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1. DESIGN BASIS REPORT



| | DESIGN BASI (FINA | S REPORT L) | |
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| EXPLORING ALT TECHNICAL INVES ⁻ ANY AND O | ERNATE ALIGNMENTS, FINAL LOCAT TIGATION, DETAIL DESIGN OF TUNNE THER ANCILLARY WORK IN SOHNA-M Prepared & Sul | ION SURVEY, GEOLOGICAL MAPPING, G L & ITS APPROACHES INCLUDING VIADL ANESAR SECTION OF HORC PROJECT. DMITTED BY | eo- Jct if |
| | M/s. S. M. Cor | isultants | |
| Prepared By | Tunnel Designer | (Shivendra Kumar) | |
| Approved By | Sr. Tunnel Consultant | (B. R. Sharma) | |
| Cli | ent: | Prepared By: | |



HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.



S.M. CONSULTANTS, S.M.TOWER, PLOT NO.-130, MANCHESWAR INDUSTRIAL ESTATE, RASULGARH, BHUBANESWAR-751010, ODISHA





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1. Introduction

Haryana Rail Infrastructure Development Corporation Ltd. (HRIDC) has been incorporated under the provision of Companies Act on 22.08.2017 with equity contribution of 51% from Govt. of Haryana and 49% from Ministry of Railways with an objective to develop, finance and implement viable railway projects (by itself or through a subsidiary SPV) including projects which require viability gap funding (VGF). Presently, HRIDC is implementing various Railway infrastructure development projects in Haryana with necessary cooperation from Indian Railways. As a sequel to its project development in Haryana state, HRIDC has planned for design and construction of New Board Gauge Double Railway line from Palwal to Sonipat via Sohna, Manesar and Kharkhouda for passenger and freight traffic. It will provide seamless connectivity to Dedicated Freight Corridors (DFC) at Prithalastation and to Indian Railways at Palwal, Patli, Sultanpur, Asaudha and Harsana Kalan stations. The projected route named as Haryana orbital rail corridor, which is 140 km rail link project to provide alternative route to Goods traffic presently moving in a circuitous and congested path via Delhi and consuming more time. Once this line is constructed movement by rail only instead of road due to curb pollution menace. This project will be beneficial to the industrial Hubs of Kharkhouda, Manesar and Sohna and will help in development, traffic can run faster and attract new traffic because of opening of rail transport. In future, environmental issues will come up in a big way favoring long distance traffic of this region of Haryana. This project has a tunnel for crossing Aravali Range near Sohna.

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2. Salient Features of Tunnel Portion

| | FEATURES | | | |
|--------|--|--|--|--|
| SL.NO, | DESCRIPTION | DETAILS | | |
| 1 | PROJECT SECTION | IMT SOHANA-DULAWAHT SECTION | | |
| 2 | NO OF TUNNEL | 2 Nos Tunnel (UP Main/DN Main) | | |
| 3 | TUNNEL | Single Tube single track | | |
| 4 | STANDARD OF LOADING | 32.5T Axel Load | | |
| 5 | TOTAL LENGTH OF TUNNEL | 4700 M (EACH LINE) | | |
| 6 | LENGTH OF NATM TUNNEL IN ROCK | 1120 M (24880-26000) | | |
| 7 | LENGTH OF NATM TUNNEL IN SOIL | 2480 M (26000-28480) | | |
| 8 | LENGTH OF CUT & COVER TUNNEL IN SOIL | 1100M (28480-29580) | | |
| 9 | PORTAL 1 IN ROCK | CH:24880 M | | |
| 10 | PORTAL 2 IN SOIL (Cut& Cover) | CH:29580 M | | |
| 11 | NO OF SHAFT | 5Nos (4 Permanent Ventilation Shafts& 1 Construction cum utility Shaft) | | |
| | | Permanent Ventilation Shaft Ch:26080 | | |
| 12 | LOCATION OF SHAFTS | Construction cum utility shaft Ch:26950 | | |
| | | Permanent Ventilation Shaft Ch:27680 | | |
| 12 | | 1-degree RHS | | |
| 15 | MAX. DEGREE OF CORVATORE IN TONNEL | 0.5-degree LHS | | |
| 14 | LENGTH OF STRAIGHT TRACK IN TUNNEL | 1660.32 M | | |
| 15 | LENGTH OF CURVATURE TRACK IN TUNNEL | 3039.68 m | | |
| 16 | TYPE OF TRACK | Ballast Less track | | |
| 17 | TRACTION | Electrified with high rise OHE (rocs) | | |
| 18 | CROSS PASSAGE | At 350.0 m interval. | | |
| 17 | MAX.ROCK/SOIL PILLAR THICKNESS BETWEEN TWO TUNNEL | 2D | | |

3. Scope of DBR

This DBR deals with preparation of methodology and baseline of support system design for portals (P1 & P2), cut and cover, tunnel excavation and primary lining design of the proposed alignment of tunnel between chainage 24+880 to Ch 29+580, total length of4700m long tunnel (1120m tunnel in Phyllite Rock, 2480m in Soil& 1100m in Cut &Cover).

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4. References

The following references are used in the context of the analysis and design of slope:

- [1] Finite Element Analysis code for Excavations and Slopes.
- [2] RocData Manual
- [3] IS: 456: 2000–Plain and Reinforced Concrete Code of Practice
- [4] RDSO Design and Construction Guidelines of Tunnels G17
- [5] IS:13365 (Part-2)-1992: Quantitative Classification Systems of Rock Mass-Guidelines - Rock Mass Quality for Prediction of Support Pressure in Underground Openings, Bureau on Indian Standards, New Delhi.
- [6] IS:15026-2002: Tunneling methods in rock masses Guidelines, Bureau on Indian Standards, New Delhi.
- [7] Indian Railway Standard Code of Practice for Plain, Reinforced and Pre-Stressed Concrete Bridge [IRS-CBC]
- [8] IS 1893(Part-1): 2002 Criteria for earthquake resistant design of structures
- [9] Seismic design and analysis of underground structures" by YMA Hashish, JJ Hook, Birger Schmidt and John I-Chiang Yao.
- [10] Lowson, A.R., and Z.T. Bieniawski. 2013. Critical Assessment of RMR based Tunnel Design Practices: a Practical Engineer's Approach. Rapid Excavation &Tunneling Conference. Washington DC.16 pp
- [11] .ITA guidelines for Tunnel ventilations and Fire Safety.
- [12]. Other relevant IS Codes and IRS Code.
- [13]. U.S. Army Corps of Engineers Manual EM1110-2-2901 _Engineering and Design Tunnel andShafts in Rock

5. Geological/Geotechnical Conditions of Project Area

Tunnel proposed lies in Delhi Ridge, Delhi ridge constitutes northernmost extension of the Aravalli range in the form of two ridges, i.e. Sohna ridge in Haryana, nearly 45 km from Delhi, and west of it is Harachandpur ridge also known as Delhi ridge, which has become famous for its environmental importance to this region. Physio-graphically the north-western part of the India

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covers deserts of the Rajasthan and Haryana, Aravalli ranges and Indo-Gangetic alluvium. The Aravalli Mountains constitute remnant monuments of Precambrian times, whereas Thar desert and alluvium are Quaternary features formed by Aeolian and alluvial processes. In Haryana and Delhi region quartzites are exposed as NE-SW trending ridges amidst the alluvial and aeolian cover. Sohna-FerozpurJhiraka ridge runs from Nowganawa in Rajasthan to Bhundsi a place about 45 km south of Delhi. Northeast of the Sohna is a broad Harachandpur ridge, which extends up to Delhi, where it is known as famous Delhi ridge. These two ridges consist of thickly bedded quartzites with minor schist. The quartzites are reported to exhibit sedimentary structures like ripple marks, current bedding, mud cracks, flute cast and certain depositional features. Volcanic fragments and bands within the Alwar quartzites in and around Sohna and stratified tuffbeds in Badkhal-Surajkund area also reported, indicating have been pen contemporaneous volcanic activity in thearea. The region around the site consists of metamorphosed arenaceous rocks of the Alwar group. The Lithology is dominated by Quartzite's with some intercalations of phyllites near the southern portal. The Quartzite's are met sedimentary rocks that comprise greater than 80% guartz along with feldspar and mica minerals, the mineral grains show an equigranularity interlocking texture.

The phyllites are low-grade metamorphic rocks, they have a marked fissility (a tendency to split into sheets or slabs) due to the parallel alignment of platy minerals; they have a sheen on their surfaces due to tiny plates of micas.

The quartzite's near to surface showed high weathering and were highly friable and non-cohesive while as we move deeper (> 15 m) the quartzite becomes more resistive and less weathered. Quartz is a tectosilicate mineral that ranks 7 on the Mohr hardness scale, since it crystallizes later according to the Bowen reaction series it is also resistive to weathering. Feldspar on the other hand ranks 6 on the Mohr hardness scale and crystallizes earlier thus is prone to weathering.In the southern part intercalation of phyllites/schist along with quartzite are observed.

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The total tunnel length is 4.7 km, out of which 1.1 km of tunnel will be within the quartzite rock mass of Delhi Supergroup and 2.9 km will run through soil and remaining 0.7Km will be Cut Cover type structure. Based on the available surface information from the geological field investigation and close observation of the drilled cores from the litho-logs, it has been observed that after crossing the soil the tunnel will enter into a folded rock mass where the axis of the tunnel will be perpendicular to the fold axis, thus favorably oriented with respect to the folded bedding planes. However, the folded rock layer has suffered extreme level of later brittle fracturing, which has been testified by the presence of 6 sets of joints of different orientation and a few late brittle discrete shear zones (which is certainly not active in nature). These joints and the fractures have significantly reduced the strength of the otherwise sufficiently cohesive metamorphic rock mass. Presence of the intersecting closely spaced joint sets make the tunnel part within the rock body highly susceptible to wedge failure.



Figure 1: Google Map of proposed Tunnel

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6. Determination of Cross Section of Tunnel

Following factors shall be taken into account while deciding the cross section of tunnel,

- 1. Fixed Structure Gauge for tunnel of HORC
- 2. Horizontal&Vertical clearance on curves as per IRSOD
- 3. Footpath Size
- 4. Drain Size
- 5. Type of OHE.
- 6. Provision for Space for Ventilation Fan
- 7. Geological Features

Maximum fixed structure gauge provided by RDSO for the HORC tunnel is shown in Annexure-1.Based on the above parameters tentative cross section of tunnel for rock and soil has been shown in **Annexure-1**.

7. Design Basis Report for Portal Slope Stability Analysis

7.1. Geology of Portal Area

For the proposed tunnel, Portal-1 is placed in moderately strong phyllite which is suitable for portal location whereas Portal-2 is placed in soil whose stability shall be ensured by suitable protection measures. The Proposed portals of tunnel are namely Portal P1 and Portal P2 at chainage 24+880 m and 29+580 m of the project area. At portal P1 there is an overburden of Rock of around 25m while at portal P2 there is an overburden of soil of less than around 1m. During the excavation and portal formation adequate slope shall be provided so that failure of any overburden material (rock/soil) shall be avoided.

Major discontinuity sets mapped in and around the portals area are presented below which is taken from **GIR Table No-3.2**.

| Joint Set | Average Strike | Average True | Average True Dip direction |
|-----------|----------------|--------------|----------------------------|
| | | Dip amount | |

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| Joint Set | Average Strike | Average True Dip amount | Average True Dip direction |
|-----------|----------------|----------------------------|----------------------------|
| J1 | 035 | 80 | SE |
| J2 | 035 | 20 | NW |
| J3 | 000 | 84 | E |
| J4 | 000 | 40 | W |
| J5 | 300 | 55 | NE |
| J6 | 300 | 80 | NE |

Table 1: Discontinuity Sets for Portal-P1

Test on joint infill material have not been carried out by the Employer. The contractor shall get infill material tested for shear strength parameters. The above proposed joint set and shear parameter which shall be obtained by the Contractor, shall be considered for kinematic analysis of rock slope at portal P1. Tunnel portal P2 falls in soil. So kinematic analysis of the same is not required. Its slope protection measures shall be designed for global failure using suitable protection measures such as SDA, shotcrete with wire mesh.

7.2. Design Data for Portal Slopes

7.2.1. Factor of Safety for portal

Local stability for portal P1 and global stability of cut slope of Portals P1 & P2 shall be checked. Minimum factors of safety for different failure load cases are tabulated in Table 2. These are based on FHWA (Federal Highway of America) guidelines

| Load Case | Description | Minimum FOS Required |
|---------------------|------------------|----------------------|
| Dead Load + Water | Normal condition | 1.5 |
| Dead Load + Water + | Extreme | |
| Seismic | Condition | 1.1 |

Table 2: FOS for various Loading Conditions

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7.2.2. Self-Weight of Rock Mass:

As per GIR Para 4.5.1.2-self-weight of rock mass (saturated unit weight) may be taken as 26.72 kN/m³ for rock while for soil it may be taken as 19kN/m3 as per GIR Para 5.4.2.

7.2.3. Earthquake Loads:

This Project area falls under seismic zone IV of Indian Seismic Zoning Map, where maximum seismic zone coefficient (Z) is0.24, so Horizontal seismic coefficient Ah = Z/2 *Sa/g *I/R here Sa/g =2.5, I =importance Factor = 1.5, R= Response Reduction Factor =2.5 so Ah = 0.24/2*2.5*1.5/2.5 =0.18 and Vertical Seismic Coefficient equal to 2/3rd of horizontal Coefficient will be 0.12.

