise and, if necessary; function wise cable shall be provided. Auxiliary signals shall be taken in different cables.
Separate cables of suitable size shall be laid for point operation.
Numbering of cable to be done in ascending order from right hand side of the cable core distribution plan.
Number of location boxes shall be kept at minimum. Where too many locations boxes (say more than 10) are coming in a close proximity generally between starter & home signal, it is proposed to use location huts instead of location boxes for security, proper protection and ease of maintenance.
Prefabricated huts (approximate size 10 feet x 10 feet) may be used, the drawing/design of which shall be issued by RDSO separately.

Planning for cable route

After deciding the size and the number of conductors in the different types of cables to be used on a

route, a foot survey along the track shall be done to determine the best route for the cable.
The route shall be shown clearly on a cable route plan showing the actual alignment of track, giving offsets from permanent way or permanent structures. The diagram shall indicate the various road and track crossings, crossing with power cables, water and sewage mains and other points of importance. It is preferable to chart the route on a route plan on which the existing routes of power cables, etc. are shown. Changes, if any, shall be incorporated in the chart/plan.
While planning cable route plan, any future yard modification/doubling etc. shall also be kept in view. Cable route plan shall also be approved by Engineering and Electrical Department. Cable route plan shall also be approved by Branch Officer of Signal & Telecom (Open Line) wherever it is prepared by organization other than open line.
As far as possible low lying areas, platform copings, drainages, hutments, rocky terrains, points and crossings, shall be avoided.
Wherever JCB/Mechanized trenching or any kind of digging cases near existing cables is resorted, instructions contained in Railway Board Joint Procedure Order/Telecom Circular No. 17/2013 issued vide Railway Board letter No. 2003/Tele/RCIL/1/Pt-IX dated 24.06.2013 (Annexure-1) shall be followed.
The cable trench should be as straight as possible. Cable Route Plan should be immediately prepared after laying of the cable showing exact location of cables at an interval of every 30 - 40 meters also showing various protective measures provided like RCC duct, DWC pipe, GI pipe, GI trough etc. Afterthe submission of Cable route plan showing protective works, the payment to the contractor for complete trenching and Cable laying of the station to be released. This should be mentioned as special condition of the contract.
Laying of cable above ground
Signalling cables for outdoor circuits shall not normally be laid above ground.In exceptional cases where it becomes unavoidable, the following precautions shall be taken:-
The cable shall be suspended in wooden cleats, from cable hangers orin any other approved manner so that no mechanical damage occurs to the cable even under exposed condition.
The cable supports shall be so spaced as to avoid sag.
In station yards, cable shall be laid in ducts suitably protected.
Indoor signalling cable shall normally be laid on ladders, channels or in any other approved manner. The cables shall be neatly tied/laced.
In AC electrified areas cables shall be laid underground only. For laying cables in RE area instructions laid down in Chapter XXII of SEM shall also be followed. Extract of this chapter are available in para 22 of these guidelines.
Excavation and backfilling of the trenches
Manual trenching is recommended for laying of signalling cables in the station yards from Home to Home signal and mechanized trenching is recommended from Home to distant signal and beyond into block/automatic section.
Under road/platforms/railway tracks/difficult terrain etc., trench less horizontal directional drilling (HDD) method may be adopted under the supervision of competent staff for laying of GI/DWC-HDPE pipe. Both ends of GI/DWC-HDPE pipes shall be closed properly using accessories and the pits shall be properly backfilled. There shall be no damage to the road/platform/tracks or any such structures etc. enrooted during or after the HDD operations.
Excavation of cable trench shall be made in all kinds of soils including clearing roots of trees, rocks etc. Trenches shall be straight as far as possible and steep angles shall be avoided.
The bottom of the trench shall be levelled and got rid of any sharp materials. No sharp object like stone chips, iron pieces etc. shall ever come in contact with laid cables irrespective of the method of laying

the same.
After cable has been laid and until the whole of the cables to be laid in the trench have been covered with their protective covers, no sharp metal tool such as spades, crowbar or fencing pins shall be used in the trench or placed in such a position that they may fall into the trench.
When cables are laid in trunking, care shall be taken to see that no ballast or stones have been dropped inside the trunking. The trunking shall be clearedof all ballast and stones before the cover is secured.
When the ends of covers are joined together with cement plaster, a piece of paper or wood shall be placed under the joint to prevent the cement plaster from falling on the cable.
It is desirable that the excavation of the trenches is not done in long lengths and does not remain uncovered for long period. It is preferable that cables are laid and refilling done on the same day.
Before commencement of the laying, inspection of the trench and inspection of protection works shall be carried out so as to ensure their conformity with the specification. A sketch No. SDO/CABLE LAYING/022 rule made of pipe for measuring depth is enclosed **(Annexure-25).**
Backfilling of the trenches shall be done properly. The earth excavated shall be put back on the trench, rammed and consolidated.
During excavation, the earth of the trenches shall not be thrown on the ballast. The earth shall be thrown by the side of the trenches away from the track.
Cable laying in underground
General
Cables may be laid underground, either in the trench, in ducts, in cementtroughs, in pipes or in any other approved manner.
Cables shall be laid generally as per instructions given in these guidelines. However, special precautions to be taken in the station yards etc. where a number of other utilities may be existing, may be detailed in a joint circular issued by the Civil Engineering, Signalling and Electrical Department (where applicable) of the Railway. Railways may provide any additional protection as necessary at a particular location due to prevailing law and order problem.
Cable is generally laid parallel to the track beyond Home signal with minimum deviations and on one side of the yard.
As far as possible, cable shall be crossed only at two locations, i.e. one crossing on each side of the yard.
The cable laid parallel to the track shall be buried at a depth of minimum 1.0 metre (top most cable) from ground level. A sketch No. SDO/CABLE LAYING/003 showing cable trench is enclosed **(Annexure-6)**. While those laid across the track must be minimum 1.0 metre below the rail flanges. However, in case of rocky soil, the depth may be reduced suitably. When it concerns the laying of tail cables which serve the track apparatus etc. the depth shall not be less than 0.50 metres. In theft prone areas the cables may be laid ata depth of 1.2 metres with anchoring at every 10 metres.
The width of manually made cable trenches shall commensurate with numberof cables. The minimum width shall be kept as 0.3 meters. The bottom of the cable trench shall be levelled and got rid of any sharp materials. In the soft ground, the cable shall be laid at the bottom of the trench previously levelled. In the rocky ground, the cable shall be laid on a layer of sand or sifted earth of 0.05 metre thickness previously deposited at the bottom of the trench. In both the above cases, the cable shall be covered with a layer of sand or sifted earth of 0.10 metre thickness and thereafter a protective cover of trough or a layer of bricks shall be placed.
Normally, not more than 12 cable are to be laid in one trench as it shall be difficult to attend failure at a later date. At a moderate size station with electrical signaling installation, generally the numbers of cable are more up to home, it is recommended that cables are laid in RCC duct up to home signalon both side of the station and may be extended up to distant, if required. This will also help later for laying

of additional cable later without carrying out trenching.
While laying the cables in accordance with the above instructions, the following instructions shall be adhered to for the safety of the track:-
Outside the station limits, the cables shall generally be laid at not less than 5.5 metre from the centre of the nearest track.
Within the station limits, the trenches shall preferably be dug at a distance of not less than 3 metre from the centre of the track, width of the trench being outside the 3 metre distance.
At each end of the main cable an extra loop length of 6 to 8 metre shall be kept.
Extra loop length of the cable should also be buried at same depth as that of cable in the same trench and not projected outside to ensure that cable is free from theft/outside interference.
Before starting cabling work location boxes shall first be erected so that cable after laying is directly taken inside location box and its multiple handling/damage by re-digging and taking inside location box/Relay Room is eliminated.
A sketch No. SDO/CABLE LAYING/002 showing position of trenches for cable laying is enclosed **(Annexure-5).**

Laying of different type of cable in same trench

Where several cables of different categories have to be laid in the same trench, they shall be placed as far as possible in the following order starting from the main track side, so that in the event of failures, the maintenance staff may easily recognise the damaged cables:-
Telecommunication cable
Signalling cable
Power cable
A distance of approximately 10 cm must be maintained between telecommunication cable and signalling cables. The signalling cables must be separated from power cables by a row of bricks between them.
A sketch No. SDO/CABLE LAYING/004 showing laying of signalling cable & Telecom/Power cable in same trench is enclosed **(Annexure-7)**.

Cable laying in ducts

RCC duct masonry or any other approved type of ducts may be used for laying the cable. The ducts shall have suitable covers and shall rest on walls of duct.
The ducts shall be of such design as to prevent water collecting in the duct.
After placing the trunking in the trench the ducts have to be aligned using 8 mm rod. For this purpose, a hole is left in the trunking for insertion of rods. Wherever there is a diversion proper care shall be taken to cover the cables, either by smoothly forming a curve with duct or a masonry structure can be constructed to protect the cables. After laying of cables the ducts shall be covered with RCC slab and shall be continuously plastered at the end with trunking.
When cables are laid in rocky area, it is desirable to protect them with split RCC ducts of suitable design.
Where it is necessary to take the cable between the tracks, it shall be carried in trunking kept sufficiently below the ballast level.
Cables for longer distances shall be laid on bottom layer. Duct shall be filled up with sand after cable is laid to avoid entry of rodents.
From Home to Home Signal, where number of signalling cables required are more, RCC duct of 500mm width with removable top cover shall be used for laying of Signalling cable for PI/RRI/EI installation having more than 100routes. Beyond Home Signal and upto Distant signal, Normal trenching as per extant practice to be continued.
Only in Automatic Signalling territory, between Advance Starter of one station and Home Signal of other station, RCC duct with 300mm width shall be used.

Partition of RCC duct for accommodating different types of signalling/telecom cables/ power cables may be provided, wherever required. This can be achieved by earmarking about 80% of inner space for multi core signalling/ telecom cables and the remaining 20% of space for carrying power cable more than 110V in a separate of chamber.

The RCC duct shall be laid at the depth such that the top of RCC cover is at the depth of Minimum 690 mm below ground level.

A sketch No. NR/Sig/Cable/001, 002 & 003 showing RCC duct is enclosed (Annexure-8, Annexure-9 & Annexure-10).

For jointing ends of RCC ducts precaution should be taken for proper alignment of RCC ducts, so that gap between two ducts is kept minimum.

Laying cable in solid & rocky soil

In case of rocky soil the depth may be reduced suitably. However, before finalising tender schedule for Cable laying in solid/rocky soil area , detailed site survey should be conducted by min. Assistant level Officer, its report tobe placed on record & approval taken from JAG level officer executing the work & accordingly quantity and depth of Cable laying in solid/rocky soil area to be finalised.

Sharp edges on the sides must be smoothened out and bottom of the chaseshall be leveled. In the rocky ground the cable shall be laid normally on layer of sifted earth of 0.05 metres thickness previously deposited at the bottom ofthe trench. Cable shall be covered with the layer of sand or sifted earth of 0.1 metre thickness.

In case, sharp edge of rocky ground cannot be prevented with sifted earth, GI pipe of medium grade of ISI mark as per IS: 1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In-charge. Inspection of GI pipe shall be done by RITES. In isolated cases, Rocky ground can be given smooth surface by using either masonry bricks or cement concrete.

A row of bricks shall then be placed lengthwise on the top and jointed with cement mortar and a layer of concrete with cement plaster shall be provided on the top of the same. A sketch No. NR/Sig/Cable/004 showing laying of cables in rocky area is enclosed (Annexure-11).

Laying in special soil condition

Cable shall not be run through abnormally high acidic or alkaline soil or through sewages. If this is unavoidable special measures shall be taken against corrosion. Cable may be laid in the Concrete/GI/CI/PVC/DWC-HDPE pipe properly jointed to prevent ingress of moisture.

Cable laying in residential area

When laying the cable in residential area, the cable shall be specially protected on both sides up to a distance of about 300 metres beyond the building line. In such cases, the cable shall be protected by means of concreting of 50 mm as proposed for rocky soil. This is better than using bricks as in a residential area bricks are usually found while digging and its special significance of cable protection may be overlooked.

Cable laying in large yard and suburban area

Main signalling cable in large yards including suburban section shall be laid in RCC ducts/DWC-HDPE pipes.

Tail cables shall be laid through DWC-HDPE pipes of suitable sizes and buried in trenches at a depth of not less than 1000 mm from ground level.

Track crossing

As far as possible, cable shall be crossed only at two locations, i.e. onecrossing on each side of the yard.

When a cable has to cross the track, is shall be ensured that-

The cable crosses the track at right angles;

The cable does not cross the track under points and crossings and

The cable shall be laid in DWC-HDPE pipes of suitable diameter as per RDSO specification RDSO/SPN/204/2011 shall be used. Diameter of DWC-HDPE pipe shall be decided by Engineer In-charge. Inspection of DWC – HDPE pipe shall be done by RITES.
Cable laid across the track must be 1.0 metre (minimum) below the rail flanges.
No digging shall be done below the sleepers. Digging work while crossinga track shall be done between sleepers in the presence of a Railways representative.
A sketch No. NR/Sig/Cable/005 showing track crossing is enclosed (Annexure-12).
Road Crossing
The cable shall be laid in GI pipe of medium grade of ISI mark as per IS: 1239 (Part-I) of suitable diameter at the depth of 1 metre from the ground level while crossing the road. It shall extend 1 metre (minimum) on each side of the road keeping in view the future increase of width of the road. Diameter of GI pipe shall be decided by Engineer In-charge. Inspection of GI pipe shall be done by RITES.
When crossing roads, it is necessary to lay the cables in such a manner as to avoid the necessity of bending the cable sharply and minimise the excavation of road surface as far as possible.
The crossing of main roads often involves difficulties, especially if traffic is heavy. Precautions to avoid accidents to workmen, pedestrians and vehicles shall be taken. On minor roads, which can be temporarily closed to traffic it is possible to open up across the entire width of the road, pipes shall be installed quickly in the cutting, which is then filled in there by reducing to a minimum the time for which the road is closed.
Some roads, which are broad, may be opened for half their width allowing the other half for use of traffic, pipes are laid, trench filled in the first half and the other half opened up after the first half is opened half is linked with those laid in the first half.
Whenever a cable is laid across an important road, particularly one with a special surface, it is good investment to provide for future expansion. Either the following methods may be adopted:-
The size of the pipe shall be so chosen that provision for laying few cable is future is kept in view. Pipes having diameters ranging from 100to 200 mm are suggested, or
A spare pipe may be laid, through which a cable can be drawn when required. It will be advantageous to leave a lead wire of G.I. wire in the pipe for drawing the cable in future.
A separate pipe of suitable dia shall be used for telecommunication cable.
A sketch No. NR/Sig/Cable/006 showing road crossing is enclosed (Annexure-13).
Cable laying on bridges/culverts

Wherever practical, the cable may be taken underground across the drain bedat a suitable depth for crossing small culverts with low flood level. A sketchNo. SDO/CABLE LAYING/011 showing cable laying on culverts with low flood level is enclosed (Annexure-14).
Where cable may not be taken underground across the drain bed, cable shall be taken on the culvert following shall be adopted:-
On approach of Bridges/Culverts, DWC- HDPE pipe of suitable diameter as per RDSO specification RDSO/SPN/204/2011.
On Bridge/Culvert portion, perforated GI pipe of medium grade of ISI mark as per IS:1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In- charge.
At junction point of GI and DWC pipe, a GI bend of 112.5 degree, 1 mtr. Length as per IS 1239 (Part-2): 2011 and overlapping 250mm with DWC pipe shall be used.
Inspection of DWC-HDPE and GI pipe shall be done by RITES. A sketch No. NR/Sig/Cable/007 showing cable laying on culverts with high flood level is enclosed (Annexure-15).
When cables have to cross a metallic bridge, they shall be placed inside a metallic trough. which may be filled, as an anti-theft measure, with sealing compound. The cable shall be supported across the bridge in

a manner which would involve minimum vibrations to the cable and which will facilitate maintenance work. Adequate cable length to the extent of 2 to 3 meters shall be made available at the approaches of bridge. A sketch No. SDO/CABLE LAYING/013 & 014 showing cable laying on metallic bridges is enclosed **(Annexure-16 & Annexure-17)**.

For Cable laying on Arch bridges, following shall be adopted -

On approach of Arch bridge, DWC- HDPE pipe of suitable diameter as per RDSO specification RDSO/SPN/204/2011.

On Bridge/Culvert portion, perforated GI pipe of medium grade of ISI mark as per IS:1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In- charge.

At junction point of GI and DWC pipe, a GI bend of 112.5 degree, 1 mtr. Length as per IS 1239 (Part-2): 2011 and overlapping 250mm with DWC pipe shall be used.

Inspection of DWC-HDPE and GI pipe shall be done by RITES. A sketch No. NR/Sig/Cable/008 & SDO/Cable Laying/016 showing cable laying on Arch bridges is enclosed **(Annexure-18 and Annexure- 19).**

Concreting of 50 mm shall be done throughout from entry/exit end of cable upto diversion point including slope on either side. The entry and exit ends of the cable from the pipe to the diversion point of the cable shall be concreted for 1 metre (minimum).

As the laying involves movement of a large number of staff over the bridge the line shall be blocked and flagman posted on other side. On a double line only the line near which the cable is being laid shall be blocked but care shallbe taken to see that staff are aware of this and measures taken to prevent staff from straying on to the unblocked line.

Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation, pier of bridge to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

In order to prevent theft and miscreant activities on approach of cable to bridge/culvert where it is not possible to ensure adequate depth, concrete protection is proposed.

Laying near to sleeper

In places where cables are to be laid within 1 metre from sleeper end, digging beyond 0.50 metre shall be done in the presence of an official from Engineering Department, and the laying of the cable and refilling of trench shall be done with least delay. Laying may be undertaken under block protection as needed.

Jumper cables for track circuits

There are numerous instances of jumper cable cut due to Engineering staff working. Such instances can be minimized if jumper cable is tied with the nearest sleeper. This shall be done on wooden sleepers using iron clamps/hooks. On PSC sleepers jumper cable shall be tied using clamps. A sketch No. SDO/CABLE LAYING/017 showing arrangement of jumper cable is enclosed **(Annexure-20)**.

Where sleeper ends, cable shall be buried underground in the line of sleeper and taken to TLJB.

Wherever required, cable may be laid in DWC-HDPE pipe.

Jumper cable shall be laid at least 0.5 metre below ground level excluding ballast depth.

Jumper cable shall be laid neatly in squared manner and shall not be kept in loose coils above the ground near TLJB.

Top surface of TLJB shall not be 1 feet above rail level.

Cable markers

Cable markers wherever provided shall be placed at 30-40 metre interval andat diversion points.
There are three types of cable markers in use in different Zonal Railways:-
Cast iron Tablet type cable markers.
Concrete cable markers.
Electronic Markers
Concrete cable markers can be adopted where RCC ducts are used or area is prone to theft. Concrete markers are projected above surface level for at least 300 mm.
A sketch No. SDO/CABLE LAYING/018, 019 & 020 showing cable marker is enclosed **(Annexure-21, Annexure-22 & Annexure-23)**.

Storing & transportation of cable

Cable drums shall not be stacked on flat side. Suitable stoppers shall be placed for stability.
Cable drums shall have easy access for lifting and moving.
When rolling the cable drum either for unloading or transportation, the drum shall always be rotated in the direction of the 'arrow' which is marked on the drum.
The drums shall not be rolled over objects that could cause damage to the protective battens of the cable.
When unloading is carried out from the vehicle the drum shall not be dropped on the ground directly to avoid damage due to impact. Fork lifter or ramp shall be used.
During all stages of storage, it is essential that the ends of the cable are effectively sealed by end cap or in any other approved manner to avoid waterentry into the cable.
It is desirable that cable drums are stored in covered shed to protect against direct exposure to sun.