7.2.4. Geotechnical Parameters for Portal P1:

Intact rock properties are based on bore holeBH-13. Rock mass properties have been determined based on laboratory test results of intact rock using Mohr Columb fit parameters using RocData software. For deriving rock mass property for FEM analysis of cut slope, shear strength parameters are required which have been derived using Roc lab software in which input parameters are UCS, GSI and mi.

| Description | | Unit | Rock MassPortal (P1) From Bore Hole BH-13 |
|-------------|--------------------------|------|--|
| | UCS(Table 6.1 of GIR) | MPa | 60 |
| | RMR (Table 6.1 of GIR) | | 20-40 |
| Intact Rock | GSI=RMR _{av} -5 | | 25 |
| Properties | mi (Roc Lab Software) | | 20(For quartzite) |
| | D-disturbance factor | | 0.2 |
| | Ŷ | | 0.3 |
| | c (peak) | MPa | 0.395 |
| | Φ (peak) | deg | 49.38 |
| Rock Mass | c (residual) | MPa | 0.354 |

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| Parameters | Φ (residual) | deg | 46.93 |
|---|---------------------|-----|-------|
| | Tensile Strength | MPa | 0.008 |
| | Deformation Modulus | MPa | 1836 |
| Disturbed 2m thick Rock Mass | С | MPa | 0.233 |
| D=0.7(Will be | Φ | deg | 37.06 |
| modelled in Phase2 to consider effect of | Tensile Strength | MPa | 0.004 |
| blasting during | | MPa | 1193 |
| excavation.) | Deformation Modulus | | |

Table 3: Rock Mass Parameters for Portal Slopes.

The above tabulated parameter of rock mass may be used for Global slope stability analysis of Portal Cut Slopes (Portal P1). The Mohr Coulomb fit parameter for rock mass has been attached as *Annexure-2*.

Value of K (In -situ stress ratio) for slope stability analysis for the Portal P1 and P2shall be taken as 0.5.

7.2.5. Geotechnical Parameters for Portal P2:

As per geological section Portal P2 falls in soil .and bore hole data obtained from **BH-32 &33 has been considered to derive geotechnical parameter** for global stability of slope. Following geotechnical parameters may be taken for global stability analysis of slope. Refer **Table 3.3 of GIR**.

| | E Value | MPa | 31 |
|-------------------------------|----------------------|--------|----|
| | C Cohesion | KPa | 8 |
| Soil Properties for Portal | Φ | Degree | 26 |
| | Saturated Density | kN/m3 | 22 |

Table 4: Soil Properties for Portal

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7.2.6. Support/Reinforcement Properties for Portals:

Support in the form of systematic rock bolt/self-drilling anchor SDA and shotcrete with wire mesh shall be used for portals. The following support properties will be considered for the shotcrete and soil nails.

7.2.7. Shotcrete with wire mesh:

The 28 days strength of shotcrete shall be minimum 25 N/mm2. The early strength will be estimated using young shotcrete strength development curve as per class J2 of Austrian guidelines (Fig 2). At portals shotcrete with wire mesh (100mmx100mm x5 mm) will be used.

| Grade of mix | Unit | Reference Code | M25 |
|--|------|---------------------|-------|
| Characteristic Compressive strength(fck) | МРа | IS 456:2000 | 25 |
| Allowable Compressive Strength | МРа | IS 456:2000 | 6.0 |
| Tensile strength= | МРа | IS 456:2000, B2.1.1 | 3.2 |
| Allowable Shear Strength | МРа | IS15026:2002 | 5.5 |
| Young's Modulus | MPa | IS 456:2000 | 25000 |



*Figure 2:*Early strength development of young shotcrete

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7.2.8. Anchor Plate

For rock bolt anchor plate of Mild steel Fe 500 of size 150 mm x150 mm x 8 mm shall be used, which is adequate for 25 mm diameter rock bolts but its adequacy will be verified at site during pull out test of rock bolts.

7.2.9. Fully Grouted rock bolt

Rock bolt of Portals will be deformed bar of Grade Fe500D, whose characteristic curve with reference to IS 456:2000 is attached as figure 3.

| Diameter of Rock Bolt | mm | 25 |
|---|-----------------|--------------|
| Minimum Dia of Hole | mm | 38/45* |
| Steel Grade (Yield Strength) | МРа | Fe 500 (500) |
| Cross-sectional Area | mm ² | 491 |
| Yield Capacity | kN | 245.43 |
| Elastic Capacity (0.80x yield) | kN | 196 |
| Design Capacity Considered (Approx.) | kN | 190 |
| Length of Rock Bolt | m | 4/6/8 |
| Factor of Safety | | 1.25 |

*Diameter of hole of rock bolt may vary from 38 mm to 45 mm.Final decision of its diameter will be taken after pull out test carried out on rock bolt at site. Pull out test shall be carried out for its full design capacity of 190 kN.

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Figure 3: Characteristic Curve of Fe500D

7.2.10. Self-Drilling Anchor

For Portal P2 which falls in soil self-drillinganchor of suitable length shall be used along with shotcrete and wire mesh.

| Specification of Self Drilling | SDRA 38/19 |
|---|-----------------|
| Anchor | |
| Outside Diameter (mm) | 38 |
| Internal Diameter (mm) | 19 |
| Cross Sectional Area (mm ²) | 700 |
| Ultimate Load (kN) | 500 |
| Yield Load (kN) | 400 |
| Weight (kg/m) | 5.5 |
| Length of Self Drilling Anchor | 6m/8m/10m |
| Factor of Safety | 1.25 |
| Design Capacity (KN) | 300kN (Approx.) |

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7.2.11. Steel Rib

Steel Ribs shall be used in portal region (around 15 m from start) where chance of rock mass movement due to planar slide and creep is more. Size of steel ribs can be optimized as per design. Steel ribs used will be of Grade Fe250. Characteristic curve of mild steel with reference to IS456:200 is attached as figure -4.

| Support type | Steel rib | | | |
|--|-----------------|---------------------------|-------------------------|----------------------------|
| Grade of Steel | | | Fe 250 | |
| Description of sectionas per IS 808 | | ISMB 150 @15 kg/m | ISMB200@ | ISMB 250 @ 37.3 kg/m |
| Depth of section | mm | 150 | 200 | 250 |
| Cross-sectional Area | mm ² | 1910 | 30800 | 4750 |
| Moment of Inertia | m ⁴ | 7.18x10 ⁻ 6 | 2.12 x 10 ⁻⁵ | 5.13 x 10 ⁻⁵ |
| Modulus of Elasticity | МРа | 200000 | 200000 | 200000 |
| Yeild Strength of Steel Rib | МРа | 250 | 250 | 250 |



Figure 4:Characteristic Curve of Fe250

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7.3. Methodology for Portals Slope Design

Tunnel Portal P1 is located in quartzite's and quartzitewith thin- inter bedded layer schist type rock. The rock mass available around the portal P1 is slightly weathered rock. Excavation of Portal shall be planned so as to minimize excavation and cut height. Portal P2 falls in soil. So kinematic analysis is omitted but global stability check shall be carried out as described below.

- 1 First Kinematic analysis shall be carried out to check toppling, planar and wedge failure.
- 2 Planar and wedge failure shall be checked with and without support system, if wedges are not stable (FOS is less than desirable) wedge shall be analyzed with support system and its adequacy against desired FOS shall be checked.
- 3 An excavated slope will be checked against global failure using strength reduction method with help of RS². Excavated slope shall be analyzed stage wise- first up to heading excavation level and then upto final excavation level. If excavated slope is unstable (factor of safety is less than desired), itshall be reanalyzed with suitable slope protection measures to achieve desired factor of safety.

7.2.1. Design of Portal Slope for various failure mode.

Portal slope shall be analyzed for various failure modes to check stability of slope. Following sections describe the methodology for slope stability of portal for different failure modes.

7.2.2. Types of Failure

Various types of failure of portal cut slope have been given below, for which adequacy of support system shall be checked.

7.2.3. Planar Failure for Portal Slope

For this type of failure to occur, the following geometrical conditions must be satisfied:

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- a) The plane on which sliding occurs must strike parallel or nearly parallel (within approximately $\pm 20^{\circ}$) to the slope face.
- b) The sliding plane must "daylight" in the slope face, which means that the dip of the plane must be less than the dip of the slope face, that is, $\psi_p < \psi_f$.
- c) The dip of the sliding plane must be greater than the angle of friction of this plane, i.e. $\psi_p > \phi$.
- d) The upper end of the sliding surface either intersects the upper slope, or terminates in a tension crack.
- e) Release surfaces that provide negligible resistance to sliding must be present in the rock mass to define the lateral boundaries of the slide. Alternatively, failure can occur on a sliding plane passing through the convex "nose" of a slope.

The typical plane sliding mechanism is shown in Figure 7.



Figure 5: Geometric Conditions for Planar Failure

7.2.4. Wedge Failure for Portal Slope

This failure occurs when slopes containing discontinuities striking obliquely to the slope face and sliding of a wedge of rock takes place along the line of intersection of two such planes. The geometry of the wedge for analyzing the basic mechanics of sliding is defined in Figure 8. Based on this geometry, the general conditions for wedge failure are as follows:

- a) Two planes will always intersect in a line. On the stereo net, the line of intersection is represented by the point where the two great circles of the planes intersect, and the orientation of the line is defined by its trend (α_i) and its plunge (ψ_i).
- b) The plunge of the lb line of intersection must be flatter than the dip of the face, and steeper than the average friction angle of the two slide planes, that is ψ_{fi} > ψ_i > ϕ . The inclination of the slope face ψ_f is measured in the

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view at right angles to the line of intersection. (**Note**: ψ_{fi} would only be the same as ψ_{f} , the true dip of the slope face, if the dip direction of the line of intersection were the same as the dip direction of the slope face).

The line of intersection must dip in a direction out of the face for sliding to be feasible; the possible range in the trend of the line of intersection is between α_i and $\alpha_{i'}$.



Figure 6: Geometric Conditions for Wedge Failure

7.2.5. Global Stability Check for Portal Slopes

The stage wise global stability analysis for portal slopes shall be carried out for critical section using RS² software. First The critical section will be analyzed without any support system. The results of the analysis will be expressed as a factor of safety which is defined as the ratio of available shear strength to the shear stresses developed on the sliding plane. If FOS of unsupported slope is less than desired, suitable support system shall be used, and it will be reanalyzed to achieve desired FOS. In global stability analysis of portal slope stage wise analysis first up to tunnel heading excavation level shall be carried out.After that analysis for final excavation up to invert level will be carried out.Although support requirement for analysis of final stage is likely to govern but stage analysis shall be included in design report pertaining to portal cut slopes.

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7.2.6. Global Stability Check with Tunnel opening

After excavation and support of portal slope tunnel will be excavated stage wise up to heading level and then up to invert level. So stability of rock mass after tunnel opening shall be checked for various conditions and requirement of steel ribs, concrete lining and fore poling will be assessed. The analysis of portal slope with tunnel opening will be covered in report pertaining to design of underground support system.

At site at many places big size boulders are available which can cause problem during portal excavations. So it will be advisable to use rock fall barrier at different locations specially at portal locations.

7.2.7. Rock Fall Barrier

At portal-1 rock fall barrier at different locations shall be installed based on the size of the boulder and its kinetic energy to protect both portal and DFCC track.

8 Design Basis Report for Tunnel Underground Excavation

8.1. Geology of Tunnel

Proposed HORC tunnel for NATM is around3600 m long out of which 1120m is inside the rock while remaining 2480 m falls in soil as indicated in geological section. For 1120m long Tunnel sub surface exploration has been carried out with total 6 Nos of bore hole namely BH-13, BH-14, BH-15, BH-15A, BH-16& BH-17. It is anticipated that rock mass encountered inside the tunnel will be mainly strong phyllite with more than six joints.

For assessing the material properties for tunneling in soil 16 Nos of bore holes have been carried out which are namely BH-17 to BH-33.

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| | 1. Unconfined Compressive Strength, |
|------------------------------------|-------------------------------------|
| | 2. Point Load Index Test |
| | 3. Tensile Strength |
| | 4. Specific Gravity |
| Loboratory tast conducted for each | 5. Modulus of elasticity |
| Laboratory test conducted for fock | Water absorption |
| | 7. Poisons' ratio |
| | 8. Triaxial Test |
| | 9. Hardness test |
| | 10. Abrasive test |

Table 5:Laboratory Test carried out in rock

| SI. No. | Laboratory tests | IS Codes |
|---------|----------------------------|--|
| 1 | Preparation of soil sample | IS: 2720(part-1)-1983 (Reaffirmed 2015) |
| 2 | Moisture Content | IS: 2720(part-2)-1973 (Reaffirmed 2015) |
| 3 | Specific Gravity | IS: 2720(part-3)(sec-1)-1980 (Reaffirmed 2016) |
| 4 | Grain Size Analysis | IS: 2720(part-4)-1985 (Reaffirmed 2015) |
| 5 | Atterberg's Limits | IS: 2720(part-5)-1985 (Reaffirmed 2015) |
| 6 | Bulk Density | (****) |
| 7 | Triaxial Shear Strength | IS: 2720(part-11)-1993 (Reaffirmed 2016) |
| 8 | Direct Shear Strength | IS: 2720(part-13)-1986 (Reaffirmed 2016) |
| 9 | Consolidation Test | IS: 2720(part-15)-1986 (Reaffirmed 2016) |

| Table 6: | Laboratory Test carried out in Soil |
|----------|-------------------------------------|
|----------|-------------------------------------|

8.2. Geotechnical Design Parameters for Tunnel

The geotechnical design parameters for the analysis shall be derived from bore holes information of tunnel (Laboratory test data&GIR). Major Discontinuities based on geological report of tunnels for kinematic analysis have been tabulated in **Table-7**.

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| Tunnels | Bore Hole | Unconfined Compressive Strength (MPa) | Modulus of Elasticity (GPa) | Point Load Index Range (MPa) |
|-----------------------|--------------|--|-----------------------------------|---------------------------------|
| | BH-13 | 63 | 53-31 | 2.18 |
| Tunnel | BH-14 | 56 | 53-33 | 2.99 |
| long) in Quartzite | BH-15 | 67 | 52-41 | 3.37 |
| Rock | BH-15A | 65 | 50-42 | 3.14 |
| | BH-16 | 64 | 55-39 | 3.07 |

Table 7: Summary of Intact Rock Mass properties

| Joint Set | Average Strike | Average True Dip amount | Average True Dip direction |
|-----------|----------------|----------------------------|----------------------------------|
| J1 | 035 | 80 | SE |
| J2 | 035 | 20 | NW |
| J3 | 000 | 84 | E |
| J4 | 000 | 40 | W |
| J5 | 300 | 55 | NE |
| J6 | 300 | 80 | NE |

Table 8: Discontinuity Sets along Tunnels (As per GIR Table No 3.2)

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8.3. Material Strength Criterion

For the numerical analysis of underground excavations, selection of the material model is a critical issue in terms of the rock mass behavior. Most widely accepted material models that phase² supports are,

- Mohr-Coulomb (for Tunnel in Soil)
- Hoek-Brown (For tunnel in rock)

The first material model Mohr-Coulomb is best suited to model the behaviour of soils, especially shear strength characteristics of soils. In case of rock, where shear modulus is high, it is recommended to use the Hoek-Brown material model. Hoek-Brown criterion is extensively used in analysis of underground excavations in rock and is based upon an assessment of the interlocking of rock blocks and the condition of the surface between these blocks. The generalized Hoek-Brown criterion is expressed by the equation

$$\sigma$$
1' = $\sigma_{3'} + \sigma_{ci} ((m_b x \sigma_{3'} / \sigma_{ci}) + s)^a$

 $m_b = m_i \exp ((GSI - 100)/(28-14D))$

s = exp ((GSI-100)/ (9-3D))

a =
$$\frac{1}{2} + \frac{1}{6} \times (e-GSI/15 - e-20/3)$$

 σ_3 and σ_1 ' are the minor and major effective principal stresses at failure.

 σ_{ci} is the uniaxial compressive strength of the intact rock material.

m_i, s and a are material constants.

 $m_{\mbox{\scriptsize b}}$ is a reduced value of the material constant mi.

GSI = Geological Strength Index.

D = Factor depends on degree of disturbance to which the rock mass has been subjected by blast damage and stress relaxation.

Ei = Intact Rock modulus.

Erm = Rock mass deformation modulus.

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8.4. Strength Properties of Material for Tunnel

A summary of the material strength parameters for Hoek-Brown criterion adopted in the analysis is presented in Table 9 below.

| Rock mass Designation | Class IV (Poor Pock) |
|---|-------------------------------------|
| DMD Dange (CID Table 6.1) | 20< RMR <u><</u> 40 |
| Kink Range (UIK Table 0.1) | |
| RMR _{av} | 30 |
| GSI= RMR-5 | 25 |
| UCS (MPa) (GIR Table 6.1) | 60 |
| m _i (Rock Lab for Quartzite Rock) | 20 |
| D=Disturbance Factor | 0 |
| m _b | 1.373 |
| S | 0.0002 |
| а | 0.531 |
| E _d (MPa) | 1836 |
| Residual Property | has been calculated by taking D=0.2 |
| mb | 1.516 |
| S | 0.0004 |
| а | 0.516 |
| Poisson's ratio | 0.20 |

 Table-9: Material Strength Parameters for Hoek-Brown Criterion-Rock

Above parameter shall be used as rock mass parameter for support design using FEM software RS² (Phase²) software. It is anticipated as per Geological Exploration that all condition of rock mass of whole stretch of tunnel in rock will be covered in

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Class IV category. Derived rock mass parameter from Roclab software is appended as *Annexture-3*.

| Parameter | Type of Soil | |
|--|---------------------------------|------------------------|
| Φ for cohesive soil (from Laboratory Test) | CL | 19° |
| Φ for non-cohesive | ML | |
| soil | ML-CL | 32° |
| (from corrected N Value) | SM | 52 |
| Cohesion (C) (from Laboratory Test) | CL | 25 KPa |
| Cohesion (C) (from Laboratory Test) | ML ML-CL SM | 3 KPa |
| | Cohesive (CL) | 28 MPa |
| Modulus of Elasticity (E) | Non-Cohesive (ML, SM, ML-CL) | 30 MPa |
| | Cohesive (CL) | 1852 kg/m ³ |
| Density | Non-Cohesive (ML, SM, ML-CL) | 1765 kg/m ³ |

Table-10: Recommended material Properties for tunneling in Soil

Note: Above mentioned property of soil has been taken from Table 6.2 of GIR.

8.5. In-Situ Stress for Tunnel

In tectonically active areas, tectonic stresses affect the stress regime possibly leading to development of locked-in stresses within rock mass Also, overlying rock mass strata gives rise to stresses due to its weight which plays important role in local stress field. Due to excavation, redistribution of stresses will take place creating new stress field around the opening. Thus, the magnitude and orientation of virgin stress field plays an important role in deciding the stability of an opening. As tunnelling projects always have limited

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information on in-situ stress testing, it is proposed to undertake a sensitivity analysis and adopt such stress values which may lead to the development of the critical stress field. Calculations, in the general case where field test data is absent, will be based on Sheory simplified equation to estimate the horizontal to vertical stress ratio k. This equation is $\mathbf{k} = 0.25+7Eh(0.001+1/z)$, where z (m) is the depth below surface and Eh (GPa) is the average deformation modulus of the upper part of the earth's crust measured in a horizontal direction. For different classes of rock horizontal stress coefficient by Sheory's formula has also been calculated. This tunnel is shallow tunnel (where cover is less than 3 times the diameter of tunnel) and no Techtronic stress is anticipated. So, taking K value as more than 1 is not advisable. So, considering fair rock k value of 1 may be considered. While k Value for soil has been adopted as per Jacky's formula

| K by Sh | eory's Formula | К | 0.73 |
|-----------------------|--|-----|---|
| K Value for Rock | to be considered | К | 1.0 |
| K value soil | considered for | К | 0.5 |
| | Vertical Stress (σ_3) | MPa | |
| In- Situ Stress | In- Situ Stress | MPa | It will be applied according to Natural Surface of above tunnel surface by in- built command of RS ² (Phase ² |
| | Out of Plane Horizontal Stress (σ _z) | MPa | software) |

Table 11: In-Situ Stress Parameters for Tunnels

8.6. Support Properties for Tunnel

8.6.1. Shotcrete Properties

The shotcrete is modeled as plastic standard beam element, so that the excess forces are transferred to the adjacent rock mass and support element, if the shotcrete yield at any point. Shotcrete with SteelFiber or

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Polymer Fiber will be used for Tunnel. Addition of fiber in shotcrete will increase its flexural and shear strength, which will be validated by laboratory test. Compressive Strength, Cracking Strength and Elastic Modulus variation with addition to fiber has been attached in *Annexure-3*. For improving strength of shotcrete either steel fiber or synthetic polymer fiber shall be used.

8.6.2. Steel fibers:

Steel fibres shall comply with the requirements given in ASTM A 820 or similar national regulations. Following will be specification of steel fibre used for SFRS.

- Average Tensile strength of fibre shall not be less than 345 MPa.
- The tensile strength of any one of the ten specimens shall not be less than 310 MPa).
- Fibers shall withstand being bent around 3.2-mm diameter pin to an angle of 90° at temperatures not less than 16°C without breaking.
- Type I:Straight/Deformed cold-drawn wire shall be used forfibers.
- Aspect ratio (I/d) shall be 40 to 60.
- The length of the steel fibers shall not exceed 0.7 of the internal diameters of the pipes or hoses used unless a test has proven that longer fibers can be sprayed without blockage.
- During design of secondary lining fiber content per kg/m³ of shotcrete shall be derived.

8.6.3. Synthetic fibers:

Synthetic fibres shall be in accordance with ASTM C1116 or regulations valid in the place of use of the sprayed concrete. Product description of synthetic fibre reinforcement is given below

Name: Structural Synthetic Fibres

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Product Description: Macro Structural Synthetic Polypropylene Fibre. Minimum tensile strength 550 MPa. These fibers show very defined ductile behavior characteristics. Performance levels are excellent in shotcrete. Width = 1.6825 Thickness = 0.4822 Length = 65mm Generates a very high energy absorption rate when used in the concrete mix for shotcreting, enabling the matrix to provide greater flexural toughness.

Since tunnel will be lined with SFRS and its durability is very important for 120 years of life so we proposed higher grade shotcrete. During design of secondary lining synthetic fiber content per kg/m³ of Shotcrete shall be derived.

| Grade of mix | FRS | Reference Code | M35 |
|---|-----|----------------|------------------------|
| Modelled in Phase ² as | | | Elasto-Plastic element |
| Characteristic Compressive strength(fck) Cube | МРа | IS456:2000 | 35 |
| Mean Tensile Strength of SFRS | МРа | IS 456:2000 | 3.5 |
| Allowable Shear strength | МРа | IS15026 | 5.5 |
| Young's Modulus | МРа | IS 456:2000 | 29580 |

Table 12: Shotcrete Properties (SFRS)

8.6.4. Fully Grouted Rock Bolt

Rock Bolt used for tunnel shall be deformed bar type of Fe500D Grade whose characteristic curve is attached *Annexure-3*. Grout hole may vary from 38 mm to 45 mm, which will be verified by pull out test up to design load at site.

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| Modelled in Phase2 as | | Elastic -Element |
|--|-----------------|------------------|
| Diameter of rock bolts | mm | 25 |
| Dia of Grout Hole | mm | 38/45* |
| Steel Grade (Yield Strength) | МРа | 500 |
| Cross-sectional Area | mm ² | 491 |
| Yield Capacity | kN | 245 |
| Elastic Capacity (0.80x yield) | kN | 203.2 |
| Design Capacity Considered (approx) | kN | 190 |

Table 13: Rock Bolt Properties

| Specification of Self Drilling | SDRA 38/19 |
|---|-----------------|
| Anchor | |
| Outside Diameter (mm) | 38 |
| Internal Diameter (mm) | 19 |
| Cross Sectional Area (mm ²) | 700 |
| Ultimate Load (kN) | 500 |
| Yield Load (kN) | 400 |
| Weight (kg/m) | 5.5 |
| Length of Self Drilling Anchor | 4m/6m |
| Factor of Safety | 1.25 |
| Design Capacity (KN) | 300KN (Approx.) |

Table 14: Self Drilling Anchor Properties

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8.6.5. Lattice Girder

Steel of Fe500D grade will be used for lattice girder formation which will be used for poor and very poor rock condition. Adequacy of lattice girder such as size and spacing will be validated by empirical and FEM design.

| Support type | Lattice Girder | |
|-------------------------|---------------------------|-------------------------|
| Modelled in Phase2 as | Elastic Element | |
| Description of section | Lattice Girder (25-25-32) | |
| Depth of section | mm | 187 |
| Cross-sectional Area | mm ² | 1784 |
| Moment of Inertia | m^4 | 1.16 x 10 ⁻⁵ |
| Modulus of Elasticity | МРа | 200000 |
| Yield Strength of Steel | МРа | 500 |

Table 15: Lattice Girder Properties

8.7. NATM Tunneling – Concept

The tunnel construction is proposed to be carried out in accordance with the principles of the New Austrian Tunnelling Method (NATM). The method is based on the concept of a cyclic sequence of excavation with subsequent installation of a primary support (outer lining) followed by the delayed installation of a secondary lining (inner or final lining).

The primary support, which consists of shotcrete, generally reinforced by wire mesh, lattice girders (where required) and rock bolts, will provide the immediate support and stability of the excavation. The secondary liningwill provide the long-term support and durability of the tunnel.

Tunnel excavation will generally be carried out by means of drilling & blasting with drilling jumbos in rock or by tunnel excavator in soil. The ground support system will vary from place to place along the tunnel length, depending on ground properties.

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8.8. Design Approach

NATM tunnel design shall be based on well accepted empirical, analytical methods and finite element numerical modeling. Empirical method shall be used for preliminary design of support system as per IS:13365 using RMR. Analytical method shall be used as the second method for design calculations for the support system and deflection. After assessing support requirement with empirical and analytical method ,numerical method shall be used to check adequacy of support system, deflection and other parameters for tunnel.

The following flowchart shows the general design approach for the primary (outer) lining of NATM tunneling sections.



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The design methodology shall cover design phases (preliminary design & definitive design) prior to construction. The design will be adjusted (if required) during construction in an "observational approach".

8.9. Design Methodology for Tunnel Support Design

The support system shall be designed by considering rock mass type, rock mass quality and in-situ stress conditions expected to be encountered along the tunnel alignment as determined by review and assessment of available geotechnical data.