Paying out the cable

For paying out cables, the cable drums shall be mounted on cable wheels. It shall be ensured that no kink is formed while paying out the cable. A sketch No. SDO/CABLE LAYING/021 showing method of unrolling cable is enclosed **(Annexure-24)**.
The drum on the wheel shall be brought to one end of the trench and the endof the cable freed and the cable shall be laid along the trench.
The cable duct shall be brought as close to the cable trench if possible. The cable drum shall clear the ground by 5 to 10 cm.
The wooden battens on the drums shall be carefully removed shortly prior to laying and before the drum is mounted on the jack.
A party of labourers shall move along the trench carrying cable at suitable intervals so that cable is not damaged due to dragging along the ground or bent unduly.
The in-charge of cable laying shall ensure proper synchronization of all labourers for smooth laying.
In cases where the wheels are not available, the drum shall be mounted on an axle at one end of the trench and cable paid out and carried by labourers.
In no case, shall the drum be rolled off on to the road for laying the cable andthe cable dragged on the ground for laying purposes.
Whenever mechanized equipment is used, the work shall be carried out by a trained operator under the supervision of SSE/SE/JE (Signal) in-charge of the work.
Where the cable drum is in damaged condition the cable may be placed on a horizontal revolving platform and the cable paid out in the same manner as given in paras above.

Paying out of cable shall be done by rotating the cable drum and not by pulling the cable with excessive force.
Wherever flaking of cable is required, it shall be done by making a succession of loops in the form of Figure '8', these loops being disposed on top of each other to avoid tangling of cable. Figure of '8' flaking shall only be carried out under the direct supervision of an experienced official.

Laying in monsoon season
It is not advisable to lay cables in monsoon when the precipitation is heavy. The trenches will be inundated and visual inspection of the bedding of the trench will be rendered difficult. Threading the cable in pipes will also be more difficult.
When however cable laying is necessary during the monsoon season, the cable ends shall be inserted in a pipe sealed at one end and the pipe buried. Termination work shall be started only when there is likelihood of a clear weather for three or four days.
Entry of cable at cabin, relay room, location boxes etc.
All cable entry points in cabin, relay room, battery room, SM's room, location boxes, location huts, junction boxes, etc. must be closed with suitable masonry works, sand covered and plastering to prevent entry of rats etc. RCC slab shall be provided on the cable pit of cabin and relay room/station.
Cable shall be protected on both sides up to a distance of 10 metre beyond building line of cabin, relay room, battery room, SM's room. In case of location boxes, location huts, junction boxes etc. cable may be protected for 1 metre on each side.
Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation/masonry to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

Cable termination

The cable termination of signalling cables shall be undertaken by providing suitable location boxes/junction boxes on approved type termination.
All the core of the cable (used or spare) shall be terminated on approved type termination in cabin/SM's office or apparatus cases. Each core so terminated will be provided with identification ferrules with letters or/numbers embossed on them as per requirement of circuitry.
Termination of signalling cable on CT rack in relay room and in location boxes shall be done duly using identification marking on cable and on conductors/terminals. This will enable easy identification of conductors in case of any failures or cable disconnections or cable cut done by outsider/ miscreants. A proper marking and termination practice ensures quick and easy restoration during failures.
For quad cable, jointing may be done as per instructions of Telecom Directorate of RDSO. For jointing of signal cable in straight portionarrangement shall be issued by RDSO separately.

Testing of cable

Before the cable is laid in the trench, a visual inspection of cable shall be made to see that there is no damage to the cable. It shall be tested for insulation and continuity of the cores. Thereafter, the cable shall be laid into the trench. Record of insulation and loop resistant must be maintained.
Testing of all main and tail cables after laying of the cable in trenches and also after termination in apparatus cases, in boxes and relay room shall be done.
Any defect noticed during the testing after laying the cable the same will be replaced.
All conductors in signalling cables must be tested for their insulation in dry weather every year as per

instructions in para 20 below. A comparison of the test results between successive tests carried on a cable under similar conditions will give an indication of the trend towards deterioration of the insulating material over a period of time. If a sudden fall in insulation is observed, the cause shall be investigated and immediate steps taken up to repair or replace the cable.
In addition to the regular testing of cables in dry weather, random tests in wet weather may also be carried out, where considered necessary, to localise any sudden deterioration in insulation of cables.
After completion of any P.Way work in the vicinity of existing cable, testingof all cable may be undertaken to verify proper working of cable.

Instructions for insulation resistance testing of signalling cable

General

These instructions apply only to cables used for Railway Signalling and do not cover open line wires and internal wiring.
Insulation Resistance tests shall be made in such a manner that safe operationof trains is not affected. It shall be ensured that no unsafe conditions are set up by the application of test equipment.
All conductors in signalling cables must be tested for their insulation at the time of commissioning and thereafter in dry weather every year preferably during the same part of the year.
The insulation resistance tests shall be made when conductors, cables and insulated parts are clean and dry.
In addition to regular testing of the cables in dry weather, random tests in wet weather may also be carried out where considered necessary.
The conductors of the cables possess appreciable electrostatic capacity and may accumulate electrostatic charge. The cable conductors shall be shorted or earthed to completely discharge any accumulated charge (i) before connecting the insulation tester while commencing the test (ii) before the insulation testeris disconnected when the test is completed. This is in the interest of safety of personnel and protection of equipment
A 500V insulation tester shall be used for insulation testing. The fact that the cable has capacitance means that it has to be discharged before a measurement of the insulation resistance can be made. The insulation resistance shall therefore be recorded after the test voltage has been applied for one minute or so when the indicator of the insulation tester shows a steady reading.
Any metallic sheath or metal work of any rack or apparatus case shall be bonded to earth during test.

Procedure

Disconnect all cores of a cable at both ends. The disconnection may be made through links of approved type terminals, if provided.
Connect one terminal of the insulation tester to the conductor under test and other terminal to all the other conductors being bunched together and connected to earth.
Similarly test remaining conductors of the cable one by one.
Insulation Resistance so measured shall not be less than 5 mega ohms per kilometer at buried temperature. If the insulation resistance is found to be lower than 5 mega ohms, the cause shall be investigated and immediate steps taken to repair or replace the cable to prevent any malfunctioning of the equipment and circuits.
The results of the insulation resistance tests shall be recorded in approved proforma. A comparison of test results between successive tests carried out on a cable under similar conditions will give an

indication of the trend towards deterioration of the insulation resistance of the cable. If sudden fall in the insulation resistance is observed the cause shall be investigated and immediate steps taken to repair or replace the cable.

Supervision of cable laying

The work shall be supervised at site personally by an official of the Signal & Telecommunication Department not below the rank of a JE/SE/SSE (Signal).

Orders will be given by the Inspector in charge only. He will be assisted by others at vulnerable places to inform him of the position and possible danger.

All concerned staff shall have full knowledge of their duties and the material handled by them.

No work shall be started unless all types of materials, tools consumable materials and staff are available.

Location boxes and junction boxes shall be in position. If the cable ends are left in the ground unattended, damage is likelyto take place.

Following record shall be maintained by JE/SE/SSE in-charge of the work/section:-

Cable route plan

Cable distribution chart

Cable termination diagram

Cable Testing Record : Summary Sheet, including supply details etc. as perAnnexure 2.

Cable Insulation Resistance Test Sheet as per Annexure 3.

Special requirements in 25 kV AC electrified area

Only unscreened cable shall be used.

Screened signalling cable may be used on signalling installations where screened cable is already in use and site condition demand its further use.

PVC insulated PVC sheathed and armoured unscreened cable to an approved specification (IRS-63) shall be used for carrying signalling circuits. Only approved type (IS-1554) power cable shall be used for signalling purposes.

The screened cable, if used, shall be PVC insulated, armored and to an approvedspecification IRS S-35.

The cable shall be so laid that it is not less than one meter from the nearest edge of the mast supporting the catenary or any other live conductor, provided the depth of the cable does not exceed 0.5 meters. When the cable is laid at a depth greater than 0.5 meters, a minimum distance of 3 meters between the cable and the nearest edge of the O.H.E structure shall be maintained. If it is difficult to maintain these distances, the cable shall be laid in concrete/heavy duty HDPE/Ducts or any other approved means for a distance of 3 meters on either side of the Mast. When so laid, the distance between the cable and the mast may be reduced to 0.5 meters. These precautions are necessary to avoid damage to the cable in the event of the failure of an overhead insulator.

In the vicinity of traction sub stations and feeding posts, the cable shall be at least one metre away from any metallic part of the O.H.E and other equipmentat the substation, which is fixed on the ground, and at least one metre away fromthe substation earthing. In addition, the cable shall be laid in concrete or heavy- duty HDPE pipes/or other approved means for a length of 300 meters on either side of the feeding point. As far as possible, the cable shall be laid on the sideof the track opposite to the feeding post.

In the vicinity of the switching stations, the cable shall be laid at least one metre away from any metallic body of the station, which is fixed in the ground, and at least 5 meters away from the station earthing. The distance of 5 meters can be reduced to one metre provided the cables are laid in concrete pipes/ heavy-duty HDPE pipes/ducts or any other approved means.

Where an independent Earth is provided for an OHE structure, i.e. where the mast is connected to a separate Earth instead of being connected to the rail, the cables shall be laid at least one metre away from the Earth.

Where there are O.H.E structures along the cable route, the cable trenches shall as far as possible, be dug not less than 5.5 meters away from the centre of the Track.
In a cable run, the number of circuits carrying 300V at any given instant shall not exceed three.
*Note: 300 V feed system shall not be used in future installations.
Drawings for cable laying
The sketches for cable laying in different areas, soils, bridges etc. are listed below and are enclosed. However, Railways may issue detailed drawings as per local requirement of Railways and number and size of cables required.

S.N.	Description	Drawing No.	Annexure
1.	TYPICAL MAIN CABLE DISTRIBUTION PLAN FOR DOUBLE LINE (4 LINES) PI STATION	SDO/CABLE LAYING/001	Annexure-4
2.	POSITION OF TRENCHES FOR CABLE LAYING	SDO/CABLE LAYING/002	Annexure-5
3.	CABLE TRENCH	SDO/CABLE LAYING/003	Annexure-6
4.	LAYING OF SIGNALLING CABLE & TELECOM/ POWER CABLE IN SAME TRENCH	SDO/CABLE LAYING/004	Annexure-7
5.	RCC DUCT 300 MM	NR/SIG/CABLE/001	Annexure-8
6.	RCC DUCT 500 MM	NR/SIG/CABLE/002	Annexure-9
7.	RCC DUCT 500 MM	NR/SIG/CABLE/003	Annexure-10
8.	LAYING OF CABLES IN ROCKY AREA	NR/SIG/CABLE/004	Annexure-11
9.	TRACK CROSSINGS	NR/SIG/CABLE/005	Annexure-12
10.	ROAD CROSSINGS	NR/SIG/CABLE/006	Annexure-13
11.	CABLE LAYING ON CULVERTS WITH LOW FLOOD LEVEL	SDO/CABLE LAYING/011	Annexure-14
12.	CABLE LAYING ON CULVERTS WITH HIGH FLOOD LEVEL	NR/SIG/CABLE/007	Annexure-15
13.	CABLE LAYING ON METALLIC BRIDGES	SDO/CABLE LAYING/013	Annexure-16
14.	CABLE TROUGH FOR METALLIC BRIDGES	SDO/CABLE LAYING/014	Annexure-17
15.	CABLE LAYING ON ARCH BRIDGES	NR/SIG/CABLE/008	Annexure-18
16.	BRICK MASONRY CHANNEL FOR ARCH BRIDGE	SDO/CABLE LAYING/016	Annexure-19
17.	ARRANGEMENT OF JUMPER CABLE	SDO/CABLE LAYING/017	Annexure-20
18.	CI CABLE MARKER & CONCRETING	SDO/CABLE LAYING/018	Annexure-21
19.	CI CABLE MARKER	SDO/CABLE LAYING/019	Annexure-22
20.	CONCRETE CABLE MARKER	SDO/CABLE	Annexure-23

		LAYING/020	
21.	METHOD OF UNROLLING CABLE	SDO/CABLE LAYING/021	Annexure-24
22.	RULE MADE OF PIPE FOR MEASURING TRENCH DEPTH	SDO/CABLE LAYING/022	Annexure-25

Annexure-1

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)
***

No.2003/Tele/RCIL/1 Pt.IX

New Delhi dated 24.06.2013

General Managers,
All Indian Railways.

Telecom Circular No. 17/ 2013

Sub: Procedure for undertaking digging work in the vicinity of Signaling, Electrical and Telecommunication Cable.

JPO No. 1/Sig/2004 dated 16.12.2004 issued by Board on the subject matter was reviewed in consultation with Signal, Electrical, Civil Engineering and Works Directorates of Board.

2. The same has now been finalized and a copy of the Revised Joint Procedure Order duly signed by ED/TD, EDCE/P, ED/SD, ED/W and EDEE/M is attached for compliance.

3. Please acknowledge receipt.

DA: 1 in 5 pages.

(Rakesh Ranjan)
Director(Telecom.

Copy to:-

i) ED/TD, EDCE/P, ED/SD, ED/W and EDEE/M
ii) CSTEs, All Indian Railways
iii) CSTEs/Construction, All Indian Railways
iv) ED/Tele, RDSO, Lucknow
v) MD/RCIL, 143, Institutional Area, Sector 44, Gurgaon – 122003.Haryana.

o/c

Annexure to Telecommunication Circular No. 17/2013

JOINT PROCEDURE ORDER FOR UNDERTAKING DIGGING WORK IN THE VICINITY OF UNDERGROUND SIGNALING, ELECTRICAL & TELECOMMUNICATION CABLES.

A. A number of Engineering works in connection with gauge conversion/doubling/third line are in progress on various Railways, which require extensive digging work near the running track, in close vicinity of the working S&T cables carrying vital safety circuits as well as electrical cables feeding the power supply to cabins, ASM room, RRI Cabin, Intermediate Block Huts (IBH) etc. Similarly, S&T organisation under open line or construction units under CAO/C, are executing various Signaling and Telecom works requiring digging of earth for laying of cables or casting of foundations for the erection of signal posts etc. RailTel is also executing the work of laying of quad cable and OFC on various Railways as a part of sanctioned works for exclusive use of Railways for carrying voice and data i.e. administrative and control communication, PRS, POIS etc. or shared by RailTel Corporation of India Ltd. On certain sections digging is also required for laying of electrical cable and casting of foundation for the erection of OHE masts by Electrical Deptt. Generally, these works are executed by contractors employed by these organisations.

B. However, while carrying out these works in the vicinity of working signaling, telecommunication and electrical cables, at times, cable cuts take place due to JCB machines working along the track or during the digging work being done by contractors carrying out the Civil Engineering works. Similarly, such cable cuts are also resulting due to works undertaken by S&T or Electrical departments. Such cable faults results in the failure of vital signaling and telecommunication circuits & electrical installations.

C. Henceforth, the following joint procedure shall be followed by Engineering, Electrical and S&T (and RailTel organisation, wherever such works are being done by them) officers of the respective divisions and by the construction organisation, while carrying out any digging work near to existing signaling & telecommunication and electrical cables, so that the instances of cable cut due to execution of works, can be controlled and minimized.

I. S&T department (and RailTel, where they have laid the cables) and Electrical department shall provide a detailed cable route plan showing exact location of cable at an interval of 200 m or wherever there is change in alignment so that the same is located easily by the Engineering official/contractor. In addition, S&T department and Electrical department shall also provide cable markers along the alignment of the cable. These cable route plans shall be made available to the Sr.DEN/DEN or Dy.CE/C, as the case may be, by Sr. DSTE/DSTE or Sr.DEE/DEE of the divisions or Dy. CSTE/C or Dy. CEE/C within 15 days in

1 of 5

duplicate. Sr. DEN/DEN or Dy.CE/C will send copies to their field unit i.e. AEN/SE/P. Way & Works.

2. Before taking up any digging activity on a particular work by any agency, Sr. DSTE/DSTE or Sr.DEE/DEE of the section shall be approached in writing by the concerned Engg. or S&T or Electrical officer for permitting to undertake the work. Sr.DSTE/DSTE or Sr.DEE/DEE, after ensuring that the concerned executing agencies including the contractor have fully understood the S&T and Electrical cable route plan, shall permit the work in writing within 7 days of the request by concerned department.

3. After getting the permission from S&T or Electrical department as the case may be, the relevant portion of the cable route plan shall be attached to the letter through which permission is issued to the contractor by concerned Engg. official for commencement of work and ensuring that the contractors have fully understood the cable route plan and precautions to be taken to prevent damage to the underground cables. The contractor shall be asked to study the cable plan and follow it meticulously to ensure that the safety of the cable is not endangered. Such a provision, including any penalty for default, should form part of agreement also. It is advisable that a suitable post of SE/Sig or SE/Tele or SE/Electrical(TRD or G) shall be created chargeable to the estimates of doubling/gauge conversion, who can help Engg. agencies in the execution of the work. However basic responsibility will be of the department executing the work and the contractor. Creation of posts is not mandatory.

4. The SE/P.Way or SE/Works shall pass on the information to the concerned SE/Sig. or SE/Tele or SE/Electrical(TRD or G) about the works being taken up by the contractors in their sections at least 3 days in advance of the day of the work. In addition Engineering control shall also be informed by SE/P.Way or SE/Works, who in turn shall pass on the information to the test room/network operation center of Rail/Tel/TPC/Electrical control.

5. On receiving the above information, SE/Sig or SE/Tele or SE/Electrical(TRD or G) shall visit the site on or before the date of taking up the work and issue permission to the contractor to commence the work after checking that adequate precautions have been taken to avoid the damage to the cables. The permission shall be granted within 3 days of submission of such requests.

6. The name of the contractor, his contact telephone number, the nature of the work shall be notified in the Engineering control as soon as the concerned Engineering officials issue the letter authorizing commencement of work to the contractor. Test room shall be given copies. Test room shall collect any further details from the Engineering control and shall pass it on to S&T/Rail/Tel & Electrical officials regularly. In case the supervisors of concerned departments do not turn up on the day as advised in terms of para 4 and 5 above, the works of contractor should not be stopped on this account.

2 of 5

7. In case of works being taken up by the State Government, National Highway Authority etc., the details of the permission given i.e. the nature of work, kilometer etc. be given to the Engineering control including the contact person's number so that the work can be done in a planned manner. The permission letter shall indicate the contact numbers of Test room/Network Operating Centre of RailTel/TPC/Elect. Control.

8. Where the nature of the work taken up by the Engineering department is such that the OFC or other S&T cables or Electrical cables is to be shifted and relocated, notice of minimum one week shall be given so that the Division/RailTel/Construction can plan the works properly for shifting. Such shifting works shall in addition, for security and integrity of the cables, be supervised by S&T supervisors/RailTel supervisors/Electrical supervisors.

9. The concerned SE/P.Way/SE/Works/SE/Sig/SE/Tele/ SE/Electrical(TRD or G) or RailTel supervisors supervising the work of the contractor shall ensure that the existing emergency sockets are not damaged in view of their importance in providing communication during accident/emergency.

10. In case of minor nature of works where shifting of cable is not required, in order to prevent damage to the cable, the Engineering contractor shall take out the S&T or optical fibre cable or Electrical cable carefully from the trench and place it properly alongside at a safe location before starting the earthwork under the supervision of SE/Sig. or SE/Tele or SE/Electrical(TRD or G). The cable shall be reburied soon after completion of excavation with proper care including placement of the brick over the cable under the supervision of S&T or Electrical supervisors. However, the work will be charged to the concerned engineering works. The responsibility for ensuring availability of SE (Signal), SE (Electrical) as per para 4 and 5 above lies with the respective department. The contractor will go ahead with the shifting of cables as per the program decided and he will not be held responsible for any cable cut.