The preliminary support assessment will be carried out using rock mass classification by IS RMR system (Bieniwaski2013). For the analysis, various parameters like rock strength, joint characteristics, ground water and orientation of discontinuities will be taken into consideration. Support recommendations will be made, based on stress-deformation analysis using RS² FEM software. The possibility of any wedge formation and tunnel stability will be also checked with UNWEDGE software (kinematic analysis will be carried out strictly for tunnel which falls in jointed rock mass).

During construction process, the support assessment shall be continuously reviewed to account for the actual geological conditions including joints, bedding, faults and fractures, infill material, surface roughness, water bearing properties and stress state and required changes in designed support shall be made accordingly.

Following steps will be followed to design rock support system of tunnel:

- Step 1: Assess rock type and find rock mass property such as RMR
(Rock Mass Rating), GSI (Geological Strength Index),MR_{value},
M_iand UCS (Unconfined Compressive Strength)
- Step 2 : From assessed rock mass categorize different class of rock mass using software RocData.
- Step 3 : Assess major discontinuities available along tunnel alignment and shear strength parameter of joint infill material.

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- Step 4 : Find unstable wedges formed for defined tunnel section using Unwedge software, if factor of safety is greater than desired ok, otherwise re –analyse with support system as shotcrete and rock bolt at suitable spacing so that factor of safety of unstable wedges become greater than desired.
- Step 5:Design preliminary support system by empirical method (IS Code method)using RMR.
- Step 6: After design of support system by empirical method use analytical method as a second method to verify the support system.
- Step 7: Finally verify support system by numerical method in following steps.
- Step 7A : Model different class of rock/Soil with different rock/soil parameters obtained from RocData and also incorporate different stages of excavation.
- Step 7B : Simulate and analyse each class of rock/soil without support systems and observe deformation, strength factor and yielded zone.
- Step 7C : Simulate and analyse each class of rock/soil with suitable support systems and observe deformation, yielded zone, and strength factor and check suitability of support system provided with capacity plots.

8.10. Wedge Analysis-Kinematic Analysis

Geo-mechanical wedge analysis shall also be carried out for rock portion. Analysis shall be carried out taking into account available joint data as main input and based upon the assumption that the wedges defined by three intersecting discontinuities are subjected to gravitational loading only.

The steps which are taken to support the structural instability caused due to discontinuities shall be as follows-

• Determination of average dip and dip direction of significant discontinuity sets.

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• Identification of potential wedges which can slide or fall from the roof or walls.

• Calculation of the factor of safety of these wedges, depending upon the mode of failure.

• Calculation of the amount of reinforcement required to bring the factor of safety of individual wedges up to an acceptable level (FOS 1.5).

• Calculation of the amount of reinforcement required to bring the factor of safety of individual wedges up to an acceptable level (FOS 1.1) with seismic loading.

In this analysis, wedges that will be formed on excavation boundary will be evaluated providing detailed information for each wedge as listed below:

- Weight of the wedge
- Apex height
- Safety factor without support
- Required support pressure
- Bolt type (diameter & design tensile capacity)
- Length
- Pattern spacing (in plane, and out of plane)
- Safety factor with support

8.11. IS Code Method-Tunnel in Rock

IS code 13365 (Part-1) gives guidelines to use support pressure in terms of RMR as load on opening of tunnel which needs to be balanced by support system. In the present case the height of overburden above the crown of tunnel is moderate (varies from 20 m to 40m), hence the ground has been considered as non-squeezing for the design of rock support of tunnel. For non-squeezing ground IS: 13365 (part 1) has recommended following empirical equations for calculating Roof and wall support pressure. For deriving design parameter/roof pressure latest Lawson -Beniawiski RMR method shall be used (10).

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The permanent roof support pressure Proof (kN/m²) can be estimated using the following empirical relationship between the joint number RMR, Density of rock and Span of Tunnel.

$$P_r = \frac{100 - RMR}{100} \cdot 10m \cdot \left(\frac{Span}{10m}\right)^{\frac{1}{2}} \cdot \rho_r \cdot \gamma_r$$

By Lawson and Bieniawiski (10)

Where $\gamma_r is \mbox{ partial safety factor and } \rho_r density \mbox{ of rock }, \gamma_r \mbox{ }_{= 1} \mbox{ shall be adopted.}$

 $\mathbf{P_v}$ rock load intensity in kN/m²

8.12. Ultimate wall support pressure

In view of the more favorable position of walls as compared to roofs, the following formula shall be applied for calculating P_{wall} :

 $P_{wall} = K_h x P_v$

Where $K_h = 1$ -Sin ϕ

where ϕ is friction angle

Horizontal Stress Coefficient which shall be taken as 0.5, considering a conservative value of 30 degree.

8.13. Bolt Spacing

Bolt spacing is taken as a function of RMR only. Spacing has to reflect fracture frequency and the need for shotcrete to provide adequate support between the bolts at the better rock end of the scale where the shotcrete cannot realistically be considered as working on its own as an arch. Spot bolting only is assumed to be needed above RMR = 85.

Rock bolt spacing

$$S_{b} = 0.5m + 2.5m.\frac{RMR - 20}{65}$$
$$S_{b} = 0.25m + \frac{(RMR - 10)^{1.5}}{140}.m$$

if 20<RMR<=85

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 $S_b = 0.25m$

RMR <=10

8.14. Bolt Length

Bolt length must vary with span and RMR. Based on empirical guidelines used in mining and the results of numerical modeling studies, the following relationship was obtained:

$$Span = \frac{(L_b + 2.5)^{\frac{RMR + 25}{52}}}{3.6}$$

where Span is width of excavation in meters and $L_{\mbox{\tiny b}}$ is embedded bolt length in meters.

8.15. Rock bolt capacity

Bolt capacity

$$F_{bd} = \frac{F_b}{\gamma_b} \left(\frac{RMR}{85}\right)^{\frac{40}{RMR}}$$

8.16. Shotcrete capacity

The design capacity of shotcrete support is based on the concept of the shotcrete acting simply as an arch in compression. The basic formula for this type of support is:

Support Pressure = Thickness x design strength / Radius

Design capacity

$$f_{cd} = \frac{f_{ck}}{\gamma_s} \left[0.2 + 0.8 \cdot \left(\frac{RMR}{100} \right)^{\frac{3}{2}} \right]$$

Where f_{ck} is shotcrete cylinder strength and γ_s is a partial factor. Ys may be taken as = 1

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8.17. : Analytical Method According to Prof. Feder and Erdmann/Duddeck

The detailed geotechnical and structural design of the primary support shall be carried out using the closed-form solutions according to Prof. Feder (Mining University of Leoben, Austria) and the analytical approach according to H. Duddeck / J. Erdmann. The main variables considered in the analyses shall be tunnel overburden, excavation cross-section, ground types and its properties and in-situ stress condition.

The analytical calculation approach after Prof. Feder is based on the closed – form solution for a circular opening in an elastoplastic medium with a primary stress field of $K_0 = 1.0$. This closed form solution has been extended by Prof. Feder to allow for primary stress fields different from $K_0 = 1$. Different rock strength parameters in the elastic and the plastic (fractured) zone around the tunnel and volume increase of the rock mass material in the fractured zone due to crack development is considered. The method allows for easy and fast parameter studies regarding the determination of the stress and displacement field around a tunnel. The bending moments are derived by assuming an eccentricity of the normal forces by 1/30 of the sprayed concrete shell thickness or 20mm whichever is higher (according to EN 1992-1-1: 2004).

This analytical calculation approach uses elastic, uniform soil/rock conditions and full shear bond between the elastic lining and the subsoil. Further circular shaped full-face excavation is assumed. As result of the Erdmann / Duddeck calculation normal forces N, bending moments M and shear forces V in the shotcrete shell at the crown, bench and invert – sections are obtained. The analysis according to Erdmann/Duddeck is generally used for shallow tunnels with a low stress-level.

9 Numerical Analysis for Tunnel

9.1 Loads

Following loads shall be considered for design of support system of tunnel excavation. Numerical analysis shall be carried out using FEM program RS².

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9.2 Dead Load

Dead Load of support element (liner, rib etc.) shall be simulated in FEM program RS² by using inbuilt command.

9.3 Rock Load:

In-Situ Stress corresponding maximum vertical cover above the tunnel shall be considered with given horizontal stress coefficient in Table 7.

9.4 Seismic Load

In the underground tunnel, seismic loading is not generally considered, unless any poor ground condition (i.e., fault) is passing through the tunnel.

9.5 External Water Pressure

The water table is below the grade level for most of the reach of tunnel. Hence, no permanent water table anticipated above the tunnel. However, to account for saturation due to rains/monsoons, saturated unit weight is considered in the analysis. Therefore, there is no need to consider the effect of external water pressure on tunnel support system design.

9.6 Properties of Proposed support system

Properties for support system for tunnel excavation such liner and rock bolts shall be adopted as per working stress method.

9.7 Material Factor of Safety

For rock bolt, lattice girder and steel rib material factor of safety of 1.25 will be taken, while shotcrete will be allowed to yield and its full strength can be used for design of support system.

10 Stages of Analysis in Numerical Method of Design:

The stability analysis of the Tunnel shall be carried out using Finite Element Program RS², as a continuum model using Hoek and Brown criteria and stresses and deformations around the tunnel shall be estimated to check the stability of the tunnel. The numerical model of excavated cavity has been conceived as plain strain model with external boundaries as natural surface around tunnel. Six node triangular finite elements with fine meshing shall be used close to the excavation boundaries of the tunnel, so that the variations in

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the stress field could be captured with higher precision. Size of the elements shall be gradually increased toward the external boundaries to reduce the number of elements and calculation time. External boundaries shall be taken as fixed and in-situ stresses are applied as per the loading corresponding to cover and horizontal stress coefficient obtained for tunnel.

Excavation sequence of the tunnel shall be simulated in the model using the stage construction approach. For all class of rock mass, heading and benching excavation will be simulated. Stage-1 is generation of model and initialization of in-situ stress. stage-2 is material softening of heading portion. stage-3 is heading excavation and support, stage-4 is material softening of benching-1 portion and stage-5 is benching-1 excavation and installation of rock support. stage-6 is material softening of benching-2 portion and stage-7 is benching-2 excavation and installation of rock support.

10.1 Sensitivity Analysis:

While doing Analysis and design of tunnel support system specifically in soil where parameters are very sensitive and has serious impact on requirement of tunnel support system, deflection and method of excavation.

Following parameters are sensitive.

- 1. Overburden depth in soil (H)
- 2. Cohesion Value of Soil C
- 3. Friction Angle value of Soil φ
- 4. Deformation Modulus of Soil E

As per GIR and Longitudinal profile specifically in soil overburden depth varies between 8m to 40m while other parameters are varying too, which has been taken from Table 5-7 of GIR as follow.

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| | SOI | L | |
|---------------------------------|----------------|--------------------------------------|---|
| Properties | | Values | |
| | Silty Sand(SM) | Inorganic Silt (ML) | Clay (CL) |
| Modulus of Elasticity (E) | 28-30 MPa | 10-40 MPa (increasing with depth) | 10-28 MPa (increasing with depth) |
| cohesion (kgf/cm ²) | 0.04-0.08 | 0.11-0.14 | 0.25 - 0.35 |
| friction angle (Deg.) | 26-27 | 23-28 | 10 - 16 |
| unit weight (y) (gm/cc) | 1.90-1.91 | 1.7-1.8 | 1.8-2.0 |

For sensitivity analysis of support system above mentioned 4 Parameters shall be varied and its adequacy shall be checked.

10.2 Interpretation of Results

The analysis results shall be used to investigate the influence of geometry and in-situ stress variability on stress changes. The induced stresses in the plane of the analysis can be viewed by means of stress contour patterns in the region surrounding the excavations. As a tool for interpreting the amount of deviatory overstress (principal stress difference) around openings, strength factor contours give a quantitative measure of "(strength) / (induced stress)" according to failure criterion for therock mass. Adequacy of rock support system as estimated by rock classification approach will thus be verified. Analysis results will provide the following information.

- Deformation of tunnel calculated by FEM analysis shall be permitted up to 1% of the excavated size of the opening. If deformation is more than 1%, these cases shall be treated separately.
- Depth of Plastic Zone: It will be used to check the adequacy of bolt length.
- Utilization of Rock Bolts and Liners: Utilization of rock bolt shall be assessed by its axial force, while utilization of steel liners will be assessed through capacity plot with significant factor of safety to cater uncertainty of geological parameters.
- Shotcrete will be modeled as elasto-plastic element and its yielding will be allowed below springing line as this will not depict complete failure of shotcrete.

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10.3 Instrumentation and Support Performance

In NATM, the primary purpose of geotechnical and structural instrumentation is to monitor the performance of the underground construction process in order to avoid or mitigate problems. Instrumentation and monitoring scheme for NATM tunnel shall be submitted by contractor to Engineer for approval.

List of Instrumentation to be provided in NATM tunnel is given below in table 16.

| S. No | Instrumentation Details | Locations of Instrumentation to be provided in tunnel |
|-------|---------------------------------------|--|
| 1 | 3 Point MPBX | 3 Nos of 3 Point MPBX at every 50 m. |
| 2 | Optical 3-D Deformation Monitoring | 7 Point Optical Convergence Array (with accuracy of 1 mm) at every 25 m. |
| 3 | Roof settlement Point | 1-Point roof settlement at every 25m. |
| 4 | Load Cells | five center hole load cells (with accuracy 0.5%) of250 kN capacity at identified locations as approved by the Engineer. |
| 5 | Pressure Cells | 7 Nos of Pressure cells of 100 bars (accuracy 0.25%) at each section at every 100 m. |
| 6 | Switch Box | 2 Nos of Switch Box at every 50 m |
| 7 | Strain Gauge | 7 Nos of Strain Gauge per section @ every 100 m. |

Table-16: Instrumentation Proposed for Tunnel Excavation

11 Design of RCC Portal

RCC portal with adequate thickness shall be designed at both end of NATM Tunnel for a length of 10m. Final thickness of portal members and size shall be decided as per structural design of portal.