11. In all the sections where major project are to be taken up/going on RailTel/S&T department shall deploy their official to take preventive/corrective action at site of work. As regards Electrical Department, the official may be deputed on need basis.

12. No new OFC or quad cable shall be laid close to the existing track. It shall be laid close to the Railway boundary on one side of the Railway track to the extent possible to avoid any interference with the future works (doubling etc.). It shall be ensured in the new works of cable laying that the cable route is properly identified with electronic or concrete markers. Wherever multiple cables are laid in a trench, RFID markers may be provided for easy identification of the cable. Henceforth, whenever cable laying is planned, before undertaking the cable laying work, the cable route plan of the same shall be prepared by the Dy.CSTE/C or Dy.CEE/C

and shall be got approved from the concerned Sr. DSTE/DSTE or Sr. DEE/DEE and also from the concerned Dy. CE/C for new lines and from the concerned Sr.DEN for all other projects including doubling GC etc., to avoid possible damage in future. Such approval shall be granted within 15 days of the submission of the request.

13. The works of excavating the trench and laying of the cable should proceed in quick succession, leaving a minimum time between the two activities.

14. In case damage is caused to OFC/Quad cable [illegible] during execution of the work, the contractor is liable to pay a penalty for damaging the cable. Penalty shall not be levied in case of the following:-

(i) Detailed cable route plan as per clause C-1 not provided by concerned department or cable is not protected as per laid down procedures.
(ii) The alignment of the cable does not tally with the information provided to the contractor.
(iii) The cable depth is found to be less than 800 mm from normal ground level.
(iv) No representative of S&T department/RailTel was available at site guarding the cables on the fixed pre determined date and time.

15. Penalty to be imposed for damages to cable shall be as under:-

Cable damaged	Penalty per location
Only Quad cable or Signaling cable	₹ 1.0 Lakh
Only OFC	₹ 1.25 Lakh
Both OFC & Quad	₹ 1.5 Lakh
Electrical Cable	₹ 1.0 Lakh

Necessary debit in this regard shall be raised on the department undertaking the work who shall in turn levy the penalty on the defaulting contractor. S&T department shall raise the debits in case of damage to OFC or Quad or Signaling cable and Electrical department shall raise the debits in case of damage to Electrical cable.

16. Railways will not lodge FIR with RPF in cases of works being executed by authorized contractors of Railways who have been duly permitted to execute the works in accordance with this JPO. Joint note by the supervisors of the concerned department shall be prepared and the responsibility of the cable cut should be decided without involving RPF. The joint note deciding the fact whether the contractor should be penalized shall be completed in a day's time from the occurrence of cable cut.

In all other cases, when the cable is cut by an agency that was not permitted to execute any work, FIR should be lodged with RPF.

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17. While giving permission for taking up the works, concerned departments may note that earthwork by engineering contractors will normally be done by machines except in a few isolated locations where the quantity of earth work is very less.

18. Railways shall make necessary correction in their future contract so that this JPO can also be enforced contractually.

19. In case of damage to OFC, RailTel should be paid 5/6th of the penalty recovered. RailTel shall raise demands on the S&T department in this regard.

20. All types of signaling & OHE bonds i.e. rail bond, cross bond and structure bond shall be restored by the contractor with a view to keep the rail voltage low to ensure safety of personnel.

21. Above joint circular shall be applicable for construction as well as open line organisation of Engineering, S&T & Electrical.

22. S&T cable and electrical cable route plan should be prepared by the concerned S&T and Electrical officers respectively and got approved as stipulated in para C-12 before undertaking the work. The completion cable route plan should be finalized block section by block section as soon as the work is completed.

23. All cable laying works shall be executed as per laid down technical specifications, such as protection measures/protective cover, compaction of refilled material etc.

(Rajeev Sharma)	(S K Saxena)	(Shobhan Chaudhuri)	(V P Dudeja)	(Surinder Pal)
Exec. Dir.	Exec. Dir.	Exec. Dir.	Exec. Dir.	Exec. Dir.
Signal Devel.	Elect. Energy (M)	Telecom (Dev)	Works	Civil Engg.(P)

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Annexure-2

CABLE TESTING RECORD: SUMMARY SHEET

Cable No.		Cable Function	
Cable Size		Make	
Length		PO No. and date	
Between Locations		Inspection No. and Date	
Type of Protection		Spare Core Nos.	

SN	Date of Testing	Insulation Test Results		Ref. No. of Test Sheet*	Remarks and Signature
		Core to Core	Core to Earth		

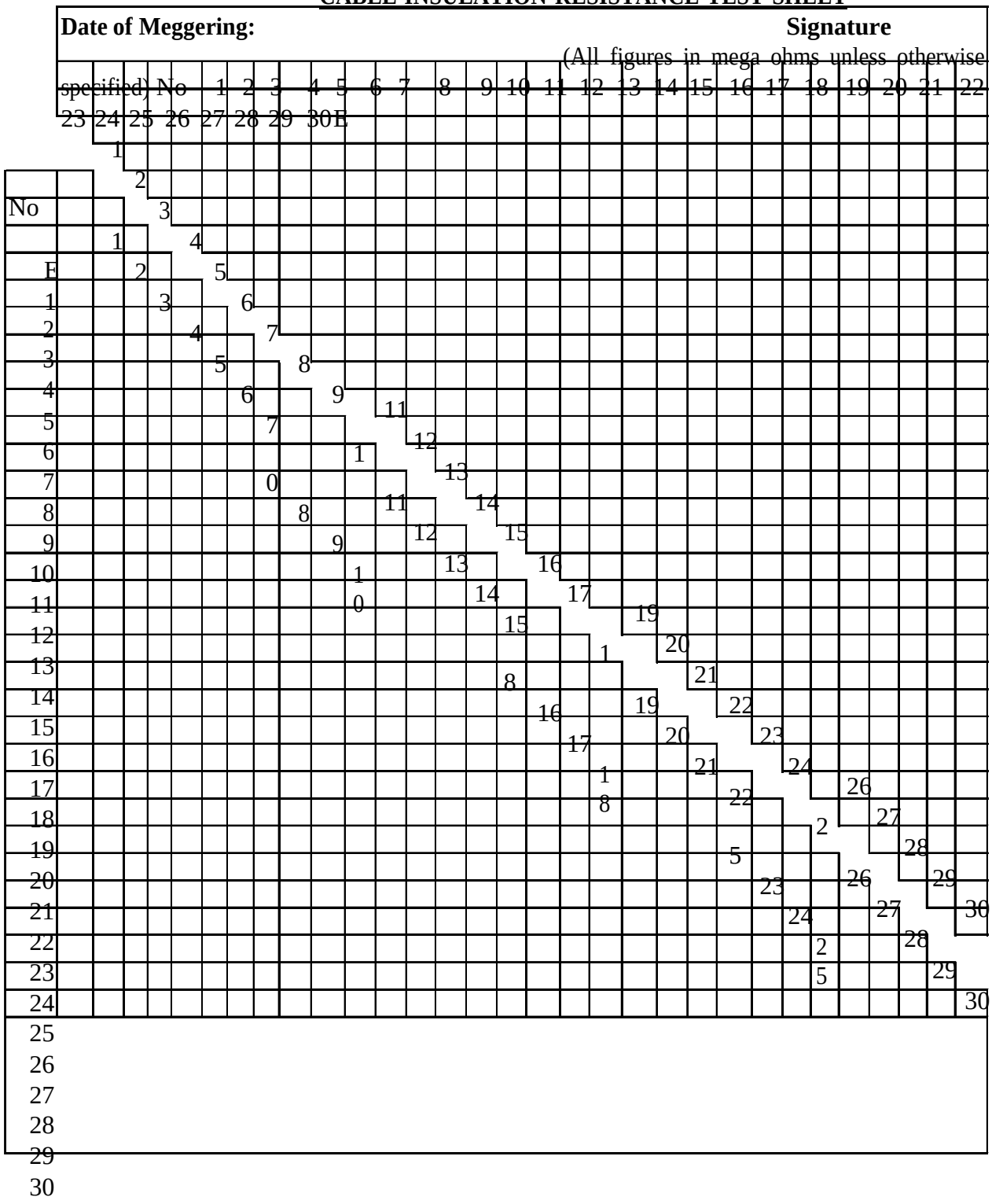
*Tests sheets for Insulation and Loop resistance results in matrix format to be maintainedseparately for each cable in the cable testing register.

Annexure-3

CABLE INSULATION RESISTANCE TEST SHEET

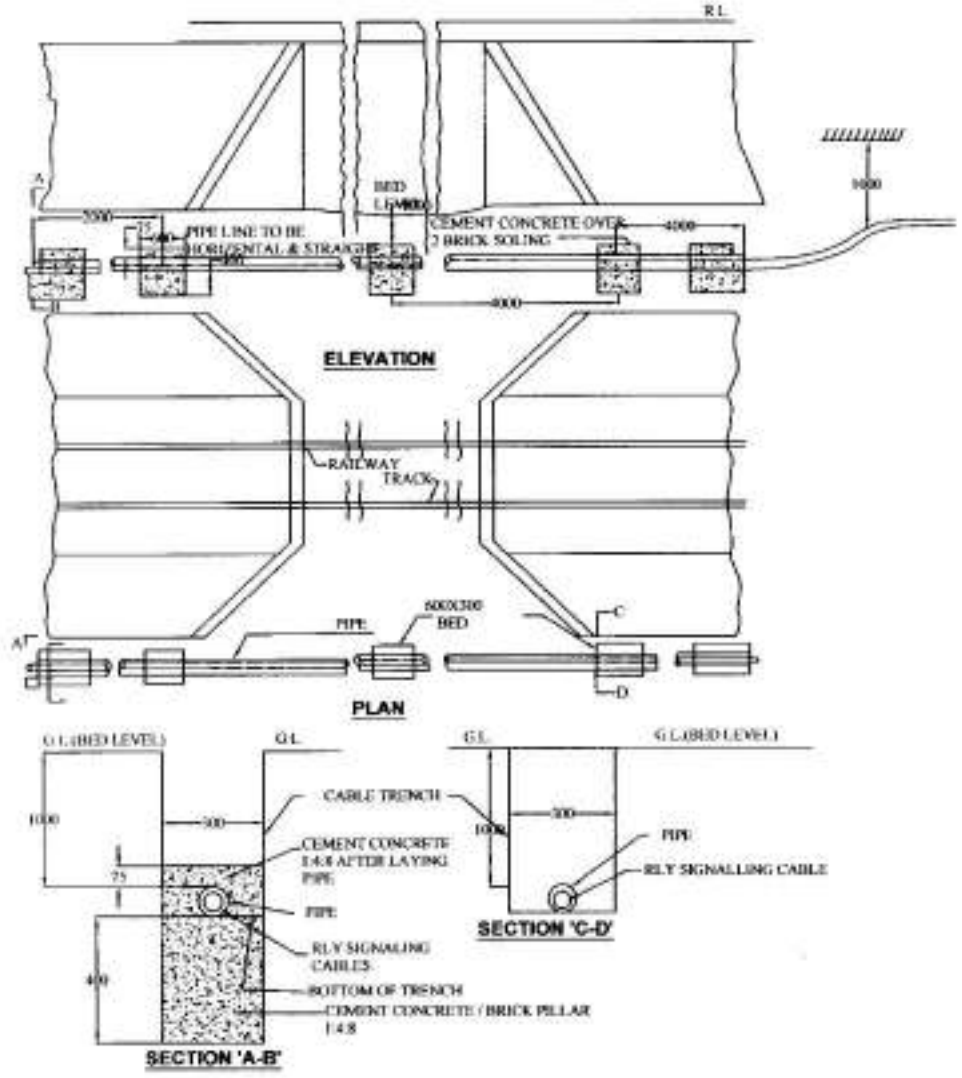
Date of Meggering: **Signature**

(All figures in mega ohms unless otherwise specified)



(All figures in mega ohms unless otherwise specified)

Date of Meggering: **Signature**

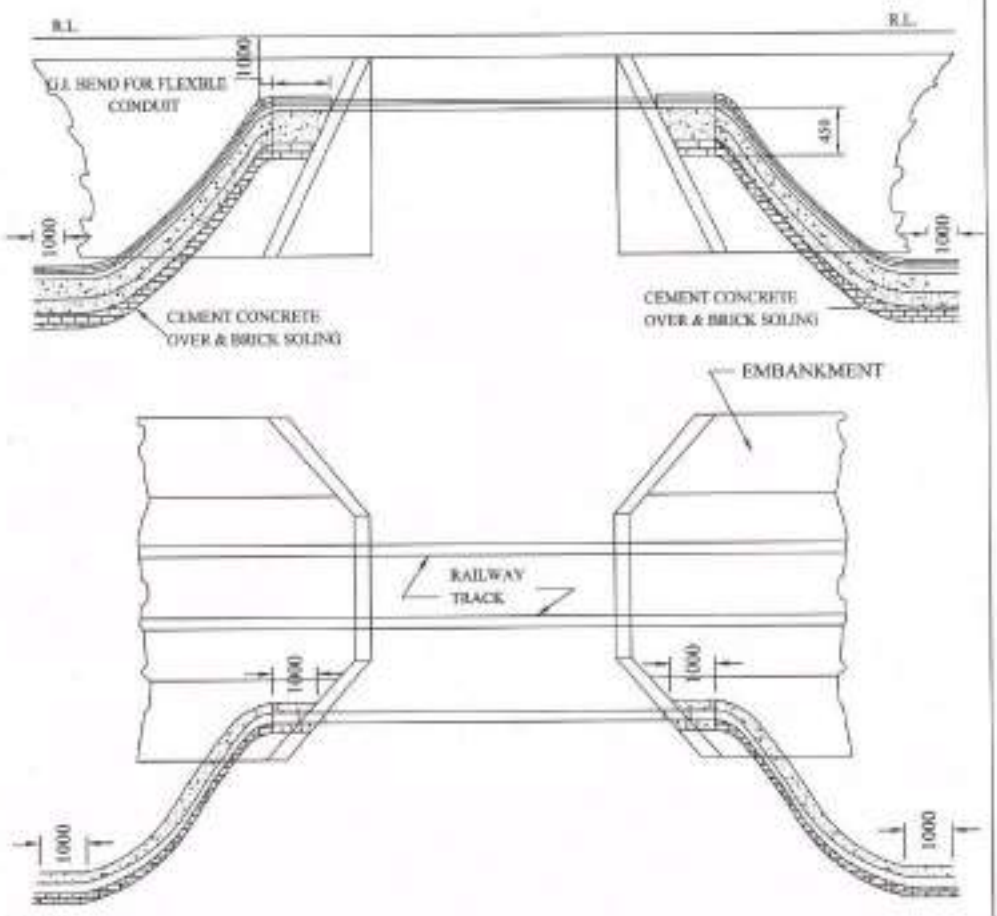


NOTE:-

ALL DIMENSIONS ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	CABLE LAYING ON CULVERTS WITH LOW FLOOD LEVEL	SDO/CABLE LAYING/011
APPROVED BY	ADE	R.D.S.O	DATE :- 31-10-2011
NOT TO SCALE			

ANNEXURE-15



NOTE:-

(I) ALL DIMENSIONS ARE IN MILLIMETER.

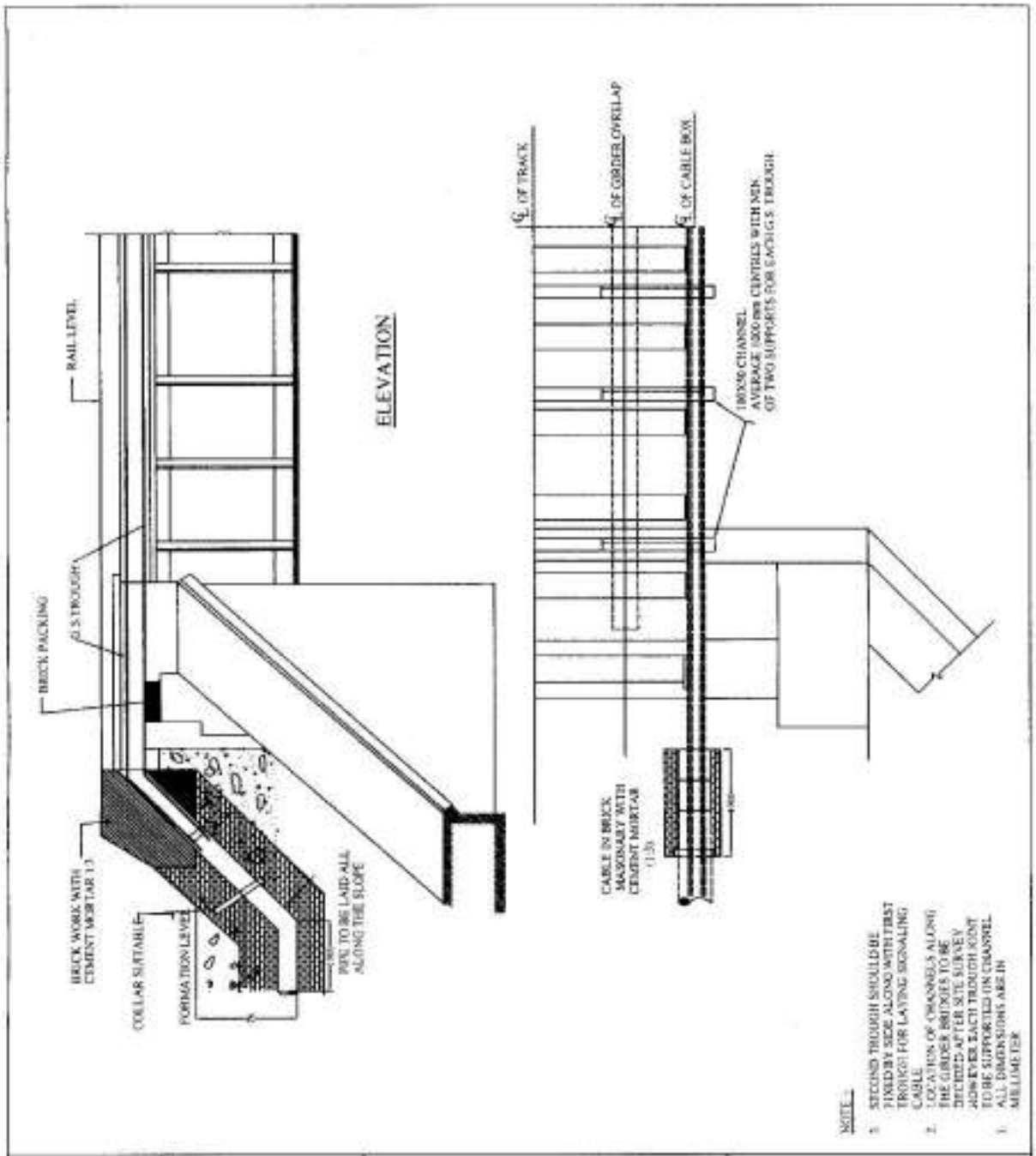
(ii) ON APPROACH OF CULVERTS, DWC- HDPE PIPE OF SUITABLE DIAMETERAS PER RDSO SPECIFICATION RDSO/SPN/204/2011 SHALL BE USED.DIAMETER OF DWC -HDPE PIPE SHALL BE DECIDED BY ENGINEER. IN CHARGE.

(iii) ON CULVERT PORTION, PERFORATED G.I PIPE OF MEDIUM GRADE OF ISI MARK AS PER IS:1239(PART-I) OF SUITABLE DIAMETER SHALL BE USED. DIAMETER OF G.I.PIPE SHALL BE DECIDED BY ENGINEER IN CHARGE.

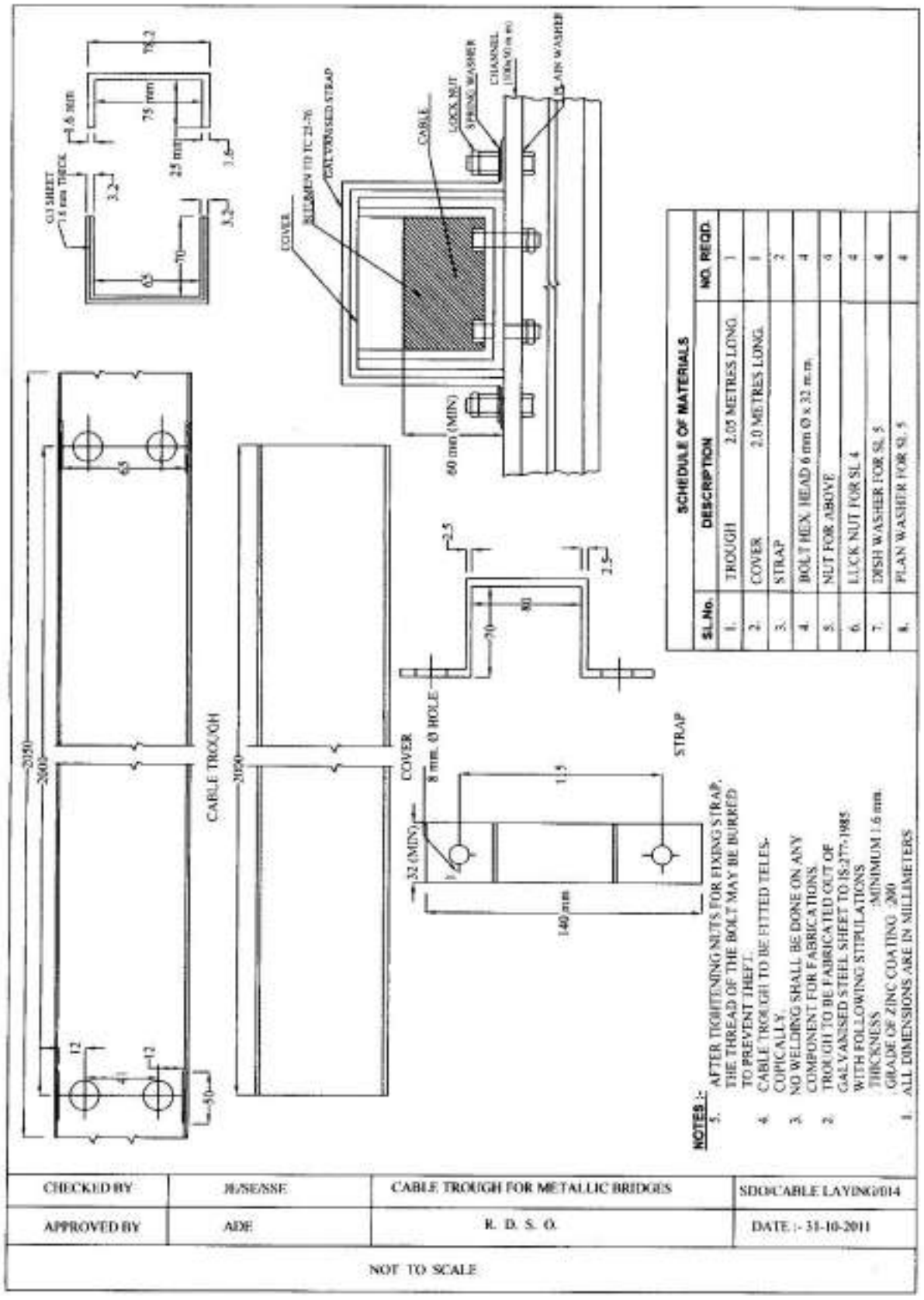
(iv) AT JUNCTION POINT OF G.I AND DWC PIPE, A G.I.BEND OF 112.5 DEGREE,1 MTR. LENGTH AS PER IS-1239(Part-2) AND OVERLAPPING 250MM. WITH DWC PIPE SHALL BE USED.

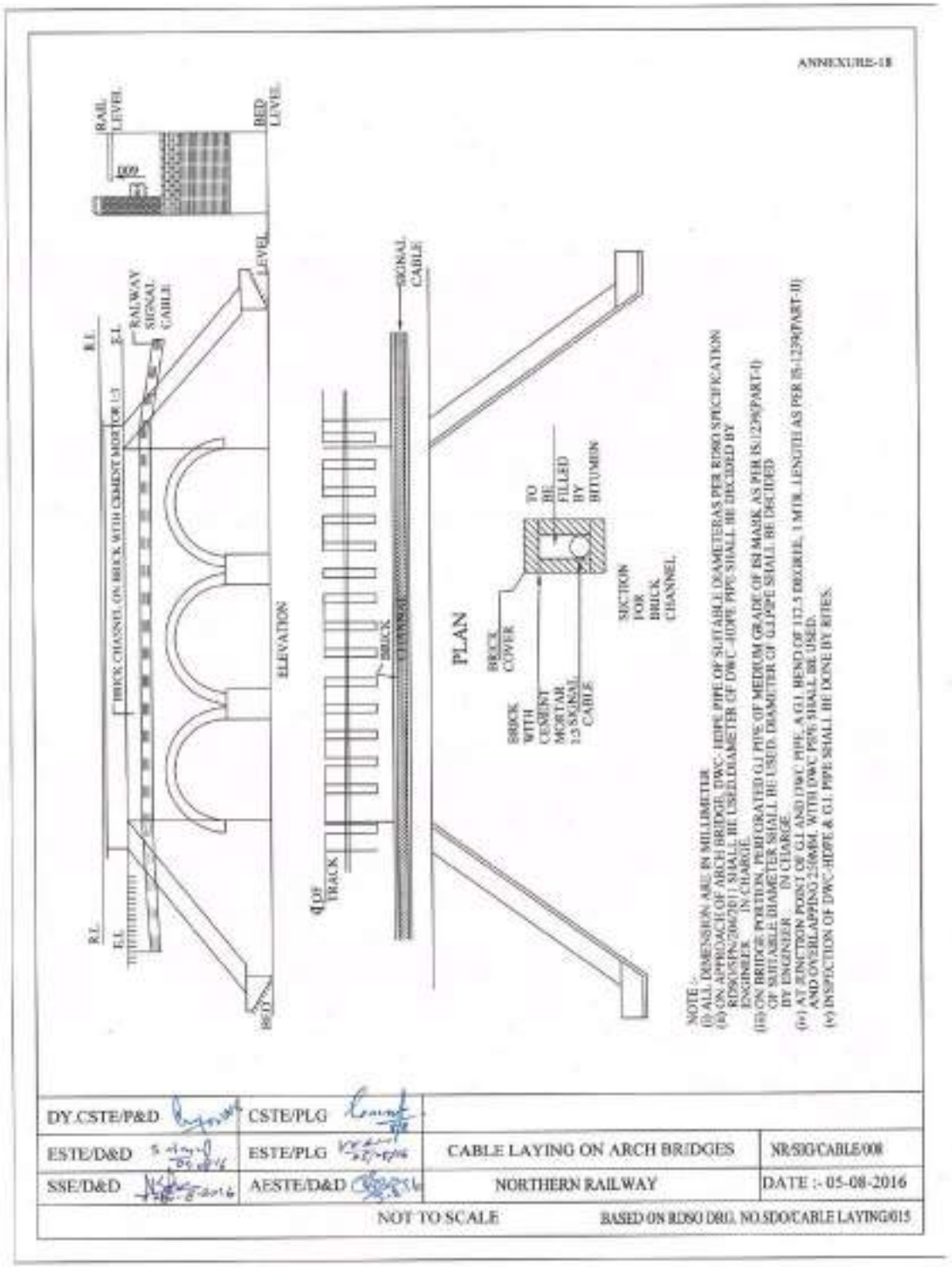
(v) INSPECTION OF DWC-HDPE AND G.I. PIPE SHALL BE DONE BY RITES.

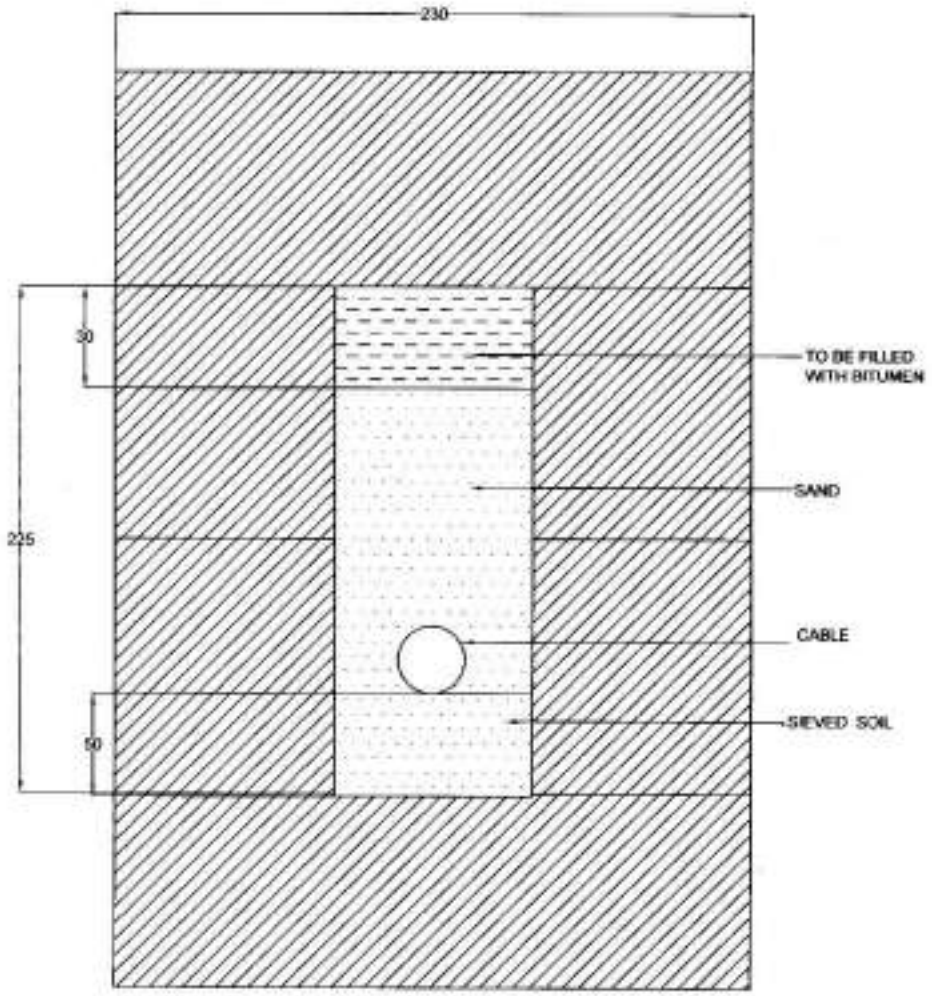
DY.CSTE/P&D	CSTE/PLG		
ESTE/D&D	ESTE/PLG	CABLE LAYING ON CULVERTS WITH HIGH FLOOD LEVEL	NR/SIG/CABLE/007
SSE/D&D	AESTE/D&D	NORTHERN RAILWAY	DATE :- 05-08-2016
		NOT TO SCALE	BASED ON RDSO DRG. NO SDOCABLE LAYING/012



CHECKED BY	JE/SE/SSE	CABLE LAYING ON METALLIC BRIDGES	SDO/CABLE LAYING/013
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

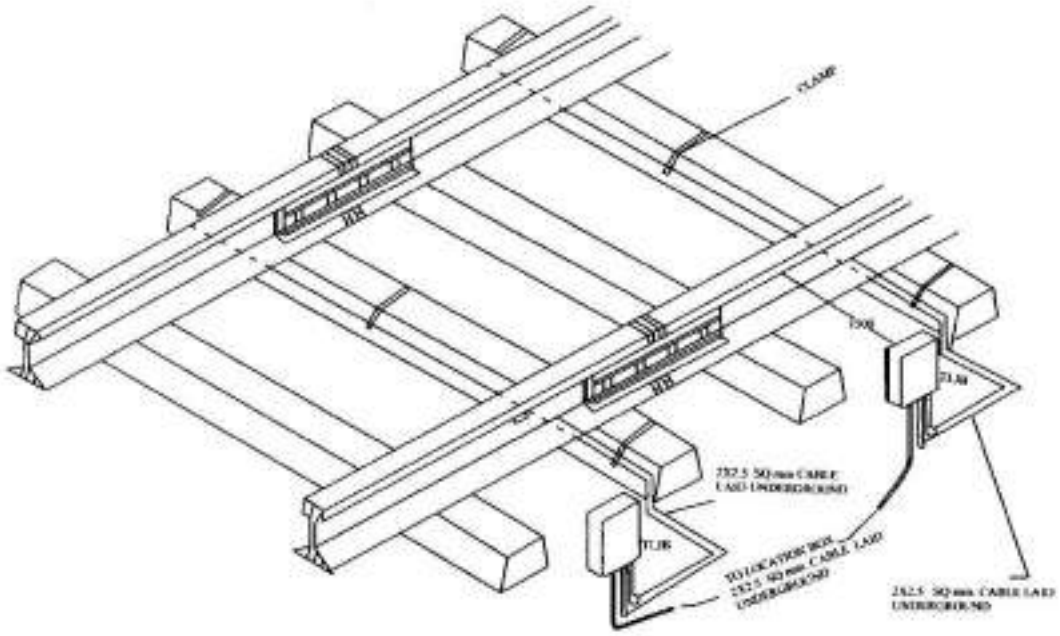

SCHEDULE OF MATERIALS
SL.No. DESCRIPTION NO. REQD.
1. TROUGH 2.05 METRES LONG 1
2. COVER 2.0 METRES LONG 1
3. STRAP 2
4. BOLT HEX. HEAD 6 mm Ø x 32 m.m. 4
5. NUT FOR ABOVE 4
6. LUCK NUT FOR SL 4 4
7. IMSH WASHER FOR SL 5 4
8. PLAN WASHER FOR SL 5 4
CABLE TROUGH
COVER
STRAP
8 mm. Ø HOLE
32 (MIN)
140 mm
60 mm (MIN)
NOTES :-
5. AFTER TIGHTENING NUTS FOR FIXING STRAP, THE THREAD OF THE BOLT MAY BE BURRED TO PREVENT THEFT.
4. CABLE TROUGH TO BE FITTED TELESCOPICALLY.
3. NO WELDING SHALL BE DONE ON ANY COMPONENT FOR FABRICATIONS.
2. TROUGH TO BE FABRICATED OUT OF GALVANISED STEEL SHEET TO IS:277-1985 WITH FOLLOWING STIPULATIONS
THICKNESS :MINIMUM 1.6 mm.
GRADE OF ZINC COATING :200
1. ALL DIMENSIONS ARE IN MILLIMETERS
CHECKED BY
JE/SE/SSE
CABLE TROUGH FOR METALLIC BRIDGES
SD0/CABLE LAYING/2014
APPROVED BY
AEE
R. D. S. O.
DATE :- 31-10-2011
NOT TO SCALE


ANNEXURE-18
RAIL LEVEL
BED LEVEL
LEVEL
RAILWAY SIGNAL CABLE
R.L.
E.L.
BRICK CHANNEL ON BRICK WITH CEMENT MORTAR 1:3
ELEVATION
BED
SIGNAL CABLE
BRICK CHANNEL
PLAN
BRICK COVER
BRICK WITH CEMENT MORTAR 1:3 SIGNAL CABLE
TO BE FILLED BY BITUMEN
SECTION FOR BRICK CHANNEL
NOTE :-
(i) ALL DIMENSION ARE IN MILLIMETER.
(ii) ON APPROACH OF ARCH BRIDGE, DWC- HDPE PIPE OF SUITABLE DIAMETER AS PER RDSO SPECIFICATION RDSO/SPN/206/2011 SHALL BE USED. DIAMETER OF DWC -HDPE PIPE SHALL BE DECIDED BY ENGINEER IN CHARGE.
(iii) ON BRIDGE PORTION, PERFORATED G.I PIPE OF MEDIUM GRADE OF ISI MARK AS PER IS:1239(PART-I) OF SUITABLE DIAMETER SHALL BE USED. DIAMETER OF G.I.PIPE SHALL BE DECIDED BY ENGINEER IN CHARGE.
(iv) AT JUNCTION POINT OF G.I AND DWC PIPE, A G.I. BEND OF 112.5 DEGREE, 1 MTR. LENGTH AS PER IS:1239(PART-II) AND OVERLAPPING 250MM, WITH DWC PIPE SHALL BE USED.
(v) INSPECTION OF DWC-HDPE & G.I. PIPE SHALL BE DONE BY RITES.
DY.CSTE/P&D
CSTE/PLG
ESTE/D&D
ESTE/PLG
CABLE LAYING ON ARCH BRIDGES
NR/SIG/CABLE/008
SSE/D&D
AESTE/D&D
NORTHERN RAILWAY
DATE :- 05-08-2016
NOT TO SCALE
BASED ON RDSO DRG. NO.SDO/CABLE LAYING/015



NOTE :-
ALL DIMENTION ARE IN MILLIMETER.