11.1. Material Properties

- Concrete
 - Grade of Concrete: M35

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• Young's Modulus of Concrete (E) :29580MPa (as per IS 456:2000)

Reinforcement steel

The steel for structural reinforcement shall correspond to Fe 500D according to IS 1786-2008:

| Young's modulus | : E=200 GPa |
|-----------------|---------------------------|
| Yield strength | : f _y =500 MPa |

11.2. Methodology for Design of RCC Portals

The structural analysis of portal frame shall be carried out using 2D model. The model shall be analyzed for various load combinations using STAAD Pro software. The resulting moments and forces shall be used to verify the ultimate limit state of collapse. The beam and columns of portal shall be designed for Limit state of collapse. The area of the footings shall be fixed on the basis of the allowable bearing pressure and the applied loads and moments under service load conditions.

11.3. Design Assumptions

(a) Unit Weights:

Following unit weights for different materials shall be considered for the design:

| Material | Unit weight (kN/m³) |
|---------------------|---------------------|
| Reinforced Concrete | 25 |
| Rock | 27 |
| Soil-rock debris | 22 |

(b) Site Specific Peak ground acceleration for DBE shall be 0.24 g.

Portal frame structure shall be considered as primary structure with importance factor 1.5 and IS456:2000 shall be adopted for design and detailing.

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- (c) Response reduction factor shall be taken as 3.
- (d) Allowable Bearing Capacity:

The allowable bearing capacity of rock mass shall be calculated as per IS:12070 - 1987. Allowable Bearing capacity of soil shall be calculated from the shear strength parameters of the soil as per GIR.

11.4. Boundary Conditions

The model of portal frame shall be fixed at foundation level.

11.5. Design Loads

The following loads shall be applied to the frame model:

- (a) Dead load [G1]
 - The dead load shall include self-weight of structural concrete. The selfweight of structural concrete is calculated internally by STAAD Pro software.
 - Rock Load: Distribution of rock loading on the portal beam along its length shall be assumed as triangular with 45° dispersion at the ends.

(b) Live Load [G2]

Live load to be applied on the beam element of portal frame shall be as followed.

 Accidental Load: Uniformly distributed load corresponding to 2.0 m height of soil-rock debris over portal beam shall be considered to account for additional load in the event of slide of rock mass.

(c) Earthquake Load (EQ):

Lateral loads on joints at the beam level shall be applied on the structure.

Wind load and temperature load shall not be considered for the design.

11.6. Load Combinations

Following load combinations shall be considered as applicable loading conditions for the structure:

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11.6.1. Ultimate Limit State (ULS)

- $I = 1.25 \times G_1$
- $II = 1.25 \times G_1 + 1.70 \times G_2$
- III = $1.25 \times G_1 + 1.70 \times G_2 + 1.6 \times EQ$

11.6.2. Serviceability Limit State (SLS)

- I =1.0×G₁
- $II = 1.0 \times G_1 + 1.0 \times G_2$
- III = $1.0 \times G_1 + 1.0 \times G_2 + 1 \times EQ$

11.6.3. Concrete Cover

Nominal cover to the reinforcement shall be provided considering mild exposure condition of weather and 1.5 hours of fire resistance. The nominal cover to the reinforcement (including links) shall not be less than dia of bar or 20 mm (for mild exposure). The nominal concrete covers adopted for the different members are as below:

| Beam | 35 mm |
|---------|-------|
| Columns | 50 mm |

11.6.4. Reinforcement

All members shall be designed based on IS 456: 2000. The reinforcements are designed to resist factored flexural moments, shear forces and axial forces for the most critical combination of loads. Shear reinforcement is designed as per the provisions stipulated in IS 456:2000

11.6.5. Crack width

A maximum crack width of 0.25 mm (moderate durability exposure) is proposed. The crack width will be calculated in accordance with IS 456-2000 or RCC shall be designed such that tensile stress in lining is within cracking strength.

11.6.6. Deflection:

The final deflection due to all loads including the effects of temperature, creep and shrinkage and measured from the as-cast level of the supports of floors, roofs and all other horizontal members, should not normally exceed Span/250.

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12 Secondary Lining Design

Secondary lining shall be provided in complete length of NATM tunnel. RCC lining shall be provided in soil portion tunnel and initial 20 m reach of Portal P1 of rock. The minimum grade of concrete shall be M35.Minimum thickness of secondary lining shall be 300mm.

12.1 Method of Analysis

A two-dimensional Plane Frame Analyses shall be performed using the computer program STAAD Pro. V8i SS5. A near realistic 2Dmodel using beams bedded by radial and tangential springs shall be considered. Analysis and design shall be carried out as per CBC.

12.2 Calculation of Spring Constants

The lining shall be modeled as a beam bedded by springs. Multiple beam elements shall be created along centroidal axis of lining subtending angle of 5^{0} to 10^{0} representing linear 2D structure.

Beam model spring constants shall be derived from following formula:

$$C_r = K_s \times A$$

$$K_{S} = \frac{E}{(1+\nu) \times R}$$
, From EM 1110-2-2901

where:

- Cr = Radial Spring Constant of soil/rock
- A= Tributary area of beam element
- Ks = Modulus of Sub grade reaction
- E... Young's Modulus of soil/rock (As per GIR)
- ^v Poisson's Ratio of rock mass (As per GIR)

R.... Radius of Tunnel (with $R \le 7 m$)

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The tangential spring constants are set as 1% of normal (radial) spring constants:

Kt = 0.01× Ks

12.3 Load Cases

12.3.1 Self-Weight [G1]

The volume used for calculation of self-weight of structures is based on the nominal dimensions of the structure. Self-weight of the reinforced concrete lining will be calculated with unit weight of concrete $ofy_{con}=25kN/m^3$.

Self-Weight will be considered as dead load with partial load safety factor of 1.25 as per IRS – CBC 1997.

12.3.2 Invert Fill [G1]

As the invert fill is acting favorable on the tunnel invert, this load is not considered in the analysis.

12.3.3 Exhaust Fan & Overhead System [G1]

An overhead system for rail and exhaust fan load is considered to be acting on inner lining of the tunnel. These systems are directly fixed by anchors. A suitable load on 7.2kN acting apart 1m shall be applied to inner lining.

An overhead system is considered as a single vertical concentrated load with a value of 33.7 KN placed 1m horizontal from the centerline of the tunnel on the left side of the arch.

A load factor of 1.25 is considered as per as per IRS – CBC 1997.

12.3.4 Earth Pressure [G2]-Rock

With regard to vertical rock pressure (vertical load of overburden to the lining),) following loads are considered to be I to be applied on lining:

Earth Pressure shall be calculated based on RMR value of different class of rock.

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$$P_r = \frac{100 - RMR}{100} . 10m \cdot \left(\frac{Span}{10m}\right)^{\frac{1}{2}} . \rho_r . \gamma_r$$

By Lawson and Bieniawiski

Where γ_r is partial safety factor for lining design this will be equal to unity and ρ_r density of rock.

 P_v rock load intensity in kN/m²

The effective lateral earth pressure is equal to the product of load due to weight of overburden and coefficient of lateral earth pressure K_0 . The assumed Earth Pressure Coefficient $K_0 = 0.5$

Earth pressure is considered with partial load safety factor of 1.70 as per IRS – CBC 1997.

12.3.5 Earth Pressure [G2]-for Soil:

With regard to vertical earth pressure (vertical load of overburden to the lining) the same shall be applied as follows:

For soil, earth pressure σ_v shall be given by equation $\sigma_v = H^* \gamma_s$ subject to a maximum of $D^* \gamma_s$ where H is height of overburden .For secondary lining design earth pressure shall be applied as indicated in sketch below.



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12.3.6 Lateral Load for Rock and soft ground:

The effective lateral earth pressure is equal to the product of load due to weight of overburden and coefficient of lateral earth pressure K0. The invert loading shall be applied up to springing line as per given vertical load distribution. For lining design both for rock and soil K value shall be considered as 0.5.

12.3.7 Shrinkage [G3]

The self-tension of the tunnel bearing elements due to concrete shrinkage is simulated as uniform cooling of the lining. The amount of lining deformation is calculated according to IS 456 -2000 and converted into uniform cooling temperature difference of -15°C.

Since the internal forces due to shrinkage results from constraint deformation the partial load factor shall be set equal to 1.25 as per IRS – CBC 1997.

12.3.8 Water Pressure [G4]

Water pressure on permanent lining shall be considered as per "design water table" along tunnel.

12.4 Live Loads [Q]

12.4.1 Temperature Load [Q1]

The temperature loads are applied only onto the tunnel arch above the construction joint. An average temperature during construction equal to t_m =+10° is assumed and active temperature differences acting on the tunnel lining are taken as follows:

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b) Since the internal forces due to temperature differences result from constraint deformation the partial load safety factor according is adopted equal to 1.15 for ULS and 0.80 for SLS as per IRS – CBC 1997.

12.4.2 Earthquake

In general, subsurface structures are subjected to much less stress in earthquake than buildings/structures above ground. These stresses reduce with increase in depth. So, it can be assumed that earthquake induced stress in tunnel are much lower due to earthquakes. As a rule, tunnels are not designed for earthquake forces. (PI refer "Guide 853.9120 to 853.2001 DB directive", concerning paragraph 16).

Hence, the effect of earthquake force is not considered for structural design of tunnel inner lining.

Further, to verify this assumption, effect of seismic on tunnel evaluated as described in literature "*Seismic design and analysis of underground structures*" by YMA Hashish, JJ Hook, Birger Schmidt and John I-Chiang Yao (ref Tunneling and Underground Space Technology 16 (2001) 247-293) shall be considered and manually seismic forces induced shall be considered.

But at initial 20m reach of the portal tunnel lining shall be designed for earthquake forces due to inclined cutting /movement of overburden of portal slope.

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12.4.3 Applied load cases

The applied load cases will be following:

- G1 Self weight (Includes Fan & Overhead System Weight)
- G₂ Earthpressure
- G₃ Shrinkage
- Q1 Temperature loads (winter and summer)
- E Earthquake loads

The general formats for combinations of actions for the ultimate and serviceability limit states as given in Indian Railway Standard- Concrete Bridge Code 1997 (IRS-CBC), Table-12

The partial factors for actions and combination of actions are taken from IRS Concrete Bridge Code 1997.

The load combinations used for the calculation are listed in the following tables.

12.4.4 Ultimate Limit State (ULS)

Calculations of ultimate limit state consider the following load combinations: Ordinary load combinations:

```
I =1.25×G<sub>1</sub>
```

- II = $1.25 \times G_1 + 1.70 \times G_2$
- III = $1.25G_1 + 1.70 \times G_2 + 1.25 \times G_3$
- $IV = 1.25 \times G_1 + 1.70 \times G_2 + 1.25 \times G_3 + 1.15 \times Q_{1,summer}$
- $V = 1.25 \times G_1 + 1.70 \times G_2 + 1.25 \times G_3 + 1.15 \times Q_{1,winter}$

12.4.5 Serviceability Limit State (SLS)

Calculations of serviceability limit state consider the following load combinations:

- I =1.0×G₁
- II = $1.0 \times G_1 + 1.0 \times G_2$
- III = $1.0 \times G_1 + 1.0 \times G_2 + 1.0 \times G_3$
- IV = $1.0 \times G_1 + 1.0 \times G_2 + 1.0 \times G_3 + 0.80 \times Q_{1,summer}$
- $V = 1.0 \times G_1 + 1.0 \times G_2 + 1.0 \times G_3 + 0.80 \times Q_{1,winter}$

12.4.6 Structural design method

The structural design is carried out in accordance with EN 1992 as Indian codes does not provide any guidelines for design of plain cement concrete

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Load combinations for the Ultimate Limit States (ULS) and the Serviceability Limit States (SLS) are considered for the reinforcement design as described in section above.

Partial safety factors for materials for ultimate limit states are adopted according to Indian codes IS456- 2000

| Load Combination | Concrete | Reinforcement Steel |
|---------------------------|----------|------------------------|
| Ordinary Load Combination | 1.5 | 1.15 |

Table-17: Partial factors for materials for ULS

12.4.7 Concrete cover

The minimum concrete covers to all reinforcement (main and distribution reinforcing bars) considering the exposure conditions are adopted as follows:

- Concrete exposed to earth (external face) 50 mm
- Concrete not exposed to earth (internal face) 40 mm

12.4.8 Crack width

A maximum crack width of 0.2 mm (moderate durability exposure) is proposed. The crack width shall be calculated in accordance with IS 456-2000 or RCC shall be designed such that tensile stress in lining is within cracking strength.

13 Design Basis for Cut and Cover Tunnel

The following Cross Section of Cut & Cover Structures shall be used as described in Figure7. As per proposed alignment where soil cover is less than 10m, twin rectangular Cut and Cover tunnel is proposed.

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*Figure 7:*Twin Rectangular Shape Cut and Cover for Two Single track The proposed cross section is preferred over a circular crown section due to anticipated difficulties by the construction agency.

13.1 Soil parameters

The following geotechnical parameters have been considered for the analysis and design of Cut & Cover structures.