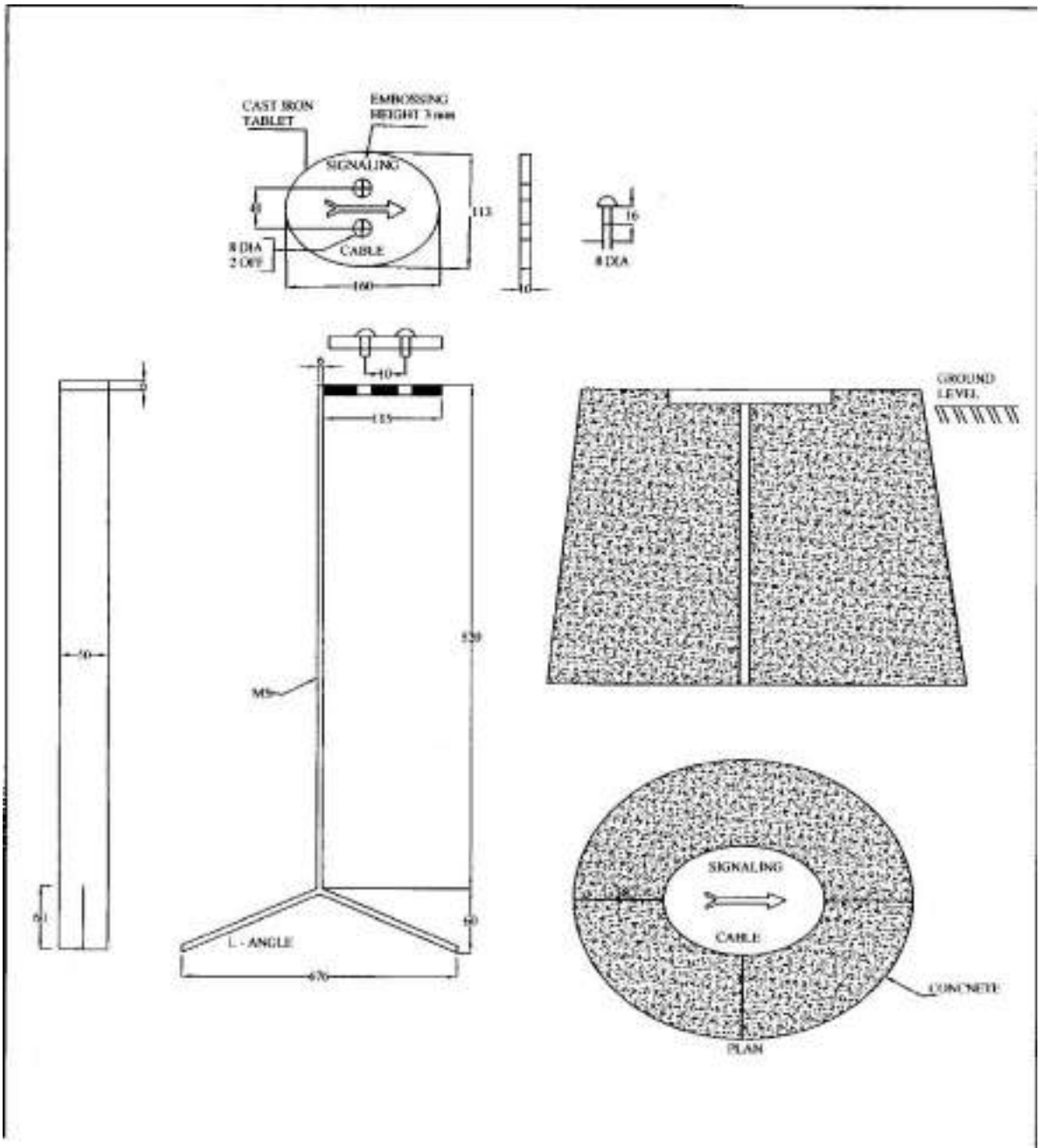
CHECKED BY	JE/SE/SSE	BRICK MASONRY CHANNEL FOR ARCH BRIDGE	SDO/CABLE LAYING /016
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			



NOTE:-

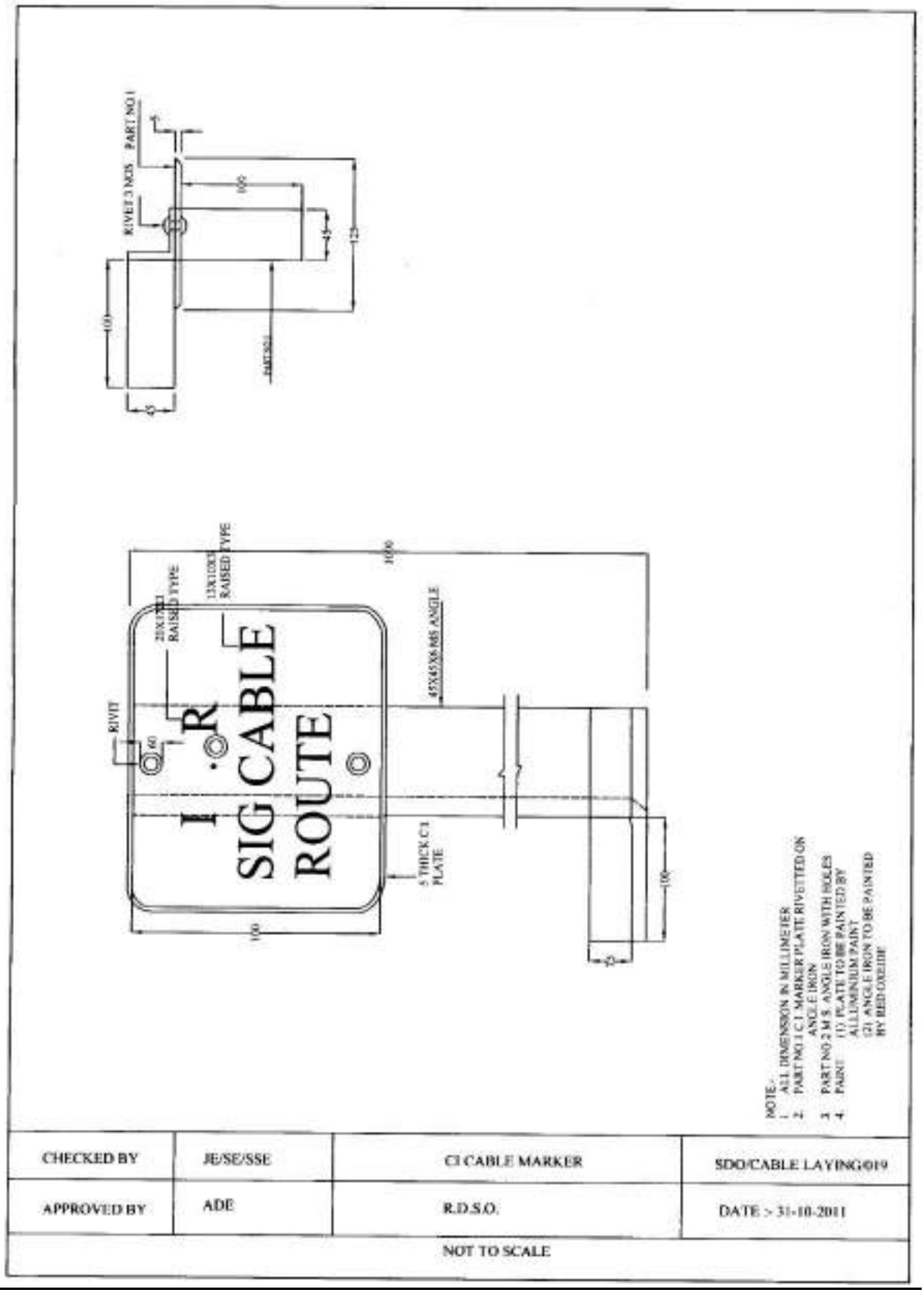
ALL DIMENSIONS ARE IN MILLIMETER.

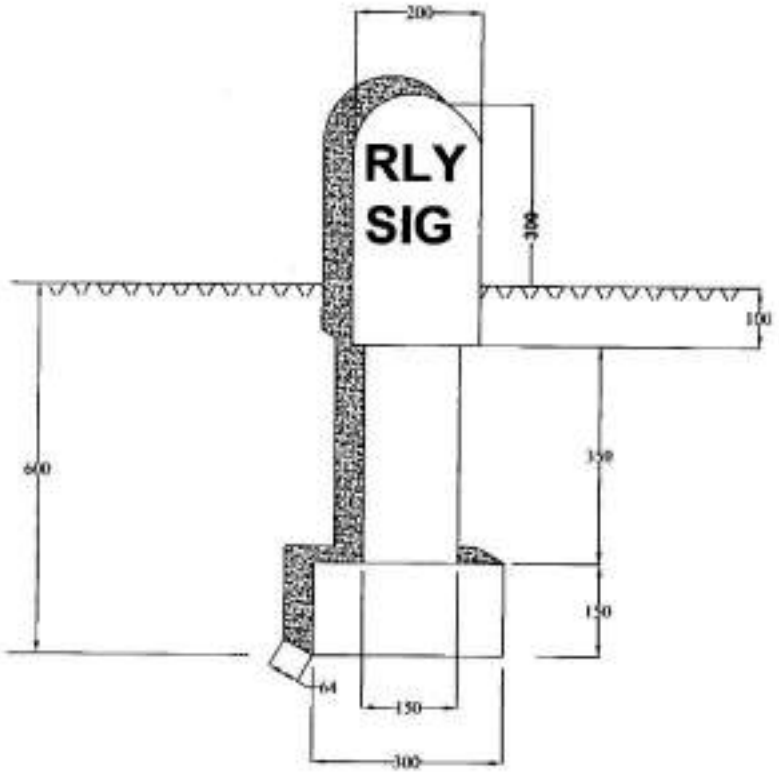
CHECKED BY	JE/SE/SSE	ARRANGMENT OF JUMPER CABLE	SDO/CABLE LAYING/017
APPROVED BY	ADE	R.D.S.O	DATE :- 31-10-2011
NOT TO SCALE			



NOTE :-
1. ALL DIMENSION ARE IN MM
2. CAST IRON TABLET IS TO BE RIVETTED TO THE L - ANGLE ON THE 2 HOLES

CHECKED BY	JE/SE/SSE	CI CABLE MARKER & CONCRETING	SDO/CABLE LAYING/018
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

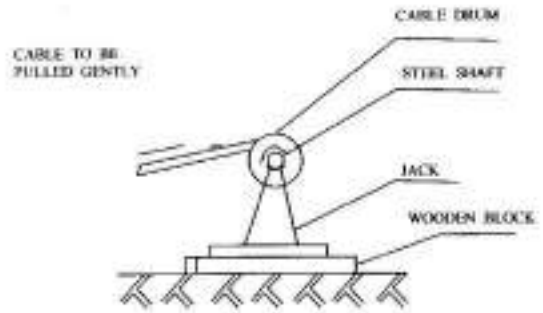

RIVET 3 NOS
PART NO 1
RIVIT
I R
SIG CABLE
ROUTE
RAISED TYPE
RAISED TYPE
45X45X6 MS ANGLE
5 THICK C1
PLATE
NOTE:-
1. ALL DIMENSION IN MILLIMETER
2. PART NO 1 C.I. MARKER PLATE RIVETTED ON ANGLE IRON
3. PART NO 2 M.S. ANGLE IRON WITH HOLES
4. PAINT (1) PLATE TO BE PAINTED BY ALLUMINIUM PAINT
(2) ANGLE IRON TO BE PAINTED BY RED OXIDE
CHECKED BY
JE/SE/SSE
CI CABLE MARKER
SDO/CABLE LAYING/019
APPROVED BY
ADE
R.D.S.O.
DATE :- 31-10-2011
NOT TO SCALE



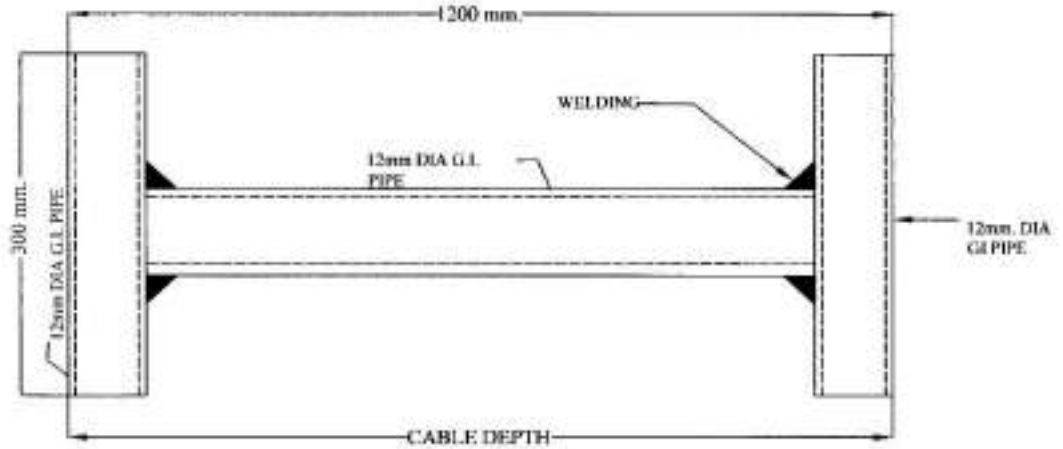
NOTE:-

1. ALL DIMENTIONS ARE IN MILLIMETER
2. PAINTED WHITE LETTERS ON RED BACKGROUND.
3. FOUNDATION CONCRETE OF 300 mm FROM THE BASE OF THE MARKER SHALL BE DONE AT SITE AT ALL PLACES WITH MIX 1:3:5.
4. COMPONENT CONCRETE SHALL BE OF M25 MIX AND WIRE MESH OF 1.5MM THICKMESS SHALL BE USED.
5. THE ENGRAVING OF "RLY" & "SIG" SHALL BE DONE ON BOTH SIDES OF THE MARKER.

CHECKED BY	JE/SE/SSE	CONCRETE CABLE MARKER	SDO/CABLE LAYING/020
APPROVED BY	ADE	R.D.S.O.	DATE :- 31-10-2011
NOT TO SCALE			



CHECKED BY	JE/SE/SSE	METHOD OF UNROLLING CABLE	SDO/CABLE LAYING /021
APPROVED BY	ADE	R.D.S.O.	DATE :- 31-10-2011
NOT TO SCALE			



NOTE :-
ALL DIMENTION ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	RULE MADE OF PIPE FOR MEASURING TRENCH DEPTH	SDO/CABLE LAYING/022
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

Note: ALL the above sketches/Drawings/Diagram given are only indicative. The detailed drawings shall be proposed by the Contractor and approved by the Engineer.

APPENDIX 18

JPO No. 1/SG/2004

(Issued under CRB's letter No. 2004/Sig/G/7 dated 17.12.2004)

JOINT PROCEDURE ORDER FOR UNDERTAKING DIGGING WORK IN THE VICINITY OF UNDERGROUND SIGNALLING, ELECTRICAL AND TELECOMMUNICATION CABLES

A. A number of Engineering works in connection with gauge conversion/doubling/third line are in progress on various railways, which require extensive digging work near the running track, in close vicinity of the working S&T cables carrying vital safety circuits as well as electrical cables feeding the power supply to Cabins, ASM room, RRI Cabin, Intermediate Block Huts (IBH) etc. Similarly, S&T organization under open line or construction units under CAO/C are executing various signalling and telecommunication works requiring digging of earth for laying of cables or casting of foundations of the erection of signal posts etc. RailTel are also executing the work of laying of quad cable and OFC on various Railways as a part of sanctioned works for exclusive use of Railways for carrying voice and date i.e. administrative and control communication, PRS,FOIS etc. or shared by RailTel Corporation of India Ltd. On certain sections digging is also required for laying of electrical cable and casting of foundation for erection of OHE masts by Electrical Deptt. Generally, these works are executed by contractors employed by these organizations.

B. However, while carrying out these works in the vicinity of working signalling, telecommunication and electrical cables, at times, cable cuts take place due to JCB machines working along the track or during the digging work being done by Contractors carrying out the Civil Engineering Works. Similarly, such cable cuts are also resulting due to works undertaken by S&T or Electrical Deptts. Such Cable faults results in the failure of vital signalling and telecommunication circuits.

C. Henceforth, the following joint procedure shall be followed by Engineering, Electrical and S&T (and RailTel Organization, wherever such works are being done by them) Officers of the respective divisions and by the Construction Organization, while carrying out any digging work near to existing signalling & telecommunication and electrical cables, so that the instances of cable cut due to execution of works can be controlled and minimized.

(1) S&T Department (and RailTel, where they have laid the cables) & Electrical Deptts. shall provide a detailed cable route plan showing exact location of cable atan interval of 200m or wherever there is change in alignment so that the same is located easily by the engineering official/contractor. This cable route plans shall be made available to the DSE/DEN or Dy. CE/C as the case may be by Sr. DSTE/DSTE or Sr. DEE/DEE of the divisions or Dy. CSTE/C or Dy. CEE/C within a reasonable time in duplicate. DSE/DEN or Dy. CE/C will send copies to their field unit i.e. AEN/SE/P.Way & works.

(2) Before taking up any digging activity on a particular work by any agency, Sr. DSTE/DSTE or Sr. DEE/DEE of the section shall be approached in writing by the concerned Engg. or S&T or Electrical officer for permitting to undertake the work. After ensuring that the concerned executing agencies including the contractor have fully understood the S&T and Electrical cable route plan shall permit the workin writing.

(3) After getting the permission from S&T or Electrical Deptt. as the case may be, the relevant portion of the cable route plan shall be attached to the letter through which permission is issued to the contractor by concerned Engg. official for commencement of work and ensuring that the contractors have fully understood the cable route plan and precautions to be taken to prevent damage to the underground cables. The contractor shall be asked to study

the cable plan and follow it meticulously to ensure that the safety of the cables not endangered. Such a provision, including any penalty for default, should form part of agreement also. It is advisable that a suitable post of SE (Sig) or SE (Tele) or SE (Elect) shall be created chargeable to the execution of the work. However basic responsibility will be of the Department executing the work and the Contractor.

(4) The SE (P.Way) or SE (Works) shall pass on the information to the concerned SE (Sig) or SE (Tele) or SE (Elect) about the works being taken up by the contractors in their sections at least 3 days in advance of the day of the work. In addition Engineering control shall also be informed by SE (P.Way) or SE (Works), which in turn shall pass on the information to the Test Room/Network Operation Centre of RailTel/TPC/Electrical Control.

(5) On receiving the above information, SE (Sig) or SE (Tele) or SE (Elect) shall visit the site on or before the date of taking up the work and issue permission to the contractor to commence the work after checking that adequate precautions have been taken to avoid the damage to the cables. The permission shall be granted within 3 days of submission of such requests.

(6) The name of the contractor, his contract telephone number, the nature of the workshall be notified in the Engineering Control as soon as the concerned Engg. officialissued the letter authorizing commencement of work to the contractor. Test Roombe given a copy and Test Room shall collect any further details from the Engineering Control and shall pass it on to S&T/RailTel & Elect. officials regularly.

(7) In case of works being taken up by the State Government, National Highway Authority etc., the details of the permission given i.e. the nature of work, kilometer etc. be given to the Engineering Control including the contact person's number so that the work can be done in a planned manner. The permission letter shall indicate the contact numbers of Test Room/Network Operations Centre of RailTel/TPE/Elect. Control.

(8) Where the nature of the work taken by the Engineering department is such that theOFC or other S&T cables or Electrical cables is to be shifted and relocated, notice of minimum one week shall be given so that the Division/RaiITeI/Construction can plan the works properly for shifting. Such shifting works shall, in addition, for security and integrity of the cables, be supervised by S&T Supervisors/RailTel Supervisors/Electrical Supervisors.

(9) The concerned SE(P.Way)/SE(Works)/SE(Sig)/SE(Tele)/SE(Elect.) or RailTel supervisors, supervising the work of the contractor shall ensure that the existing emergency sockets are not damaged in view of their importance in providing communication during accident/emergency.

(10) In case of minor nature of works where shifting of cable is not required, in order to prevent damage to the cable, the Engineering Contractor shall take out the S&T oroptical fibre cable or Electrical cable carefully from the trench and place it properly alongside at a safe location before starting the earthwork under the supervision of SE (Sig) or SE (Tele) or SE (Electrical). The cable shall be reburied soon after completion of excavation with proper care including placement of the brick over the cable by the concerned S&T Supervisors or Electrical Supervisors. However, the work will be charged to the concerned engineering work.

(11) In all the sections where major project are to be taken up/going on RailTel/S&T Deptt. shall deploy their official to take preventive/corrective action at site of work.

(12) No new OFC/Quad cable shall be laid close to existing track. It shall be laid close to Railway boundary as per extant instructions i.e. 1.0 m from the Railway boundary to the extent possible to avoid any interference with future works (doubling etc.). It shall be ensured in

the new works of cable laying that the cable route is properly identified with electronic or Concrete markers. Henceforth, wherever cable laying is planned and before undertaking the laying work, the cable route plan of the same shall be got approved from the concerned Sr. DEN orDy. CE/ Constn. to avoid possible damages in future. Such approvals shall be granted within 7 days of submission of the requests.

(13) The works of excavating the trench and laying of the cable should proceed in quick succession, leaving a minimum time between the two activities.

(14) Any damage caused to OFC/Quad cable or Electrical cable during execution of thework, necessary debit shall be raised on Engineering Department who shall bear the cost of the corrective action.

(15) All types of bonds i.e. rail bond, cross bond and structure bond shall be restored by the Contractor with a view to keep the rail voltage low to ensure safety of personnel.

(16) Above joint circular shall be applicable for construction as well as open line organization of Engineering, S&T & Electrical.

(17) The S&T cable and Electrical cable route plan should be got approved from the concerned Sr. DSTE/DSTE & Sr. DEE/DEE respectively, before undertaking the work and completion cable route plan should be finalized Block section by Block section as soon as the work completed.