Below Mentioned soil parameter for Cut and Cover has been taken from Table 3.3 of GIR.

| Locatio n | Depth from N.G.L in m. | Group of sample | Cohesi on (C) in KPa | Angle of internal friction (Φ) | E (in MPa) | Safe Bearing Pressure for 25 mm settlement in T/m ² | Recomme nded SBC in T/m ² |
|--------------|---------------------------------|-----------------------|----------------------------|---|---------------|--|--|
| BH-32 | 21.0 | ML | 4 | 26 | 31 | 39.0 | 35 |
| | 24.0 | | | 20 | 51 | 35.0 | 35 |
| BH-33 | 20.0 | ML-CL | 8 | 26 | 27.6 | 27 | 27 |

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Table-18: Soil parameter for Cut& cover Box

13.2 Cast in place concrete

- Specified characteristic compressive Cylinder strength f_{ck} = 35 N/mm² (Concrete Grade M35 according to IS 456:2000)
- Young's modulus: E = 29580 MPa
- Poisson's ratio: v = 0.2
- Unit weight: $Y = 25 \text{ kN/m}^3$
- The steel for structural reinforcement shall correspond to Fe 500 according to IS 1786-2008:
- Young's modulus E=200 Gpa
- Yield strength f_{yk}=500 MPa

13.3 Concrete cover

For Underground structural elements in contact with non- aggressive soil

| Sl. No. | Structural Components | Nominal Cover(mm) |
|---------|-----------------------|-------------------|
| 1. | Inner slabs, walls | 50 |
| 2. | Outer slabs | 70 |
| 3. | Walls outer | 70 |

13.4 Crack Width

All structural concrete elements shall be designed to prevent excessive cracking due to flexure. The maximum crack widths shall be as specified below.

A. Permissible crack width

Flexural crack width for different structural components is to be checked for all the load combinations at service stage except for instantaneous loading like seismic, winds.

1. For Members in Contact with Soil: -

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- 0.2mm for soil face
- 0.3mm for inner face

13.5 Calculation of Spring Constants

The cut and cover box are modelled as a beam bedded by springs.

Beam model spring constants are derived from modulus of sub grade reaction Ks, which is calculated from: Ks = E / [1+v] From EM 1110-2-2901

where: E... Young's Modulus of soil/rock mass

v ...Poisson's Ratio of soil/rock mass = 0.2

The spring constant of a bedding spring representing a certain area A of sub grade is derived as: (Ks x A) per meter.

For a typical E value of 30 MPa, Ks=25 MPa/m i.e. 25000 kN/m²/m

13.6 Primary Load case for Cut and Cover

13.6.1 G1 -Self-Weight:

The structural thickness/sizes of various elements are described in STAAD input and self-weight of all these members are calculated by STAAD itself by specifying the density of material used.

Density of reinforced concrete is considered as 25 KN/m3.

13.6.2 G2-Lateral Earth Pressure on Wall

The walls of the cut and cover tunnel will have compacted granular backfill and for that the soil properties proposed for design are as follows:

 $E = 15000 \text{ KN/m}^2$

Angle of Friction (\emptyset) = 30 degrees

Unit Weight (γ) = 20 KN/m³

 K_o the initial geological earth pressure at rest coefficient is used in the ground/structure interaction analysis with design earth pressure at rest ($K_o = 0.5$)

LEP at top of Roof slab ($K_o\gamma H$)

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13.6.3 G3- Weight of Fill

This load corresponds to dead weight of soil above roof of box. It is height of fill above top slab multiplied by density of soil.

13.6.4 E1 -Earthquake/Seismic Load

Following the seismic mapping as per Indian Seismic Zoning Map IS 1893 and 1984, the project site is situated in seismic zone V, the highest seismic zone in India. Seismic coefficient has been calculated as per IS 1893-1:2002,

As per IS 1893:2002, the design horizontal seismic coefficient (Ah) for a structure shall be determined by the following expression:

$$Ah = (ZISa) / (2Rg)$$

The description and values of above variables as per 0 are provided below:

| Z: | Zone Factor = | 0.24 (for Sei | smic Z | one IV) |
|------------|----------------------|---------------|--------|------------|
| I: | Importance factor = | • 1.5 | | |
| Sa/g:Avera | age response acceler | ration factor | = | 2.5 |
| R | Response reduction | n factor | = | 3.0 (OMRF) |

Hence, the design horizontal seismic coefficient (Ah), using above values has been calculated as,

Seismic load due to earth pressure from soil has been calculated in accordance with IS 1893-2002, wherein Dynamic earth pressure (full value) is considered up to a depth of $0.5H_T$ (where H_T = Depth to bottom of Tunnel box) and reduces linearly from this value to half of this value at the base of the structure.

Dynamic lateral soil pressure increments at top of box = $A_h x \gamma x H_T$

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Dynamic lateral soil pressure increments at Bottom of box = $0.5^*A_h x \gamma x H_T$

13.7 Analysis Method of Cut and Cover

A two-dimensional Plane Frame Analyses are performed using the computer program from STAAD Pro. V8i SS5. A near realistic 2Dmodel using beams bedded by springs has been created and loads have been applied using STAAD command Springs have been generated by using Staad command and reference can be made to STAAD manual for further details.

The bedding is modeled in such a way that the parts of the cross-sections where inward deformation occurs, i.e. where the springs would be subject to tensions, are neglected. The material behavior of ground and lining is generally assumed as being elastic.

After applying all the forces on the model in STAAD Pro .The loads are combined as per the prescribed and the Members are checked for the load combiation for Ultimate Limit State (ULS) and Serviceability Limit State (SLS).

ULS Load Combinations

- I =1.25×G₁
- II =1.25×G₁+1.70×G₂
- III =1.25× G_1 +1.70× G_2 +1.25× G_3
- $IV = 1.25 \times G_1 + 1.70 \times G_2 + 1.25 \times G_3 + 1.15 \times Q_{1,summer}$
- $V = 1.25 \times G_1 + 1.70 \times G_2 + 1.25 \times G_3 + 1.15 \times Q_{1,winter}$

SLS Load Combinations

$$I = 1.0 \times G_{1}$$

$$II = 1.0 \times G_{1} + 1.0 \times G_{2}$$

$$III = 1.0 \times G_{1} + 1.0 \times G_{2} + 1.0 \times G_{3}$$

$$IV = 1.0 \times G_{1} + 1.0 \times G_{2} + 1.0 \times G_{3} + 0.80 \times Q_{1,summer}$$

$$V = 1.0 \times G_{1} + 1.0 \times G_{2} + 1.0 \times G_{3} + 0.80 \times Q_{1,summer}$$

Seismic Load Combinations

Min V/ Max H == 1.0 x G₁ + 1.0 x E₁

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Max V/Max H = $= 1.0 \times G_1 + 1.0 \times G_2 + 1.0 \times G_3 + 1.0 \times E_1$

Where G1, G2, G3, E1 and Q1 is explained in Para 8.1.2.4

The Normal force, Bending moment and shear force for all members are taken from the Staad Pro and designed as per ,"*IS* 456:2000 Plain and Reinforced Concrete (Fourth Revision).

Deflection:

As per clause No-23.2 of IS456:2000 Deflection of Top slab and Wall shall be restricted to Span/250 and H/250 respectively.

14 Cross Passages

Cross passages shall be provided at maximum distance of 350m c/c. The main purpose of cross passage is to connect the running twin tunnels for the purpose of emergency egress. The cross passages shall be constructed by NATM method and temporary support using rock bolt, shotcrete linings and lattice girders. The design of the temporary support will encompass issues such as:

- Temporary face stability and support;
- The need for ground treatment and/or pre-support measures;
- Control of groundwater; and
- Excavation and support sequencing to limit ground movement.

For cross passage Concrete lining of minimum thickness 250mm shall be used.

Primary support and secondary lining Design shall be carried similar to main tunnel.

15 Permanent Ventilation Shafts

To minimize ventilation requirement four rectangular permanent ventilation shafts at Chainage Km 26+080 and Chainage Km 27+680 has been provided. Size of rectangular ventilation shaft shall be 25m x 12m (clear opening). At the locations of permanent ventilation shafts it is mandatory to provide

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connecting cross passage with clear opening of 3.5m x 3.6m. All the permanent ventilation shafts shall be lined with RCC and same shall be designed for all the loadings during construction and design life.

Permanent ventilation shaft shall be designed for all load cases and combination as mentioned in Cut and Cover Design.

16 Construction cum Utility Shaft

A construction cum utility shaft shall be provided at Chainage Km 26+950. The main purpose of construction shaft is to provide multiple faces to expedite the tunnel excavation. At the location of construction cum utility shaft cross passage shall be provided having the same cross-sectional area as the main tunnel. The size of construction shaft may be kept as per requirement of the contractor. Design and construction of construction cum utility shaft shall be carried out by the contractor accordingly.

17 Waterproofing System

Robust waterproofing of underground structures is one of the most costeffective ways to enhance safety and function as well as to increase the useful design life of new and existing structures. Special maintenance due to deterioration of the structure can be eliminated or minimised and, more importantly, the structure is able to function for the duration of its design life. As water ingress through a sprayed concrete lining is possible through cracks and flaws; areas where the concrete may have a greater permeability than the surrounding, well installed concrete. cracks on the sprayed concrete lining are mainly located in the vicinity of lattice girders and construction joints, e.g. in the interface top heading-bench or bench-invert, in part due to the increased likelihood of shadowing or poorly compacted concrete in these zones. They are mostly caused by external loads, temperature changes, shrinkage, and placement of sprayed concrete. water tightness is directly related to the durability and serviceability of the sprayed concrete lining. Sprayed concrete can be produced to be watertight in small scale samples. However, building a large watertight sprayed concrete surface, as required for tunnel linings, can most practicably be done by means of additional measures. The waterproofing system should also protect the final permanent

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lining against aggressive environment. For serviceability of secondary lining for longer term sprayed water proofing membrane has been proposed. There are different types of spray applied waterproofing membranes. They may be produced by means of non-reactive systems (curing by hydration or airdrying), or reactive systems (curing by polymer reaction). They are all thin elements, typically with a total final thickness of 3- or 4-mm. Spray applied waterproofing membranes are produced and installed in situ against the primary tunnel lining and typically covered later on by a secondary tunnel lining or a non-structural protective layer (e.g. mortar or sprayed concrete) according to the design requirements, generally, the membrane can be applied in one stage directly onto the concrete lining or substrate. Some membranes require first the application of a primer layer onto the substrate before application of the membrane in one or two consecutive layers. when installed between the primary and secondary concrete linings, spray applied membranes may bond to both primary and secondary linings (doublebonding) or only to one lining (single-bonding), depending on the design requirements and the product chosen. In the case of a spray applied membrane with double bonding properties, the resulting sandwich-structure (concrete-membrane-concrete) may act as a quasi-monolithic structure, depending on the bonding characteristics and properties of the membrane. A typical sketch depicting application of sprayed water proofing membrane has been attached in Figure 8.

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Figure 8:Water Proofing detail in Tunnel

Following are main features of sprayed water proofing membrane.

- Continuity without discrete joints; confinement measures (injection, tubes, weld links, compartmentalization with water stops etc.) are not required as the bond between the membrane and the substrate prevents waterpath developing between layers.
- Spray applied membranes do not have any welded seams, and are simply connected by spraying a short overlap zone onto the previously applied membrane section •
- Easier and quicker location and repair of leaks. A seepage point through the membrane can be easily resolved locally precisely where the seepage occurs since this point corresponds to the seepage channel in the concrete behind the membrane •
- They can be combined with other waterproofing systems. Standard joint details between spray applied and sheet membranes are available, making the system totally flexible •
- They are compatible with all concrete placement techniques, allowing placement of a sprayed concrete inner lining, and reinforcement types (mesh, rebars and fibers) on either side of the membrane. The membrane

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can be sprayed straight onto many types of penetrating items (e.g. anchored reinforcement) •

• There is no folding and stretching of the spray applied membrane during the casting or spraying of the secondary/ permanent lining as it is in intimate contact and fully bonded to the primary lining.

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Annexures

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NOTES:-

- ALL DIMENSIONS, NORTHING & EASTING AND LEVELS ARE IN METER, UNLESS OTHERWISE SPECIFIED. NO DIMENSIONS SHALL BE MEASURED FROM DRAWING. TUNNEL EXCAVATED BY HEADING AND BENCHING METHOD.