NOTE: Various designations mentioned in the above Joint Procedure Order are for Railways. In the HORC work, all approvals/inspections will be by the Engineer/HRIDC rather than the designated officials mentioned in the above Joint Procedure Order.

Appendix 19
NON - INTERLOCKED WORKING OF STATION

Non-Interlocking

i) N.I. Working means temporary disconnection of points, signals, track circuits, axle counters and other signaling gadgets for any designated works. This kind of working is normally resorted to works such as over hauling of lever frames, yard remodeling, introduction of panel/RRI working, cable etc.,

ii) In another sense, at an interlocked station when points and signals become defective, station becomes non-interlocked for the purpose of working.

In both the cases the safeguards ingrained through normal functioning of various signaling equipment are missing and as such responsibility of the part of staff increases manifold. N.I. working puts staff under severe strain and hence prone for lapses. Unflagging attention from every quarter is the need of the hour so that safety is ensured.

Non - Interlocked working entails not only slowing down of train operations; it is also a less safe system as compared to interlocked working. Since it is desirable to avoid NI altogether, both from safety as also customer convenience point of view, attempt must be made at the project proposal stage itself to dispense with NI altogether and undertake the work by means of traffic blocks.

Instructions given below are in addition to existing rules for Non - Interlocked working such as issue of Green Notice etc. They must be read together with existing provisions in G&SR, Block Working Manual etc.

A. Requirement of Non - Interlocked Working:

The following guidelines are laid down for a correct assessment of whether NI working is required in the first place or whether it can be dispensed with altogether.

a. NI working should not be resorted to as far as possible, in case of installation of new S&T gears. NI is unavoidable only if modifications are to be made to existing S&T gears.
b. For new S&T gears, there is no need of NI and the work can be managed through well- planned pre-change over works (insertions of point & crossing etc). The final change over to new gears can be carried out under partial or complete traffic block.
c. At the project proposal stage itself, S&T department should make it clear whether the project requires NI or not; and if it does, the duration of such NI. This fact must be mentioned in the check list on the original tracing itself.
d. Sr. DOM & Sr. DCM must quantify the actual impact of such NI, and deduce it to monetary terms, by calculating anticipated losses both on account of passenger and freight traffic. These should include losses on account of cancellation, short termination, diversion, rescheduling, detention to trains and imposition of restriction on booking/movement of freight traffic.
e. Expenses likely to be incurred on account of TA/DA of temporary NI staff, and other administrative costs should also be added to arrive at the traffic cost of proposed NI working.
f. This traffic cost of NI should be communicated to S&T, who will evaluate if new

gears can be installed without resorting to NI for less than the expected cost of proposed NI, if necessary by constructing a new building etc. as the case may be.

g. If new gears can be installed in a new building and commissioned under traffic block at a cost that is comparatively less than the overall traffic cost of proposed NI, then the project should be recorded as one to be taken up without NI.

h. This entire exercise must be carried out under the personal supervision of DRM, who will ensure that all estimates are reasonable and no figures are unrealistic both with regard to duration of NI or the anticipated traffic cost.

i. Thus, NI will be undertaken only if found to be unavoidable, and this fact will be recorded on the original tracing, to be signed by branch officers concerned, and the DRM.

Minor and Major Works :

1. Guidelines given below should be followed for deciding whether NI working is required or not. NI working is not required and the work can be managed by traffic block in following cases :
   (i) Replacement of Mechanical lever frame by another Mechanical lever frame.
   (ii) Replacement of Mechanical lever frame by panel.
   (iii) Replacement of Panel by RRI.
   (iv) Replacement of RRI by RRI.
   (v) Commissioning of new SSI/RRI.
   (vi) Amalgamation of newly constructed double line portion into existing conventional double line.
2. NI working is required only for following cases :
   (i) Overhauling of cabins.
   (ii) Replacement of Panel by Panel at road side stations.
   (iii) Meggering of cables.
   (iv) Changes in yard layouts
3. NI working can be divided into 2 distinct categories, namely minor and major works.
   (i) Minor works - Overhauling of cabins at road side stations.
   (ii) Major works - Changes in yard layouts, overhauling of cabins etc. at comparatively bigger terminals and junction stations.

MINOR WOHKS

(A) Procedure to be followed for Non - Interlocked Working for Minor Works :
Road side stations on double line having up to 2 lines in each direction, and on single line having up to one main line and 2 loop lines are covered under this heading of Minor Works.

(C1) Duration of NI workinq for Minor Works :

1. A road side station would normally have about 21 lever in each end cabin (including spare levers).
2. S&T department must suitably augment the strength of their NI gang so that each cabin can be completed in one day.
3. NI working at the 1 ^{t} cabin should start at 8/- hrs. in the morning and by 18/- hrs. the same must be interlocked and handed back to traffic.
4. The same procedure should be repeated the next day for the 2'^{d} cabin.

(C2) General Instructions for Train Operation :

1. Speed restriction of 15 kmph. shall be imposed over all facing points.
2. No train/wagon should be stabled on any running line of the NI station.
3. The common line should not be used for reception of trains coming from opposite directions.
4. Emergency and other crossovers including sidings taking off from the station should be set for normal position and clamped and padlocked. The keys of all padlocked points must be kept in the personal custody of the overall in-charge of NI working to prevent their being used even by mistake.

(C3) Train Running on double line section during NI working :

1. Twin single line should be suspended during the duration of NI working and section worked as conventional double line only.
2. No temporary single line working should be introduced during NI period, except in case of an accident or blockade of through communication.
3. At road side stations on double line, route must be set for platform line in each direction and clamped and padlocked.
4. In case there is more than one platform in each direction, route must be set for one nominated platform.
5. At all such stations no precedence should be arranged.
6. During the NI period station should basically function as a halt station.

(C4) Train Running on single line section during NI workinq :

1. Ideally, if possible, only one platform line should be nominated for train running.
2. The route must be set for this platform line in each direction and clamped and padlocked.
3. No precedence or crossing should be arranged at this station.
4. In case it is not possible to nominate only one line, then 2 specific lines should be nominated for Up and Down movement.
5. In that case, while crossings would have to take place, no precedence should be arranged at this station.

(C5) Staff requirement :

1. Sectional TI and SI will be overall in-charge of NI working at the station.
2. Additional staff if required should be managed locally .

MAZOR WORKS

Procedure to be followed for Non - Interlocked Working for Major Works :

Changes in yard layouts, overhauling of cabins etc. at comparatively bigger terminals and junction stations are covered under this heading of Major Works.

(D1) Duration of Non Interlocked Workinq :

1. NI working must not be simultaneously introduced at more than one station in a Division.
2. NI must be planned during temperate weather, to avoid wrong actions on account of harsh and inclement weather.
3. Period of Non - interlocked working must be kept to the bare minimum as it is a potential safety hazard.
4. Staff of all departments must work round the clock in three shifts so that the work can be completed at the earliest.
5. For NI working of up to 3 days, plans will be finalized in consultation with DRM, Branch Officers and concerned HOD of Construction/RE Organization.
6. For NI working of more than 3 days, plans will be finalized in consultation with CTPM, CPTM and HOD of RE/Construction Organization at Zonal level to assess the duration and arrangements of NI working.
7. For more than 3 days NI, plans should be worked out for cancellation, diversion, rescheduling, short termination or even extension of trains as the case may be.
8. For NI working of more than 7 days personal approval of the General Manager must be obtained.
9. No NI working should last for more than 14 days.

(D2) Sanctions, clearances and preparatory works :

1. Signal Plan must be finalised in Hdqrts. at least 45 days in advance.
2. All plans and clearances including CRS sanctions that are required for NI working must be available at least 1 month before commencement of NI working.
3. Under no circumstances should this period of 1 month be relaxed.
4. NI working must be postponed in order to provide for 1 clear month before start of NI either in case of :
   (i) Delay in receipt of above clearances/sanctions etc.
   (ii) Last minute modifications to Signal Plan.

5. All pre - NI work that can be carried out without non - interlocking must be completed before actual NI working begins. These include changes in yard layout, insertion /removaI of points & crossings etc. Changing/installation of new point machines must be done in advance.
6. Preparatory work in connection with OHE work must also be done in advance, including shifting of neutral section, if required.
7. Lessons learnt during previous Nls must be gone through in detail so that shortcomings of earlier occasions are avoided.

(D3) Level of Supervision/Responsibility :

1. Responsibility to ensure availability of proper arrangement for NI working shall be of Construction/RE organization.
2. Though the responsibility to provide necessary arrangement will be of Construction/RE organization, concerned branch officers from open line shall be responsible to ensure its availability and functioning during train operation. For this he shall be the coordinating officer for the department concerned.
3. PERT chart should be made out detailing various activities to be completed on a day-to-day basis.
4. For round the clock working PERT chart should be made out detailing various activities to be completed on a shift to shift basis.
5. Dy. CSTE/Dy. CE/Dy. CEE as applicable shall make themselves available in non-interlocked area where the work is being undertaken.
6. The concerned Project in - charge (XEN, DSTE/Con. etc) shall camp near the non-interlocked area till completion of non-interlocked working.
7. Overall in charge for NI working will be Sr. DOM/DOM as the case may be for both Safety and Operations.

(D4) Green Notice :

1. Construction officials responsible for carrying out the work should send a 'circular notice' to the Sr. DOM/Sr. DSO at least two months in advance.
2. They will advise as to when the work will be undertaken with a request to issue special instructions. A copy of the notice shall also to be sent to SS of the station concerned.
3. Sr. DOM/Sr. DSO on receiving such 'circular notice' get special instructions prepared for that station. These are then issued to all concerned.
4. Green notice is to be issued by Sr. DOM. It should incorporate the following :
   (i) Details of existing yard layout and its various provisions.
   (ii) List of all works to be completed by Civil Engg./S&T/Elec. before start of NI.
   (iii) List of all works to be undertaken by Civil Engg./S&T/Elec. during NI period.
   (iv) Additional facilities to be made available after commissioning of new works.
   (v) Existing facilities that are to be dismantled.
   (vi) Details of yard layout to be made available after completion of NI.
5. Signalling Plan must indicate permissible routings and simultaneous movement facilities to be made available.
6. Signalling Plan must invariably indicate whether any of existing facilities for train movement are to be (i) either curtailed, (ii) modified or (iii) restricted.

(D5) Time Tabling changes :

For assessing the impact of NI working at a bigger terminal or at a Junction station, a detailed exercise has to be undertaken as indicated below.

1. During the course of NI working changing of points manually after passage of a train and after completing all formalities takes about 10 minutes time.
2. The capacity of the junction station to handle maximum number of trains during a particular time period has to be worked out keeping in mind the above constraints.
3. Every possible train movement of reception and despatch must be clearly documented,
   (i) Along with time of movement.

(ii) With exact sequence of points, whether in normal or reverse.

4. For time-tabled moves, trains demanding same point either at the same time or within 10 minutes must be identified since this is the time required before an existing setting of points can be changed. In case of conflicting moves, the less important moves have to be cancelled, rescheduled or diverted.
5. Crossing and precedence must be restricted to the bare minimum with few specific routes being selected for most movements.
6. As a thumb rule, only 80% of the reduced capacity as worked out should be utilized since unforeseen failures such as ACP, equipment failures etc. are likely to take up the remaining 20% of the available capacity.
7. In all such planning it is better to keep adequate cushion in train operations and initially cancel, reschedule or divert more number of trains than what may be required. In case NI working progresses smoothly without major detentions and it is felt that some of the cancelled trains can be restored, the same may be done after a week or so.
8. Clear corridor for freight must be charted out, with exact number of moves possible, and extra freight trains that cannot be handled should be planned to be diverted to other routes. In case diversion is not possible then operating restrictions must be imposed.
9. More time must be spent in precise planning of each move during NI period, such that the station is not brought under pressure at any time.
10. Changes in PRS reservation system for cancellation, diversion, rescheduling etc. must be done in advance as per advance period of reservation.

(D6) Advance preparation for Train

Running : Stoppages on Platform :

1. Duration of stoppages of Mail/Express trains must be reduced to the extent feasible.
2. Loading/unloading of parcels should be reduced to the bare minimum. If possible handling of parcels should be suspended giving due publicity in the Press and other media.
3. Running of trains with single SLR must be prohibited.
4. Shunting operations must be restricted to the bare minimum and preferably avoided altogether as far as possible.
5. Booking of through carriages, inspection carriages, etc. to the NI station must be restricted.
6. Quick watering of coaches must be ensured by deputing additional staff as required.
7. Nominated stations for watering of coaches may also be changed if alternate stations are available.
8. Extra TXR staff on platforms for attending to defects in rolling stock and promptly attending to complaints.
9. Extra train lighting staff must also be deputed on platform duty for promptly attending to complaints.
10. Special squads of commercial and RPF staff must be deputed on platform duty for checking ACP etc.
11. All efforts must be made to minimize detentions. Crew Changing :

1. Loco Supervisor must be kept on round the clock duty on the platform for quick change over of crews.
2. If possible crew changing for through passing trains may be planned at adjoining stations.
3. If necessary, Lis may be deputed to accompany the loco pilot from one station before NI station till one station after NI station.Traffic Supervisor must be kept on round the clock duty on the platform for quick change over of guards.
4. At notice stations, computerized print out of caution orders must be used for saving time.
5. Similarly, extra porters should be deputed for delivering these caution orders to loco pilot and guard.

Locomotives :

1. Engine changing for through trains must be curtailed.
2. Locomotives must be freely extendable beyond territorial jurisdiction.

3. If it is unavoidable, then changing of locos may be done at either side of NI station.
4. For avoiding changing of locos from Diesel to Electric and vice versa, train routings may be changed during the duration of NI working.
5. For traction changing, half shunt of locos may be freely resorted to.
6. Attaching of locos in rear should be resorted to in case of stations where trains reverse.
7. Sending of light engines to sheds must be restricted. For this purpose, an out pit may be opened, if necessary.

Controlling of Trains :

1. In case of major terminal stations, a mini control office may be opened at the station. This mini control will liasion with divisional control office for purposes of train running. The jurisdiction of this mini control office would be the NI station itself, and 2 - 3 stations on either side in each direction.
2. Station under going NI must not be permitted to be brought under any pressure whatsoever at any time during NI working.
3. All relevant notices must be issued in advance.

(D7) Goomty Arrangements :

Location and number of goomties is an extremely important aspect of advance planning for NI. Sr. DOM/Sr. DSO should personally approve final arrangements regarding goomties.

1. Cabins should not be used as goomties.
2. For a group of maximum of three sets of points operated from the ground, one goomty should be made.
3. Ideally, only 2 sets of points should be controlled from a single goomty.
4. Each goomty should be provided close to the group of points that it controls. This will ensure that physical movement of staff is reduced to the bare minimum.
5. A group of 3 - 4 goomties at one end of the yard should be put in one zone.
6. Under no circumstances should 2 ends of the same points/crossings be with different goomties. This must be specially ensured for diamonds with single slips and also with double slips. Each such diamond must be under the same zonal in-charge.
7. Location of each goomty as also number of points that are controlled from it should be tentatively marked out in yard diagram. This should then be physically cross checked at site by visiting the station yard.
8. At site it must be ensured that staff are not required to walk long distances for setting of points.
9. Both ends of each point must be clearly visible from the goomty itself.
10. A goomty must be provided near the first stop signal for prompt issue of OPT forms etc. as required. Another goomty must be provided at the last stop signal to ensure correct dispatch of trains.

(D8) Staff Arrangements :

Staff Requirement :

1. Each goomty should have one ASM and two Pointsman in each shift. These extra ASMs posted in goomties shall be called goomty ASMs. ASM posted with indoor ASM will be termed as co-ordinating ASM.
2. For cabin operated points, extra commensurate staff as required (ASM/cabinman/ pointsman) should be provided. However, cabins should not be used as goomties as far as possible.
3. Goomty ASMs during their duty hours shall be fully in-charge of working of points/levers under their charge. They shall discharge all obligations of the cabinman/pointsman working at the station/cabin. They shall work under the direct supervision and instructions of the co- ordinating ASM on duty.
4. A group of four goomties or more at each end of the station should be put in one zone. Each zone should be under the charge of a TI in each shift. TI will periodically keep moving about amongst the goomties within his zone. He will check up and monitor the working of group of goomties under his charge.

5 For non-interlocking work at major terminal stations, necessary arrangement for additional staff should be made, if necessary, from adjoining divisions, before undertaking NI working.

6. Under no circumstances should NI working be started unless full complement of staff is available at the station as per above norm and adequate training has been imparted to them.

7. Preferably those staff should be drawn from outstation who have
   (i) Adequate knowledge of NI working.
   (ii) Previous experience of the same.

8. Boarding and lodging of outstation staff is an important aspect of NI preparation. Dormitory type arrangement would be ideal, if these can be arranged. At major junctions these can be taken care of by stabling a few coaches at sidings. However, facilities will have to be arranged for electrical charging, watering, cleaning of bathrooms, sanitation etc.

9. On divisions where separate non - interlocking gangs are already in existence their strength may be adjusted accordingly. However, composition of such NI gangs should be periodically changed by inducting fresh faces and with drawing earlier ones.

10. Round the clock engineering gangs with crow-bars and handles should be available to move points in emergency. One gangman should be available with each goomty in each shift for this purpose.

11. At each non-interlocked station one Asst. Scale officer of operating department will be nominated for over all supervision.

(D9) HOER :

1. Under no circumstances HOER violation should be permitted during NI working. As far as possible duty hours of staff should be restricted to 8 hrs. duty per shift in continuous roster.

2. For catering to unexpected casualties such as leave, sickness etc. during the NI period, RG and LR staff must invariably be provided for.

3. RG and LR must be made available shift wise. The standard of RG and LR should be the same as that of regular duty cadre staff for that shift as stipulated.

(D10) Duty Rosters shift wise :

Meticulous detailed planning must be carried out for drawing up roster of staff to be deputed for NI working. While drawing up roster of staff for various shift duties, following guidelines must be followed :

1. Duty rosters must be drawn up as per guidelines given below.
2. These should be drawn up for the entire duration of NI period.
3. Duty rosters drawn up should be openly displayed and given wide publicity.
4. No staff shall be permitted to mutually exchange his duty roster with any other staff, without prior permission of his departmental officer at site.
5. Level 'N + 1' shall be responsible for ensuring that level 'N' has followed all instructions, etc. as laid down above.

Last Night Shift Duty :

1. Regular staff permanently posted at the NI station must be rostered during the last night shift.
2. Second preference should be for staff who have previously worked at that station.
3. Best and most competent supervisors should be deployed for last night shift duty.

First Night Shift Duty :

1. Regular staff permanently posted at the NI station, if still available for deployment after covering last night shift, should be rostered for first night shift duty.
2. Second preference should be for staff who have previously worked at that station.
3. Amongst outstation staff preference should be as follows :
   (i) Senior staff having previous experience of NI working.
   (ii) Staff who are presently posted at major junctions. Dav Shift Dutv .

1. Comparatively junior inexperienced staff from outstation should be deputed for day shift

working.

2. Teams for different goomties should be so formed as to include at least one staff having previous experience of NI working.
3. For day shift working, more number of staff may be deputed per goomty, if required, to cater for comparatively inexperienced staff.

(D11) Temporary Workinq Instructions (TWI) :

1. When NI is undertaken, inter - locking provisions stipulated in SWR are no longer available. So the SWR in its existing form becomes invalid.
2. TWI is basically meant to replace some portion of Station Working Rules of the station during the period of NI working. While they need not be as detailed as the original SWR of the station, nevertheless, they must cover all aspects of train operation that are included in the existing SWR.
3. Static information of SWR will continue to be valid. These include :
   (i) Inter - station distances.
   (ii) Description of yard layout.
   (iii) Level crossing gates.
4. TWI is to be read in conjunction with G&SR, Operating Manual, Block Working Manual. It must also be read along with existing SWR of the station.