- THE GRADE OF SHOTCRETE WITH SFRS AS PER DETAIL DESIGN. NEAR PORTAL PULL LENGTH SHOULD BE LIMITED TO 500 MM, ONLY AFTER SUPPORTING EXCAVATED STRETCH (500 MM), THEN NEXT
- AFTER EXCAVATION OF ACE .
- IT IS PROPOSED TO PROVIDE 100 MM THICK SFRS ON SLOPE PROTECTION. ALTERNATIVELY, PLAIN SHOTCRETE WITH WIREMESH 150x150x5mm MAY ALSO BE USED.
- PROPOSED ROCK BOLT SHALL BE WITH FOLLOWING SPECIFICATION CONFORMING TO IS 1786, DIAMETER OF ROCK BOLT = 25 MM, GRADE OF ROCK BOLT Fe415 FULLY GROUTED SIZE OF ANCHOR PLATE =150X150X8MM PROPOSED SUPPORT SYSTEM IS BASED ON GIR PROVIDED BY
- PROPOSED SUPPORT SYSTEM IS BASED ON GIR PROVIDED BY GEOLOGIST. ACTUAL SUPPORT SYSTEM MAY BE REVISED BASED ON ACTUAL RESPONSE OF STRATA DURING EXCAVATION. THE NUT OF THE GROUTED ROCK BOLT SHALL BE TIGHTENED 12 HOURS AFTER INSTALLATION TO ACHIEVE A FORCE AT THE ANCHOR PLATE OF APPROX. 20(M), THIS FORCE SHALL BE APPLIED DV AUVED TO TOOL OF APPROX.
- BY CALIBRATED TORQUE WRENCH. THE LENGTH AND THE DIRECTION OF ROCK BOLTS MAY BE ALTERED IN CONSULTATION WITH SITE GEOLOGIST AND ENGINEER-IN-CHARGE. WHEREVER REQUIRED, ADDITIONAL SPOT BOLTING SHALL BE DONE IN LOCALIZED AREA OF POTENTIAL INSTABILITY OR WEAKNESS AS DETERMINED DURING EXCAVATION.
- SLOPE SUPPORT SHALL BE INSTALLED AS EXCAVATION PROGRESSES SUCH THAT NOT MORE THAN 2.0m VERTICAL HEIGHT 12. OF SLOPE IS LEFT UNSUPPORTED AT ANY TIME.
- PULLOUT TEST SHALL BE CARRIED OUT ON ROCK BOLTS FOR 190KN. . 13.
- I JUNN. . DRAINAGE PIPE SHALL BE 150mmØ, PERFORATED PVC PIPE WRAPPED WITH NON-WOVEN GEOTEXTILE FABRIC AS PER IS-4984. EXCAVATION SEQUENCE WILL BE PROVIDED BASED ON GFC. 14.
- 15. 16.
- EXCAVATION AT EAST PORTAL LOCATION SHALL BE MATCHED WITH DEEP CUT EXCAVATION. 17 GUARD RAIL SHALL BE PROVIDED THROUGHOUT THE LENGTH OF
- BALLASTLESS TRACK.
 BALLASTLESS TRACK.
 BALLASTLESS TRACK TO BE DESIGN FOR 32.5 T AXLE LOADING.
 DIMENSIONS OF PRIMARY SUPPORT & CONCRETE ARE TENTATIVE.

| S.N. | CURVE NAME | RADIUS (m.) | START | END | ARCH. LENGTH (m.) |
|------|------------|-------------|-------|-----|-------------------|
| 1 | S1 | R3.581 | A1 | A2 | 3.964 |
| 2 | S2 | R6.407 | A2 | A3 | 2.102 |
| 3 | S3 | R7.487 | A3 | A4 | 7.427 |
| 4 | S4 | R1.846 | A4 | A5 | 1.254 |
| 5 | S5 | R9.254 | A5 | A5' | 0.796 |
| 6 | S6 | R0 | A5' | A6' | 5.001 |
| 7 | S5' | R9.254 | A6' | A6 | 0.796 |
| 8 | S4' | R1.846 | A6 | A7 | 1.254 |
| 9 | S3' | R7.487 | A7 | A8 | 7.427 |
| 10 | S2' | R6.407 | A8 | A1 | 2.102 |

| EXCAVATED AREA | = 91.704 Sqm. |
|------------------|---------------|
| FINISHED AREA | = 71.063 Sqm. |
| EXCAVATED WIDTH | = 10.690m |
| EXCAVATED HEIGHT | = 10.676m |
| FINISHED WIDTH | = 9.470m |
| FINISHED HEIGHT | = 9.010m |
| | |

PROJECT: HARYANA ORBITAL RAIL CORRIDOR ECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING IT-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE CLIEN

| | | HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED. | | | | |
|------|-------------------------------------|---|-------------|--|---|-------------------------------------|
| | GENERAL CONSULTANT: GENE SIGN | | | | ULTANT FOR RAIL CORRIDC | HARYANA IR national Pty. Ltd. |
| (EDI | | - | | | TE5 | |
| iki | | GCHORC DRG. NO. GCHRDC-C4-DRW-TL-QLT-01001_A0 DRAWING NAME SINGLE TRACK TUNNEL CROSS SECTION (ROCK) | | | | EL CROSS SECTION K) |
| | | SCALE- | AS | SHOWN | | |
| | | SMC DRG. NO:- | SMC/ | HRIDC/TUN/CS-1 | (REV-5) | |
| | | CONSULTANT: | 8 | S.M. CONSULTA Jubanesseer / Balascre / Secure Web : www.amcindia.com , E | NTS An ISO 9001 Company wabad / South Andaman / New Delhi Mail : support@emcinda.com | (B) |
| | | Stup | al | ha | Non- | Eres, D |
| | | SIVENDRA KUI TUNNEL DESI | MAR GNEℜ | St.CONSU | R.SHARMA LTANT / TUNNEL | A. A. SAMANT PROJECT INCHARGE |
| | | RELEASED FOR | | RELIMINARY | TENDER | CONSTRUCTION |



NOTES:-

- ALL DIMENSIONS, NORTHING & EASTING AND LEVELS ARE IN METER, UNLESS OTHERWISE SPECIFIED. NO DIMENSIONS SHALL BE MEASURED FROM DRAWING. TUNNEL EXCAVATED BY HEADING, BENCHING / MULTI DRIFT 3.
- TUNNEL EXCAVATED BY HEADING, BENCHING / MULTI DRIFT METHOD. THE GRADE OF SHOTCRETE WITH SFRS AS PER DETAIL DESIGN. PROPOSED SUPPORT SYSTEM IS BASED ON GIR PROVIDED BY GEOLOGIST. ACTUAL SUPPORT SYSTEM MAY BE REVISED BASED ON ACTUAL RESPONSE OF STRATA DURING EXCAVATION. DRAINAGE PIPE SHALL BE 150mm0, PERFORATED PVC PIPE WRAPPED WITH NON-WOVEN GEOTEXTILE FABRIC AS PER IS-4989 EXCAVATION SEQUENCE WILL BE PROVIDED BASED ON GFC. 4.

- EXCAVATION SEQUENCE WILL BE PROVIDED BASED ON GFC.
 PIPE ROOFING/FOREPULING OF 114 MM DIA SHALL BE PROVIDED WHERE EVER IT IS REQUIRED.
 SELF DRILING ANCHOR OF CAPACITY 190 KN SHALL BE PROVIDED FOR PRIMARY SUPPORT DURING EXCAVATION.
 LATTICE GIRDER 25-25-32 OF DEPTH 187 MM ISMB 200 MM SHALL BE INCASED IN SFRS OF MINIMUM THICKNESS 250 MM.
 GUARD RAIL SHALL BE PROVIDED THROUGHOUT THE LENGTH OF BALLASTLESS TRACK.
 BALLASTLESS TRACK TO BE DESIGN FOR 32.5 T AXLE LOADING.
 DIMENSION OF PRIMARY SUPPORT & CONCRETE ARE TENTATIVE.

| S.N. | CURVE NAME | RADIUS (m.) | START | END | ARCH. LENGTH (m.) |
|------|------------|-------------|-------|-----|-------------------|
| 1 | S1 | R3.581 | A1 | A2 | 3.964 |
| 2 | S2 | R6.407 | A2 | A3 | 2.102 |
| 3 | S3 | R7.487 | A3 | A4 | 7.427 |
| 4 | S4 | R1.846 | A4 | A5 | 1.254 |
| 5 | S5 | R9.254 | A5 | A6 | 6.656 |
| 6 | S4 | R1.846 | A6 | A7 | 1.254 |
| 7 | S3 | R7.487 | A7 | A8 | 7.427 |
| 8 | S2 | R6.407 | A8 | A1 | 2.102 |

| EXCAVATED AREA | = 101.090 Sqm. |
|------------------|----------------|
| FINISHED AREA | = 71.063 Sqm. |
| EXCAVATED WIDTH | = 10.690m |
| EXCAVATED HEIGHT | = 11.680m |
| FINISHED WIDTH | = 9.470m |
| FINISHED HEIGHT | = 9.010m |

HARYANA ORBITAL RAIL CORRIDOR CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING

| | | ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE | | | | |
|------|------|--|---------------|---|---|----------------------------------|
| | | CLIENT:- | HA DE | RYANA RAI VELOPMEN | L INFRASTRUC | CTURE ON LIMITED. |
| | | GENERAL CONSUL | TANT: | | | |
| RIDC | | | GEN | ERAL CONS | SULTANT FOR RAIL CORRIDO | HARYANA R |
| ION | SIGN | | RITE | S Limited in conso | ortium with SMEC Interr | ational Pty. Ltd. |
| DI | | | | | | SMEC |
| | | GC/HORC DRG. NO | o:- G | C-HRIDC-C4-DRV | V-TTL-CLT-01002_A0 | |
| 1 | | DRAWING NAME SINGLE TRACK TUNNEL CROSS SEC (SOIL) | | | | ROSS SECTION |
| | | SCALE | - AS | SHOWN | | |
| | | SMC DRG. NO:- | SMC/H | RIDC/TUN/CS-2(R | REV-5) | |
| | | CONSULTANT: | \odot | S.M. CONSULTA Industries / Balasce / Securi Web : www.amcinda.com , 5 | ANTS An ISO 9001 Company derabad / South Andaman / New Delhi E-Mail : support@emcindia.com | 630 |
| | | Stor | x1 | M | eller- | Contraction of the second |
| | | SIVENDRA KL TUNNEL DES | IMAR IGNER | Sr.CONSL | B.R.SHARMA LTANT/TUNNEL | A. A. SAMANT PROFECT INCHARGE |
| | | RELEASED | | PRELIMINARY OR APPROVAL | TENDER | CONSTRUCTION |

PROJECT:



| GC/HORC | | HRIDC | | |
|------------------------------|--------------|-------------------------------------|------|--|
| NAME / DESIGNATION | SIGN | NAME / DESIGNATION | SIGN | |
| CHAHATEY RAM PD | Unahates Row | SHIV OM DWIVEDI <i>CPM/HRIDC</i> | | |
| SUDHIR AGRAWAL DPD/CIVIL | still | RAJU SOLANKI DGM/CIVIL/S | | |
| AJAY VIJAYVARGIYA DPD/EST | | DGM/S&T | | |
| REETU PATIAL CDE /CIVIL | Rentin | DGM/Elect. | | |
| AMARNATH SINGH CRE/S&T | | | | |
| STIPHEN SAHOO | | | | |
| SRE/Elect. | | | | |

NOTES:~

- ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS, UNLESS OTHERWISE SPECIFIED.
- 2. NO DIMENSION SHALL BE MEASURED FROM THE DRAWING.
- 3. MINIMUM EXCAVATION LINE SHALL INCLUDE CONSTRUCTION & DEFORMATION TOLERANCE.
- 4. GUARD RAIL SHALL BE PROVIDED THROUGHOUT THE LENGTH OF BALLASTLESS TRACK
- 5. BALLASTLESS TRACK TO BE DESIGN FOR 32.5 T AXLE LOADING
- 6. DIMENSIONS OF SLAB THICKNESS ARE TENTATIVE.


ANNEXURE-2



Figure 1: Above mentioned chart is Mohr Coulomb fit output from Roclab software for rock mass derived from intact rock property of laboratory with disturbance factor *D*=0.



Figure 2: Above mentioned chart is Mohr Coulomb fit output from Roclab software for rock mass derived from intact rock property of laboratory with disturbance factor *D*=0.2.



Figure 3 :Above mentioned chart is Mohr Coulomb fit output from Roclab software for rock mass derived from intact rock property of laboratory with disturbance factor D=0.7

ANNEXURE-3



Figure 1: Shotcrete Compressive Strength



Figure 2:Shotcrete Cracking Strength



Figure 3: Early strength development of young shotcrete



Figure 4:Shotcrete Elastic Modulus



Figure 5 :For tunnel Above mentioned chart is Mohr Coulomb fit output from Roclab of rock mass derived from intact rock property of lab with disturbance factor D=0.