5. Portions of SWR that will get replaced pertain to :
   (i) Ensuring clearance of running lines.
   (ii) Granting of line clear.
   (iii) Reception/despatch of trains.
   (iv) Working of level crossing gates.
   (v) All checks that are done by means of :
      (a) Slots.
      (b) Lock bars.
      (c) Point locks.
      (d) Signals.

   All these checks have to be taken care of manually.
6. TWI should list out :
   (i) Number of goomties.
   (ii) Portions of yard that each goomty would control.
   (iii) Which goomties are to be involved for reception/departure of a train on/from different lines.
7. TWI should list out different conditions required to be fulfilled for receptiondespatch of train :
   (i) How line clear is to be granted/obtained.
   (ii) How clearance of nominated line is to be ensured.
   (iii) Procedure for closure of level crossing gates, if any.
   (iv) How the route is to be set.
   (v) What are the series of points involved.
   (vi) Which one of them are to be in normal position and which ones in reverse.
   (vii) How signals are to be lowered.
   (viii) W

hich staff would do what.

(D12) Field level Advance Preparation :

1. Detailed working instructions clearly specifying the zone of responsibility of each and every staff and supervisor along with temporary working instructions must be issued well in advance of the NI working. In any case these should be ready at least 15 days in advance of NI workinq.
2. Station Superintendent/Traffic Inspector who is overall in-charge should be fully aware of their responsibilities/duties. Temporary working instructions should clearly stipulate these unambiguously.
3. Each Station Masters/Assist. Station Master, Cabin Man and point man deployed on shift duty should be supplied with copies of temporary working instructions. In addition SM/ASM and Cabin Man shall be supplied with yard layout diagrams and pull charts for their guidance.
4. The temporary working instruction shall be supplied to SS/ASM/Cabinman and Pointsman in advance for study by them and for explaining to illiterate staff.
5. The instruction should be prepared in Hindi, English and Vernacular language and assurance to the fact that they have understood shall be obtained.
6. Ready made pull charts indicating normal and reverse

position of points for specific routes must be prepared goomty wise. All such pull charts should be prepared at least 15 days in advance.

7. TI should be entrusted with the job of personally checking each and every pull chart. Compliance report must be submitted by TI at least 10 days in advance.
8. These pull charts must be printed, laminated and displayed in goomties as also given to each staff concerned.
9. Draft instructions and pull sheets must be computerized and prepared in advance. Thereafter these should be revised on a day to day basis. Actual revision should take into account the progress of work as per the original time schedule.
10. A checklist of items to be inspected jointly by Traffic, Signal and Permanent Way Inspector should be drawn and controlling officers should monitor that instructions in the checklist are complied with.
11. The exact location on the stock rail where clamps are to be fixed must be marked with white paint and clamps should actually be fitted to check that there are no obstructions. Clamps should be actually fitted to check that there are no obstructions.
12. It may not be possible to fix clamps on motor operated points provided with second leading stretcher bar. In all such cases provision must be made for cotter bolting of points.
13. In any case, cotter bolting of points must always be preferred as compared to clamping and padlocking since it is a much faster method.
14. Normal/reverse position of points should be painted on tongue rail to indicate position of the road.

(D13) Mock Drill and Staff Assurance :

1. Before the SM/ASM/Cabinman/Pointsman and other staff connected with train passing work are allowed independent duty, the Station Superintendent shall obtain their verbal assurance that they have understood the same.
2. With regard to semi - literate and illiterate staff :
   (i) SS/TI should explain detailed working.
   (ii) Test their knowledge.
   (iii) Satisfy himself that they can work independently.
3. Before starting actual non-interlocked working, a "mock drill" or "hands-on" demonstration/training should be given to all staff for at least 1 to 3 days in advance (depending on the size of the station) to familiarize them thoroughly with the type of work they have to handle.
4. This should be carried out in all the 3 shifts to ascertain difficulties, if any, which may be encountered during NI working.
5. Teams already formed for different shifts should be deputed as per roster.
6. "Mock drills" should be carried out without actually disconnecting signal

gears, points etc.

7. Whatever deficiencies are noticed during this period should be rectified before introduction of actual NI. This experience should also be used to accurately estimate capacity to be available during N.I. and the number of trains planned to handled should be accordingly revised.
8. Written assurances are required to be obtained before staff connected with train passing duties are allowed to work independently.
9. This written assurance should be taken from the staff only after :
   (i) They have participated in the "mock drill".
   (ii) Worked independently as per their laid down roster.
   (iii) Successfully carried out all responsibilities entrusted to them during the "mock drill".
10. No staff should be deployed unless proper entries are made in the "Assurance Register" and relevant signatures obtained.

(D14) Dissemination of information :

1. All aspects of working during NI, and changes post-NI should be clearly documented and explained at all Loco pilot/Guard lobbies, whose staff pass through that yard.
2. For this purpose loco/traffic inspectors, senior subordinates will be nominated to visit these lobbies, with yard plans and camp at these lobbies.
3. Assurance of each and every running staff regarding these changes should be recorded in respective lobby assurance registers, and complete report submitted to Sr. DOM/Sr. DSO/Sr. DME/Sr. DEE on return.
4. Adjoining divisions/railways including notice stations and inter-change points should also be intimated of the detailed program pertaining to NI working.
5. All control staff including CHC, Dy. CHC, Section controllers, Power controllers, TLCs, TXR control etc. should be appropriately briefed.
6. The section controllers working on control boards must be fully conversant with the proposed changes pre-NI, restricted movement during the course of NI working and post-NI facilities to be made available.
7. Adequate publicity must be given through newspaper advertisements, electronic media, announcements at stations etc. informing the public of the likely repercussions on train running.

(D15) Telecommunication, Lighting and Medical :

1. Absolutely foolproof arrangements must be made regarding communication between the station and two adjoining stations on either side so that under no circumstances should there be a situation of total failure of communication between these stations.
2. Satisfactory arrangements for telephonic communication between station (indoor), Cabins, Goomty and Level

Crossings Gates should be made to ensure efficient functioning of telephones provided at various locations.

3. Additional fail safe communication between control office and the NI station must be provided as a backup to existing section control channels.
4. Arrangements for public address system should also be made so that the same can be used for warning the public etc.
5. Loud speakers must be provided on each goomty for making announcements regarding train movement.
6. Walkie - Talkie sets must be provided to all supervisors working at site.
7. Gangmen, Keymen and Patrolmen in 2 block sections on either side of the NI station must be provided with walkie - talkie sets, electronic hand signal lamps etc.
8. Arrangements of staff and recharging facilities should be available for charging of batteries of telecom equipment including walkie - talkies.
9. General lighting in yard should be adequate.
10. Separate lighting should be provided in each point zone. Lighting should be adequate so as to ensure that each point controlled from a goomty is clearly visible to the ASM/Cabinman in charge of that goomty.
11. Adequate generator backup should be provided. Spare bulbs should also be provided at each location.
12. Round-the-clock medical post with doctor and para-medical staff must be provided. They should be equipped for handling first aid and crush injuries. Anti-snake venom (Covalent) should be available. Road ambulance should be permanently stationed for quick transportation if needed.

(D16) Safety Equipment :

1. Safety equipment required for each location such as goomty, cabin, level crossing gate etc. must be spelt out in detail and full complement arranged.
2. Adequate spares must be arranged for safety equipment such as of hand signal flags, detonators, fusees, clamps and pad locks etc.
3. LED based flashing Hand Signal Lamp must be provided to each such location for better visibility.
4. Cotter bolts, cotter pins and clamps & padlocks must be thoroughly tested to be in proper working condition.
5. Spare numbered crank handles must be provided in goomties where point machines are pre- dominantly working.
6. Each goomty must be provided with the following safety equipment :
   - (i) Clamps, padlocks, detonators, fusees.
   - (ii) Flags, hand signal lamps etc.
   - (iii) Relevant pull sheets, yard diagrams etc. duly laminated.
   - (iv) Torches, emergency light, in addition to normal lighting.
   - (v) Umbrellas, caps, raincoats as required.
   - (vi) Cotton Gloves for staff handling points etc.
   - (vii) Table, chairs in tent or covered area.
   - (viii) Containers and glasses for drinking water.

(ix) Thermos for tea/coffee and provision of snacks and meals for staff deployed from other station or /headquarters.
(x) Mosquito/insect repellant creams.
(xi) Magnetto, and VHF walkie talkies, Public Address Equipment.
(xii) Private number books, paper, pens.

(D17) Security arrangements :

1. Adequate RPF security staff round the clock must be arranged at following locations :
   (i) ASM's office.
   (ii) Central place at the station.
   (iii) Level crossing gates.
   (iv) Outer most goomties on either end.

(D18) Introduction of NI working :

1. Before permitting introduction of NI working DRM/ADRM will satisfy himself regarding arrangement of staff, safety equipment, lighting, telecommunication and ground position.
2. On the day of commencement of NI working, branch officers concerned from Operating/Safety, Engineering, Signal, Electrical and Mechanical along with DRM/ADRM will visit the place of work. They shall satisfy themselves of availability of necessary arrangement as per standard before permitting introduction of non-interlocking.
3. On the notified day, for introduction of NI working, Signal Inspector concerned shall give a general disconnection memo for gears proposed for NI workinng.

(D19) Train Operation during NI period : Workinq of Signals :

1. Speed restriction of 15 kmph. must be in force over all points and crossings. Speed restriction Board of 15 kmph. must be exhibited at the foot of the first stop signal.
2. The following signals should be provided with caution aspect :
   (i) In case of colour light signals, a common NI home signal without route indicator.
   (ii) In case of MAUQ/TALQ, single arm NI home signal.
   (iii) Warner signals, if any are to be put out of commission by putting 2 cross bars.
3. NI Home/Starter signal can be taken off only after ensuring that :
   (i) All points on the route are correctly set, both facing and trailing points clamped and padlocked.
   (ii) In addition to correct setting, clamping and padlocking of facing points, they must also be manned.
   (iii) Level crossing gates on the route have been closed against road traffic.
4. Last stop signal should not be disconnected throughout NI working except at the fag end.
5. Movement of trains to and from the block sections should be controlled by

taking off the last stop signal.

6. Normally, no Paper Line Clear should be issued to the loco pilots as authority to proceed in the block section.
7. A traffic block of 2 - 3 hrs. should be taken for disconnecting the last stop signal and block instrument and reconnecting the new last stop signal and new block instrument.

Train Running

1. Each train movement must be announced well in advance on the loudspeaker:
   (i) Along with the number of the goomty involved.
   (ii) Sequence of points required to be set and locked in normal or reverse condition.
2. Trains must be allowed to enter cautiously at 15 kmph.
3. Loco pilot of an incoming train must not under any circumstances pass the outermost facing points even though signals have been taken off:
   (i) Unless he also sees that the points are manned.
   (ii) A proceed hand signal is exhibited towards him from the points.

(D20) Failures :

1. All indicative accidents during the period of NI working must be immediately reported to the site in charge in order to ensure prompt corrective action and avoidance in future.
2. Details regarding such cases must be promptly intimated to DRM and Sr. DSO.
3. A register must be opened at each goomty in which before handing over charge, staff will enter details of whatever difficulties they have faced during their shift. The person in charge of NI working at that station must scrutinize this register daily.
4. Cases of bursting of NI target should be appropriately dealt with and individual responsibility should be fixed up.

(D21) Revised Station Working Rules :

1. After completion of NI working, new works are to be commissioned.
2. Since the yard layout, facilities etc. have changed, the previous SWR is no longer valid.
3. A new SWR duly approved by CRS is to be brought into effect after completion of NI.
4. Staff assurances for the revised SWR must be taken afresh.

(D22) Completion of NI Working:

1. NI working must not be terminated unless and until each and every item originally scheduled for completion has been successfully complied with.
2. Designated operating officer must visit the NI station and verify the following:
   (i) Completion of work as per program.
   (ii) Correspondence of yard layout as per SWR.
   (iii) Correspondence of movements permitted as per SWR.
3. The installation shall jointly be tested by Traffic, S&T

and Engg. officials and for their correct functioning.

(i) The lever/knobs, signals, points and connections work freely and properly and that the installation fulfils its objective.

(ii) Signals are properly focussed, the indications on the panel correspond with the signal aspect and point position at site.

(iii) Engineering officials shall check the proper housing of points gauge level etc.

4. Before issue of Safety certificate and taking over of stations, the Transportation/Safety Officer shall instruct the station staff responsible or working the interlocking installation and test them in their knowledge of the signalling arrangement.

5. Engineering and S&T officers shall give a certificate stating that all works as per the approved plan are completed.Staff concerned shall be notified through Station Order Book, Control Order Book and their acknowledgement obtained. All inspectors and other supervisors shall ensure strict compliance and report any deviation or violation with prompt to notify then and there.

6. On the day of completion of work, branch officers concerned shall visit the work site to ensure completion of work as per program.

(D23) Post NI analysis :

1. Within 7 days of completion of NI, a brain storming session should be held with all the senior supervisors involved for taking stock of lessons learnt.

2. These lessons learnt should be compiled at one place for successive Nls, so that they are available for future reference.

A copy of the same may also be sent to other divisions for reference purposes.

Appendix 20
Management Information System (MIS) for Signal & Telecom Maintenance

General -MIS is required to be developed for effective monitoring and management of following mainactivities of Signalling and Telecommunication fields of Railways.

1. Signaling Assets Maintenance
2. Joint Inspection of Point and Crossing
3. Signal Incidences Monitoring
4. Remote Information Monitoring
5. Telecom Assets Maintenance
6. Asset Register
7. Statistics of Signal & Telecom
8. Alerts for Midlife Rehabilitation
9. MCDO, Periodical/Annual/Monthly/Weekly Achievements
10. Drawing and Documents Monitoring
11. Inspections Monitoring
12. Action Plan/Prime/FAP

Signaling Assets Maintenance :

1.1 This shall be GPRS based system and signaling supervisors or Technicians shall used hand held i-pad or Tablet to access MIS application for entering Maintenance schedule done or parameters measured only when they are in the close vicinity of concerned gear being maintained by them.

1.2 At Station also a desk top PC will be connected to MIS through dedicated E1 stream used for networking station desk top.

1.3 It shall be possible to fill up maintenance schedule or measurements at station desk top also, in the event of GPRS failure, but it shall be possible to do it only when access is permitted by In- charge ADSTE/DSTE. To achieve this station system on request of maintenance staff shall send auto generated SMS with OTP to concerned ADSTE/DSTE, who in turn if permits do manual entry will advise this OTS on phone to the concerned station staff to access MIS. It shall be possible to generate report of such instances.

1.4 In case of station PC link failure, the data shall be stored locally and automatically updated on resumption of link or whenever PC is switched on.

Name and number of gear shall be selectable options so that there are no mistakes in therts being generated. To achieve this data of all gears of the stations have to make in theof Data Form, which shall be regularly updated by Divisional HQ immediately after any ges are done. Previous Data sheet shall be automatically stored in the history folder and data sheet shall be in use. It shall be possible to generate report of such changes

highlighting the changes done and authority who did it.

1.5 On opening of MIS display option shall come On Main Screen " Activity to be Done" – Replacement per Codal Life or due to failure or MLR/Maintenance. On selecting of Maintenance further forms shall open up as detailed in next paras. On selecting option of replacement, the EDIT

menu shall appear to edit all the details and keeping the previous records.. Name & designation of official making this entry should also be entered. Reports shall be generated asper required format which will be given later.

1.6 Following format to fill data-Form be adopted all from Drop Down Menu unless speciallymentioned otherwise and data sheet has to be made for each of these -

i) Select –Railway
ii) Division
iii) Station/Section
iv) Type of assets – Sig or Tele

1.7.1 For signal Type of gear – Afterwards in MIS while filling maintenance forms these gears have to be selected at site by the staff doing maintenance.

a) Signal
b) Points
c) Vehicle Detection Devices
d) Control Panels/VDU
e) EKT
f) Relays
g) Power Supply
h) Fuses
i) DG Sets
j) Solar PANELS
k) Apparatus cases/location boxes/Cables
l) Earthing
m) Axle counters
n) Block instruments
o) Block Panels
p) Level Crossing Gates
q) Electronic Interlocking

1.7.2 Further Drop-Down Menu for each of the above gears has be made like for Signal

a) Signal – Main/ Shunt/ Subsidiary Signal:
b) Next Selection under Subsidiary Signals Calling –ON/ A Marker/ AG Marker/Route Indicator/Stencil /Numeric Display/Theatre Type.
c) After Selecting from the above two next sheet shall appear depending up on selection to fill upfollowing data for main signal-

i) Signal Number form DDM, only numbers to be selected, later on display prefix shall automatically come like S for Main Signal, SH for shunt, CO for calling On, A for A Marker,AG for AG marker, Route for Route Indicator and so on.
ii) Type of Unit – From DDM – Metallic/FRP
iii) Number of Aspects No. =1 to 4 from DDM
iv) On selecting number of Aspect display next sheet to select Aspect 1-Red/Yellow/Yellow/Green form DDM, Aspect 2 and so on. For each aspect selected further details like LED make from DDM linked to RDSO approved sources list, specifications Type,
Month of Manufacturing, Serial No. and Date of Installation, Mid Life Rehabilitation – Yes/No
v) Mileage - Kilometer of Signal along with Latitude & Longitude

vi) Location – through DDM Left Hand/ Right Hand/ Extreme Left Hand/ Extreme RightHand/Gantry
vii) Either Side Implantation of Signal
viii) Sacrificial Mast – Provided or Not Provided.
ix) Installation Date – Signal Base
x) Installation Date – Signal Post
xi) Installation Date – Signal Unit
xii) Installation Date – Route Indicator
xiii) Installation Date – Shunt Signal
xiv) Installation Date – Calling On
xv) Installation Date – A Marker
xvi) Installation Date – AG Marker

1.7.3 Points – This form is simple and following details shall be entered to be used in MIS:

i) Point Number – In MIS P shall get prefixed automatically only number to be entered from DDM and point means each turnout of a crossover if it is.
ii) Line on which point is provided, It shall be selectable from DDM ie. ML A Route/ML Other Route/Other Portion of Yard
iii) Type of Turn Out: from DDM -Single Ended/ X-Over/Derail Switch /Single Slip/ DoubleDiamond Slip
iv) Kg.: from DDM- 52Kg/60Kg/Thick Web Switches
v) Type of Curve – from DDM -1 in 8 ½ , 1 in 10, 1 in 12 & 1 in 16.
vi) LH/RH Curve – LH/RH
vii) Type of Sleepers – PRC/Wooden/Steel
viii) Nos. of Gauge Tie Plate -1/2/3/4-
ix) Nos. of Gauge Tie Plate insulations sets -1/2/3/4-
x) Nos. of William Stretcher Bars– 1/2/3/4
xi) Nos. of William Stretcher Bar Insulations sets– 1/2/3/4
xii) Spring Setting Device- Provided/ Not Provided.
xiii) Type of Point Machine: IRS/Siemens (143 mm or 220 mm stroke shall get automaticallyselected from selection of Kg
xiv) Point Machine LH/RH – LH/RH
xv) Pont Machine Make – Selectable from RDSO List of Manufacturer
xvi) AC immunization – From DDM -300V/400V
xvii) Pont Machine Date of Manufacturing
xviii) Pont Machine Date of Installation
xix) Serial No. of Point Machine
xx) Point Motor – Make,
xxi) Pont Motor Date of Manufacturing
xxii) Point Motor Date of Serial No.
xxiii) Point Motor Date of Installation.
xxiv) Installation dates of following shall automatically appear for following with date edit option tofacilitate entering of Replacement details while retaining the previous entry:
   a) CH Box,
   b) Detection Trolley,
   c) Friction Clutch, Slides –
   d) Normal Detection Slide,
   e) Reverse Detection Slide,
   f) Throw slide
   g) Lock slide normal
   h) Lock slide reverse

i) Mechanical fuse

xxv) Ground Connection – Date of Installation (Editable).

xxvi) Similar to point machine, Installation dates of following shall automatically appear for following with date edit option to facilitate entering of Replacement details while retaining the previous entry, this may be linked with track circuit field:

a. Normal /Short Detection Rod
b. Reverse/Long Detection Rod
c. Throw Rod
d. Normal Lock Rod
e. Reverse Lock Rod
f. Clamp Lock –
g. L Bracket
h. P/D Bracket LH
i. P/D Bracket RH
j. Insulation of P/D Bracket – LH,RH;
k. Insulation of L bracket,
l. Insulation of Clamp lock,
m. Insulation of William Stretcher (WS) No. 1,
n. Insulation of WS2,
o. Insulation of WS3,
p. Insulation of WS4, ,
q. Insulation of Gauge Tie Plate 1
r. Insulation of Gauge Tie Plates (1, 2, 3, 4) of Crossing with

1.7.4 Vehicle Detection Devices:

i. Track phases provided at the station:
   a) FM-FM,
   b) FM-BSL T/O
   c) FM-Home Straight,
   d) FM-Home T/O,
   e) Loop Line1.2.3……
   f) Other goods line 1, 2, 3, --, 30. (Fixed Display)
   g) Sidings 1.2.3…..

ii. Details Track Circuits Provided at the stations and for each Track Circuit

a. Track Circuit No.
b. Type of Vehicle Detection Device – DC/ AFTC/ SSDAC/ MSDAC/ HASSD/ UAC from DropDown Menu (DDM)
c. Redundancy – Provided or Not Provided.
d. If provided –then type of redundancy. DC/ AFTC/ SSDAC/ MSDAC/ HASSD/ UAC from DropDown Menu (DDM)
e. TC Line – UP Main, Dn Main, PF1 (Line No.--), PF2 (Line No.--), ----Other Lines. fromDrop Down Menu (DDM)
f. TC Location (Km.) - Relay End, Feed End, Bx Jumper Location 1, Bx Jumper Location 2, BxJumper Location 3
g. Length of TC –
h. Track Feed Battery Charger- Make (As per RDSO List), Month of Manufacturing, Date ofInstallation, Date of Replacement (Editable).
i. Choke- Make (As per RDSO List), Month of Manufacturing, Date of Installation. Date ofReplacement (Editable).
j. Regulating Resistance - Make (As per RDSO List), Month of Manufacturing, Date ofInstallation. Date of Replacement (Editable).
k. TF Battery Set - Make (As per RDSO List), Month of Manufacturing,

Date of Installation. Dateof Replacement (Editable).

l. Track Relay - Make (As per RDSO List), Month of Manufacturing, Date of Installation. Date ofReplacement (Editable).
m. Track Feed End Fuse Holder - Make (As per RDSO List), Month of Manufacturing, Date ofInstallation. Date of Replacement (Editable).
n. Track Feed End Fuse - Make (As per RDSO List), Capacity, Month of Manufacturing, Date ofInstallation. Date of Replacement (Editable).
o. TF End PPTC Fuse - Make, Capacity, Month of Manufacturing, Date of Installation. Date ofReplacement (Editable).
p. TF End- Auto Change Over Fuse System – Make, Month of Manufacturing, Date ofInstallation. Date of Replacement (Editable).
q. Track Lead Junction Boxes (TLJB) – Made of cast iron/FRP, TLJB No. – 1, 2, 3 ,4, 5 Date ofReplacement (Editable).
r. Type of Track Lead Wire – GI Wire/ PVC Jacketted Wire Rope/ Signalling Cable(Editable) Date of Replacement (Editable).
s. Nos. of Track Lead Wires - Double/ Single Date of Replacement (Editable).
t. Date of Installation of Track Lead Wires – Feed End, Relay End, Bx1, Bx2, Bx3 (Editable)Date of Replacement (Editable).
u. Date of Replacement of Track Lead Wire - Feed End, Relay End, Bx1, Bx2, Bx3 (Editable)Date of Replacement (Editable).

v. <u>Insulation/Glued Joints: For ech Insulation joints</u>
    i. No. of Glued Joint: 1, 2, 3, --- 10
    ii. No. of Insulation Joints: 0, 1, 2, 3, -------10
    iii. GJ Nos. – 1, 2, 3, -- : Date of Installation, Date of Replacement (Editable).
    iv. IJ Nos. – 1, 2, 3, -- : Date of Installation, Date of Replacement (Editable).

1.7.5 Similar Data Sheet for AFTCs & Various Types of Axle Counters and their component.

1.7.6 Earthing

a. A Class protection provided or not Y/N
b. If provided DOI, Make, Type
c. Perimetric earthing provided or not – Y/N
d. If provided then number of earth electrode
e. Relay Room Earthing details –
    i. Conventional/Maintenance Free Earth
    ii. Date of Installation
    iii. Initial value.
f. Signal Earthing details for each signal–
    iv. Conventional/Maintenance Free Earth
    v. Date of Installation
    vi. Initial value.

g. DAC Earthing details for each unit provided in location–
    vii. Conventional/Maintenance Free Earth
    viii. Date of Installation
    ix. Initial value.

1.7.7 LC Gate- Electric Lifting Barrier, Mechanical Lifting Barrier It has to made in more details inthe similar way

Signalling Maintenance MIS:

1.7 Fill up all type of maintenance schedules as given in DSMG so that it can be easily seen for selected gear or all. The format for filling and searching to be Type of Gera, Schedule No., Periodicity and Description of the maintenance activities to be done under each of the Schedule.

1.8 Initial Record of Last maintenance done by DSMG/SSE.

1.9 Based on last maintenance done record Daily schedule due including overdue - Daily job card is to be generated for DSMG/SSE.

1.10 Similar Schedules shall be generated for Weekly schedule due and Monthly schedule due

1.11 While filling the maintenance record it shall ask Maintenance done by – DSMG/SSE.

1.12 It Shall be possible to fill up the maintenance schedule done only when the staff carrying out maintenance is in maximum 50 meter range of the gear being maintained.

1.13 Maintenance and Measurement Record which is to be filled up to selectable from DDM.

1.14 Provision shall be made to view various records with selectable option.

1.15 Maintenance Record

2.9.1 On selecting Maintenance record – select gear maintained, then from DDM schedule done. Date and Time stamp shall automatically come. Say for Point Maintenance - on selecting type of gear as Point, the Display of the Maintenance Schedule Details as per prescribed maintenance schedule (P1, P2, P3, P4, P5 & P6) shall be selected from DDM.

2.9.2 To see the Maintenance Record on Selecting Type of Gear and Date Range, the record shall display in the Format SMC 11A & B.

1.16 Measurement Record

2.10.1 On selecting Measurement Record Range of various parameters to be measured shall get recorded in the respective format. While filling up the measurement during the Maintenance Schedule being done, only blank row of the format shall appear so that measurements are not biased but they are really done and only after submission of entry, show complete record.

2.10.2 Test Circuit Test record Card SMC9A to made for separate data entry form for each of the TC. SN 1 to 21 to be one time entry with editable form and rest of the entry from SM 22 to 45 to measured and recorded every six months as per DSMG. Similarly for SMC9C and other type of TC to be made. Report to be generated for part I for all the TC and Part II as per the format given in DSMG.

2.10.3 Test Results of Motor Points SMC12- It shall be as per the format. The initial data be is taken from the details filled earlier which is editable form and to fill measurements operating values and other details to be shown in the single blank row.

2.10.4 Cable Testing and Megger Measurements SMC 13A & B- These shall be as per the format for each of the cable. The initial details of 13A for Sr 1 to 11 to be filled for which data entry form shall be designed. Table of record shall be generated automatically after

meggering is over of each of the cable in which date of testing and defective conductors shall automaticallyappear as per the date on which measurement done and test result of meggering for the conductors less than 20 mega Ohm, to be shown in blue, less than 10 M Ohm in Yellow and less than 5 M Ohm in Red. SMC 13B report to appear as per format and for filling measurements suitable data entry form shall be developed.

2.10.5 Battery Cell and Power Equipment Measurements – SMC13A for Battery Voltage and Specific Gravity measurement, the first data SN 1 to 7 shall be for each type of battery bank provided at the station or mid-section and for measurement different data entry form to be made. Similarly for Power Supply Equipment measurements.

2.10.6 Earth Resistance Measurements SMC15- First data entry form to be made like SN 1 in DDM OF Signal/DAC/Relay Room and rest in entry filling form, these shall be editable. Nest part to be data recording form as per table.

2.10.7 Initial parameters or permissible limit will be entered for each kind of measurement for eachof the format and Exceptional report to be generated if derivation in parameter is beyond tolerance limit.

2.10.8 Major alarm to be generated if parameters not entered in two consecutive due schedules.

1.17 Replacement Record-

2.11.1 Record of LED Lamps & Current Regulator SMC1- This Record shall be generated for eachof the Signal, from Initial entries and subsequent entries of replacement done. The promptsto make sure shall be shown in the data entry format for replacement also. Similarly SMC2 shall be generated as per DSMG instructions for each type and make of LED signal aspect and automatically calculating life hours based on replacement hisotry. Index shall for all the signals shall be automatically made so that to view the record of concerned signal, it can be selected.

2.11.2 Record of fuses SMC5 & 6 shall be developed as the details contained in DSMG format.

2.11.3 Relay Replacement Record SMC7-This shall be first entering all type of relays installed at various locations and initial record to made by providing suitable data base entry in MIS. The suggested fields are each type of relay or relay group

a. Select Type of Relay Main Drop-Down Menu
b. Then each selected type of relay one can enter all the relays of that type installed at that station or in secton.
c. The other fields of this MIS be as per SMC7 and all fields be in DDM, except Sr. No. of Relay and Last Date of OH, Date put in use, Date Removed to be from calendar, in DOH the manu shallalso have NA. Position in relay rack or location shall be manually entered. Manufacturer column to be added with DDM as per RDSO list. This will facilitate to generate various type reposts of relays, total number, make wise, year wise, station wise, failure year wise, failure from the date of Manufacture i.e. within one year, 2, 3, and so on, due for OH or as required.

2.11.4 Replacement and Test record of GJ/IBJ to be maintained in the format SMC10. IBJ/GJ No. tobe taken from track bonding plan.

2.11.5 Mid Life Replacement (MLR) SMC 17- The data entry form for each

of the equipment to be made separately and equipment type shall be selectable from DDM. There shall be table of content to have details of equipment type, then equipment number and MLR Periodicity, which shall facilitate to generate exceptional report of equipment due for replacement as per MLR, during the year or year wise. Next shall be to select equipment and then number and fillup replacement date.

1.18 Work Register SMC 18, the data entry form it to be made so that it shall help in making tender schedule for SSMC.

1.19 **DCN Module:** Linking of maintenance activities of Signal requiring Disconnection Memos (DCN).This Module shall be made to monitor DCN activities and acceptance of DCN. This shall bemade as under-

2.13.1 Select type of gear like Point, Signal, Track Circuit, Axle Counter, Complete EI. This shall be selectable from DDM and gear no. to be disconnected from DDM. It shall be possible toselect more than one gear so after selecting one gear next prompt shall be do you want to disconnect additional gear. Similar facility shall be to reconnect one by one or all together.

2.13.2 It shall then ask for Option for maintenance/ Replacement/Works/Construction

2.13.3 In case of Maintenance ask to Select maintenance Schedule No.

2.13.4 Display DCN (Disconnection Memo) Form

a. By default, date, SN, Stn. Name, offered time should be filled up
b. Enter Gear No. from table (by default).
c. Period of DCN required in Hours & Minutes.
d. Print the DCN.
e. After print command, previous entries shall be fixed ie. uneditable.

2.13.5 There should be DCN Table for Each Station / section

Gear No. disconnected	Line Affected	Signal Affected

2.13.6 There should be another table of Maintenance Schedule & Disconnection required or not for the required maintenance schedule.

Maintenance Schedule	DCN Required/Not required

2.13.7 If DCN is given, automatically display form for filling parameters if DCN given as per table for the work which require DCN. Otherwise don't accept maintenance schedule entry & ask for issue of DCN. In rest of the schedule, automatically display DCN form.

2. Joint Inspection of Point & Crossing and Track Circuit Module – This module shall be made for having the record of inspection, summarize deficiencies and monitor compliance. The password for opening of this MIS shall be two separately for Engineering and Signalling supervisors.

2.1 The point number shall be selectable from data, through DDM and it shall catch current date as date of inspection.

2.2 Against each of the item of inspection, for each point there shall be DDM Like –

2.2.1 Condition of LH Tounge Rail –Not Worn Out/Worn Out Requires

Replacement

2.2.2 Condition of RH Tounge Rail –Not Worn Out/Worn Out Requires Replacement

2.2.3 Condition of LH Stock Rail –Not Worn Out/Worn Out Requires Replacement

2.2.4 Condition of RH Stock Rail –Not Worn Out/Worn Out Requires Replacement

2.2.5 Condition of packing of point Layout with our without MSP- Properly Packed/Racking Required.

2.2.6 Housing of Switch Rail with Stock Rail on LH Side (with no excessive spring) if any Jim- crowing required- Full Housing up to 5 sleepers/Housing up to 4 sleepers attention required/ Housing up to 3 sleepers attention required/ Housing up to 2 sleepers attention required/ Housing up to 1 sleepers attention required/ Housing only at Toe attention required.

2.2.7 Housing of Switch Rail with Stock Rail on RH Side (with no excessive spring) if any Jim- crowing required- Full Housing up to 5 sleepers/Housing up to 4 sleepers attention required/ Housing up to 3 sleepers attention required/ Housing up to 2 sleepers attention required/ Housing up to 1 sleepers attention required/ Housing only at Toe attention required.

2.2.8 Resting of Tongue Rail on slide chairs LH-Complete Resting/floating

2.2.9 Resting of Tongue Rail on slide chairs RH-Complete Resting/floating

2.2.10 Condition, Adequacy and Tightness of complete fittings – All fittings tight/Fittings Loose/Fitting Loose & Missing/Stock Bolt Loose/Stock Bolt Missing/Chair plate broken. (This shall be with faculty to tick the concerned field so that more than one filed can be selected.

2.2.11 Whether Tongue Rails are in square more than 15 mm out of square to be attended- In Square/Out of Square by less than 5 mm/ Out of Square by less than 10 mm/ Out of Square by less than 15 mm/ Out of Square by more than 15 mm.

2.2.12 Whether any Burr on Stock/Tongue Rail obstructing Movement of Lock Bar/Housing of Switch etc. (LH Side)- No Burr/Burr to be attended

2.2.13 Whether any Burr on Stock/Tongue Rail obstructing Movement of Lock Bar/Housing of Switch etc. (RH Side)- No Burr/Burr to be attended

2.2.14 Opening of Switch at Toe in mm (95-115 mm for BG and 220mm for TWS)LH Side
-<95mm/95mm……115mm/>115mm/150mm….170mm

2.2.15 Opening of Switch at Toe in mm (95-115 mm for BG and 220mm for TWS)RH Side -<95mm/ 95mm……115mm/>115mm/150mm….170mm

2.2.16 The clearance between leading stretcher & bottom of Rail not to exceed 1.5 mm. Nuts and Bolts provided are of standard size-<1.5mm/1.5……25mm/>25mm. Nuts and Bolts of standard size/Standard size Nuts & Bolts to be provided

2.2.17 Gauge at the Toe of the Switch-zero/>-5mm/-5…..-1mm/+5mm…..+1mm/>+5mm

2.2.18 Obstruction Test with 5 mm –Withstood/Required Adjustment

2.2.19 Gauge Tie Plate is of standard size, chair plate fixing Nuts/Bolts are

tight. No Gap betweenMS Strap revitted on Gauge Tie Plate and Chair Plate – Standard size/Requires attention

2.2.20 Switch Setting Device –Working Properly/Needs Adjustment/Pressure inadequate,-Clearanceat JOH -<40 mm/04 70mm, Lubrication – Proper/Needs Lubrication, Insulation-Proper/ Needs replacement

2.2.21 Any Other Item –

2.3 Track Circuits –

3.3.1 Ballast is clear of the foot of the rail not less than 50 mm, throughout track circuit- Clear/NotClear Require clearance

3.3.2 Whether track is having proper drainage and no possibility of water stagnating due tomud/garbage inballast etc.Proper drainage available/Proper drainage not available/Drainage needs clearance (These shall be selectable by tick for one or more options)

3.3.3 Whether insulated joints are square and well packed? – In square/Not in square have to be provided at proper place/Properly packed/Require packing. (These shall be selectable by tickfor one or more options)

3.3.4 J Clips are provided and not touching fish plate at insulated joint.-J Clips Provided/J Clips notprovided/Pendrol clip touching fish plate. (These shall be selectable by tick for one or more options)

3.3.5 On girder bridge with metallic channel sleepers insulation of is proper-Proper/Worn out needsreplacement

3.3.6 Metal flow at joints is not shorting track circuit – No metal flow/Metal flow & may short, needs attention

3.3.7 Whether longer fish bolts are provided at block joints & holes are of standard size-Yes/Not proper & need attention

3.3.8 Whether planned fish plates are used on block joints – Yes/No & need replacement

3.3.9 Whether the gap between the rail ends is sufficient to accommodate the end post and the railends are smooth square and clear of burrs and Battered ends at insulated joints-Sufficient gap/gap has to be made sufficient/rail ends smooth & no burr/Rail ends need attention. (These shall be selectable by tick for one or more options)

3.3.10 Proper insulation of rails of L-xing provided- Provided/Not provided needs attention

3.3.11 Nos. of defective sleepers-0/1.....20

3.3.12 Nos. of Liners missings-0/1....100/>100

3.3.13 Nos. of Pads missing -0/1…100/>100

3. Signal Incidences Monitoring

Module should monitor signal incidences which include signal bobbing, signal blanking and otherincidence monitoring in signal and to be customized as per site requirement

4. Remote Information Monitoring

The SFR module shall provide mobile application for registering faults from fields along with webbased access for accessing SFR, reason of failure , date time stamp etc.

All signaling gears failure history shall be stored in the central database and accessible from web application as and when required. The SFR report module shall be available for download and print .

The formats for SFR will be provided by Railways during implementation which needs to be integrated with Asset management system.

In addition, Codal Life notification module shall be provided for the asset for managing codal life of signaling gears. The gears whose codal life is likely to expire in configurable time shall be notified to mobile user and also shall be displayed on web based dashboard.

5. Telecom Assets Maintenance
Telecom asset maintenance module as per S&T guidelines and to be customized as per siterequirement

6. Asset Register
Asset register module will maintain details of all S&T assets / gears of station. Asset details include its relevant datasheet if available, asset type, name, name of supplier and to be customized as per site requirement
Statistics of Signal & Telecom:

Complete statistics of Signal & telecom assets in tabular form and to be customized as per siterequirement

7. Alerts for Midlife Rehabilitation:
Alert generation for any gears or assets or items if it passes through its at least midlife of itsexpiry period and to be customized as per site requirement

8. Module should have MCDO, Periodical/Annual/Monthly/Weekly Achievements at division and tobe customized as per requirement

9. Drawing and Documents Monitoring:
Module shall be there to keep database of all drawings and documents of gears and shall beavailable through searching criteria and to be customized as per requirement

10. Inspections Monitoring:
Module for Gears inspection data/results and shall be available through searching and to becustomized as per requirement

11. Action Plan/Prime/FAP :
Module should be customized as per requirement