Figure 6 Above mentioned chart is Mohr Coulomb fit output from Roclab of rock mass derived from intact rock property of lab with disturbance factor D=0.2

2. LIST OF CURVE AND GRADIENT

| Gradient Details PKG-C4 with Tunnel Portion | | | | | | 18.08.202 | | | |
|---|-------|---------|--------|----------|-----------|-----------|---------|---------|--|
| | Chair | nage KM | Length | Gradient | | I | PFL | | |
| S.No. | From | upto | metre | 1 in | RISE/FALL | From | То | Remarks | |
| 1 | 11748 | 12208 | 460 | 170 | F | 203.018 | 200.312 | | |
| 2 | 12208 | 12374 | 166 | L | EVEL | 200.312 | 200.312 | | |
| 3 | 12374 | 12859 | 485 | 200 | F | 200.312 | 197.945 | | |
| 4 | 12859 | 13198 | 339 | 1200 | R | 197.945 | 198.158 | | |
| 5 | 13198 | 13539 | 341 | 1201 | F | 198.158 | 196.136 | 1 | |
| 6 | 13539 | 14373 | 834 | 170 | R | 196.136 | 200.878 | 1 | |
| 7 | 14373 | 14573 | 200 | L | EVEL | 200.878 | 200.947 | 1 | |
| 8 | 14573 | 14743 | 170 | 530 | R | 200.947 | 201.248 | e .e | |
| 9 | 14743 | 15000 | 257 | 157 | F | 201.248 | 199.749 | 1 jin | |
| 10 | 15185 | 15520 | 335 | 259 | R | 198.571 | 199.864 | ill' | |
| 11 | 15520 | 16200 | 680 | L | EVEL | 199.864 | 199.864 | Miar | |
| 12 | 16200 | 16660 | 460 | 550 | R | 199.864 | 200.701 | | |
| 13 | 16660 | 17000 | 340 | L | EVEL | 200.701 | 200.701 | 1 | |
| 14 | 17000 | 17520 | 520 | 580 | F | 200.701 | 199.804 | 1 | |
| 15 | 17520 | 18020 | 500 | 175 | F | 199.804 | 196.947 | 1 | |
| 16 | 18020 | 18500 | 480 | L | EVEL | 196.947 | 196.947 | | |
| 17 | 18500 | 19840 | 1340 | 1200 | R | 196.947 | 198.064 | 1 | |
| 18 | 19840 | 20000 | 160 | 165 | R | 198.064 | 199.033 | 1 | |
| 19 | 23740 | 25960 | 2220 | 165 | R | 219.142 | 232.596 | | |
| 20 | 25960 | 26300 | 340 | 152 | R | 232.596 | 234.833 | 1 | |
| 21 | 26300 | 28230 | 1930 | 165 | R | 234.833 | 246.53 | TUNNEL | |
| 22 | 28230 | 28420 | 190 | 152 | R | 246.53 | 247.78 |] | |
| 23 | 28420 | 29800 | 1380 | 160 | R | 247.78 | 256.405 |] | |

| | Horizonatal Curve Details PKG-C4 with Tunnel Portion | | | | | | | | | | | | | | |
|-------|--|------|-------|----------------|----------|----------------------|----------------|-------------------|----------------------------------|---------------------------|---------|-----------|-----------|-----------------|----------------|
| S.No. | Curve No. | SIDE | | DEGREE | RADIUS | DEF.ANGLE (Delta) | CANT (SE) (mm) | TANGENT LENGTH | Circular Curve Length(CCL) | TRANSITION LENGTH & Ca | Cd | CH. TTP-1 | CH. TTP-2 | TOTAL LENGTH | |
| 1 | 18 | RHS | 0.500 | 00° 30' 00.00" | 3500.000 | 0°51'14" | 20.000 | 70.900 | 51.900 | 45.000 | 45.000 | 11879.000 | 12021.000 | 142.000 | |
| 2 | 19 | RHS | 0.831 | 00° 49' 52.44" | 2105.300 | 26°30'02" | 70.000 | 560.900 | 843.800 | 130.000 | 130.000 | 12070.000 | 13173.000 | 1103.000 | |
| 3 | 11 | RHS | 0.583 | 00° 35' 00.00" | 3000.000 | 33°19'13" | S=0.139 M | 897.769 | 1744.646 | Ca=35 | cd=85 | 15574.000 | 17419.000 | 1845.000 | |
| 4 | 12 | LHS | 2.481 | 02° 28' 52.36" | 705.300 | 65°50'48" | S=0.510 M | 1036.110 | 1838.786 | Ca=115 | cd=100 | 18108.453 | 20087.239 | 1978.786 | Main Line |
| 5 | 15 | RHS | 0.884 | 00° 53' 01.81" | 1980.000 | 56°13'24" | S=0.412 M | 1102.582 | 2012.054 | Ca=110 | cd=65 | 23777.000 | 25930.000 | 2153.000 | UPline |
| 6 | 16 | RHS | 1.000 | 01° 00' 00.00" | 1750.000 | 32°0'30" | S=0.402 M | 501.942 | 977.639 | Ca=110 | cd=35 | 2634.000 | 27447.000 | 24813.000 | |
| 7 | 17 | LHS | 0.500 | 00° 30' 00.00" | 3500.000 | 19°57'37" | S=0.096 M | 615.894 | 1219.304 | Ca=70 | cd=30 | 28474.000 | 29783.000 | 1309.000 | |
| 1 | 7 | RHS | 1.167 | 01° 10' 00.00" | 1500.000 | 26°30'21" | 70.000 | 557.700 | 837.700 | 130.000 | 130.000 | 12073.179 | 13170.832 | 1097.653 | |
| 2 | 11 | RHS | 0.250 | 00° 15' 00.00" | 7000.000 | 33°19'13" | S=0.139 M | 899.415 | 1747.844 | Ca=35 | cd=85 | 15574.000 | 17419.000 | 1845.000 | |
| 3 | 12 | LHS | 2.481 | 02° 28' 52.36" | 705.300 | 65°50'48" | S=0.510 M | 1036.110 | 1838.786 | Ca=115 | cd=100 | 18108.453 | 20087.239 | 1978.786 | Main Line |
| 5 | 15 | RHS | 0.884 | 00° 53' 01.81" | 1980.000 | 56°13'24" | S=0.425 M | 1102.582 | 1951.060 | Ca=110 | cd=65 | 23777.000 | 25930.000 | 2153.000 | DN line |
| 6 | 16 | RHS | 1.000 | 01° 00' 00.00" | 1750.000 | 32°0'30" | S=0.402 M | 501.942 | 994.396 | Ca=110 | cd=35 | 2634.000 | 27447.000 | 24813.000 | |
| 7 | 17 | LHS | 0.500 | 00° 30' 00.00" | 3500.000 | 19°57'37" | S=0.097 M | 615.894 | 1393.489 | Ca=70 | cd=30 | 28474.000 | 29783.000 | 1309.000 | |

3. LIST OF CONTROL POINTS

Project Name:-Field verification for land boundary and supplying, fixing of boundary pillars along HORC alignment and it's connectivities to existing IR/DFC networks, picking up of finalized land boundary and centre line coordinates using DGPS (RTK Method) by establishing control points in connection with Haryana Orbital Rail Corridor (HORC) from Palwal to Sonipat

| GCP's DATA OF CH: -12KM TO 18 KM | | | | | | | | |
|--|-----------------|-----------------|-------------------|------------------|-----------|--|--|--|
| Name | WGS84 Latitude | WGS84 Longitude | Grid Northing (m) | Grid Easting (m) | Elevation | | | |
| | | SC | CP'S | | | | | |
| SCP-009 | 28°12'25.3731"N | 77°09'09.6978"E | 3122015.079 | 711280.047 | 194.380 | | | |
| SCP-010 | 28°14'42.9312"N | 77°08'00.6765"E | 3126216.341 | 709323.220 | 199.402 | | | |
| SCP-011 | 28°11'39.2352"N | 77°07'12.9607"E | 3120538.658 | 708121.475 | 193.529 | | | |
| SCP-012 | 28°14'07.9269"N | 77°06'12.5381"E | 3125087.181 | 706394.085 | 199.346 | | | |
| SCP-013 | 28°10'47.0640"N | 77°05'43.5348"E | 3118890.253 | 705710.322 | 193.408 | | | |
| SCP-014 | 28°13'39.4318"N | 77°03'49.0236"E | 3124142.674 | 702496.512 | 206.820 | | | |
| | | т | CP'S | | | | | |
| TCP-031 | 28°13'32.7210"N | 77°08'15.0757"E | 3124061.929 | 709753.912 | 196.424 | | | |
| TCP-032 | 28°13'34.4235"N | 77°08'10.2582"E | 3124112.021 | 709621.637 | 196.726 | | | |
| TCP-033 | 28°13'24.1071"N | 77°07'33.5187"E | 3123776.815 | 708625.507 | 195.883 | | | |
| TCP-034 | 28°13'26.0676"N | 77°07'28.5870"E | 3123834.806 | 708489.981 | 195.888 | | | |
| TCP-035 | 28°13'06.1224"N | 77°07'04.0268"E | 3123209.091 | 707831.072 | 196.092 | | | |
| TCP-036 | 28°13'08.4893"N | 77°07'01.1748"E | 3123280.594 | 707752.032 | 196.182 | | | |
| TCP-037 | 28°12'46.0137"N | 77°06'30.9154"E | 3122574.323 | 706939.003 | 196.105 | | | |
| TCP-038 | 28°12'48.2184"N | 77°06'28.5920"E | 3122641.090 | 706874.466 | 195.849 | | | |
| TCP-039 | 28°12'26.9901"N | 77°06'02.1892"E | 3121975.106 | 706165.842 | 195.179 | | | |
| TCP-040 | 28°12'28.5366"N | 77°06'00.3063"E | 3122021.822 | 706113.673 | 195.220 | | | |
| TCP-041 | 28°12'02.1341"N | 77°05'38.0417"E | 3121198.560 | 705520.574 | 194.986 | | | |
| TCP-042 | 28°12'05.5195"N | 77°05'35.9737"E | 3121301.798 | 705462.378 | 194.676 | | | |
| TCP-043 | 28°11'41.1865"N | 77°05'25.8750"E | 3120547.998 | 705199.897 | 196.170 | | | |
| TCP-044 | 28°11'42.7878"N | 77°05'22.1513"E | 3120595.539 | 705097.490 | 194.453 | | | |
| TCP-045 | 28°11'09.1126"N | 77°05'11.8430"E | 3119554.071 | 704834.200 | 192.723 | | | |
| TCP-046 | 28°11'10.7340"N | 77°05'08.4153"E | 3119602.374 | 704739.851 | 192.474 | | | |
| | | | | | | | | |
| GCP's DATA OF CH: -29.200 KM TO 49.700KM | | | | | | | | |
| | | SC | CP'S | | | | | |
| SCP-016 | 28°14'24.9297"N | 77°00'38.4942"E | 3125455.819 | 697278.697 | 293.012 | | | |
| SCP-017 | 28°12'09.7271"N | 76°59'49.0726"E | 3121271.671 | 696000.073 | 285.465 | | | |
| SCP-018 | 28°15'19.2876"N | 76°59'11.9851"E | 3127090.138 | 694892.969 | 273.709 | | | |
| SCP-019 | 28°12'36.4995"N | 76°58'28.9449"E | 3122059.974 | 693801.589 | 267.623 | | | |
| SCP-020 | 28°16'14.8549"N | 76°57'40.0201"E | 3128759.717 | 692358.624 | 265.112 | | | |
| SCP-021 | 28°13'47.9549"N | 76°57'05.9422"E | 3124222.828 | 691502.865 | 255.562 | | | |
| SCP-022 | 28°16'55.1346"N | 76°56'08.4654"E | 3129959.400 | 689843.726 | 263.025 | | | |
| SCP-023 | 28°15'13.5971"N | 76°54'58.7895"E | 3126803.659 | 687994.658 | 251.916 | | | |
| SCP-024 | 28°18'24.4724"N | 76°55'12.5797"E | 3132685.086 | 688277.200 | 269.222 | | | |
| SCP-025 | 28°17'16.6389"N | 76°52'57.2887"E | 3130539.057 | 684624.084 | 247.585 | | | |
| SCP-026 | 28°19'55.3848"N | 76°54'39.3566"E | 3135469.180 | 687327.824 | 274.734 | | | |
| SCP-027 | 28°18'49.3740"N | 76°52'18.0110"E | 3133376.943 | 683509.660 | 248.185 | | | |
| SCP-028 | 28°21'34.0782"N | 76°54'03.4730"E | 3138491.703 | 686302.627 | 280.255 | | | |
| SCP-029 | 28°20'24.3860"N | 76°51'42.8468"E | 3136286.731 | 682506.665 | 247.017 | | | |
| SCP-030 | 28°23'07.8703"N | 76°53'32.8386"E | 3141365.673 | 685423.154 | 233.634 | | | |
| SCP-031 | 28°22'08.1544"N | 76°51'03.7859"E | 3139464.494 | 681393.875 | 237.072 | | | |



| TCP'S | | | | | | | |
|---------|-----------------|-----------------|-------------|------------|---------|--|--|
| TCP-067 | 28°13'06.4061"N | 77°00'21.6871"E | 3123031.074 | 696860.575 | 271.034 | | |
| TCP-068 | 28°13'10.1973"N | 77°00'24.0409"E | 3123148.838 | 696922.820 | 267.933 | | |
| TCP-069 | 28°13'18.2988"N | 76°59'48.3517"E | 3123382.138 | 695945.625 | 266.631 | | |
| TCP-070 | 28°13'19.9142"N | 76°59'51.8013"E | 3123433.416 | 696038.857 | 267.836 | | |
| TCP-071 | 28°13'30.9119"N | 76°59'07.9414"E | 3123752.284 | 694837.477 | 268.041 | | |
| TCP-072 | 28°13'34.8089"N | 76°59'10.8492"E | 3123873.541 | 694914.788 | 265.898 | | |
| TCP-073 | 28°13'52.9970"N | 76°58'45.2818"E | 3124421.995 | 694208.575 | 268.496 | | |
| TCP-074 | 28°13'56.2575"N | 76°58'46.5997"E | 3124522.949 | 694242.866 | 265.104 | | |
| TCP-075 | 28°14'13.3161"N | 76°58'21.1823"E | 3125036.739 | 693541.378 | 264.634 | | |
| TCP-076 | 28°14'16.1903"N | 76°58'23.6378"E | 3125126.302 | 693606.877 | 263.697 | | |
| TCP-077 | 28°14'37.2068"N | 76°57'55.7443"E | 3125760.863 | 692835.976 | 265.078 | | |
| TCP-078 | 28°14'39.8343"N | 76°57'57.5805"E | 3125842.554 | 692884.717 | 261.528 | | |
| TCP-079 | 28°14'57.9545"N | 76°57'26.5372"E | 3126386.614 | 692029.490 | 267.744 | | |
| TCP-080 | 28°15'01.0976"N | 76°57'26.4793"E | 3126483.340 | 692026.347 | 263.061 | | |
| TCP-081 | 28°15'15.1912"N | 76°56'53.7368"E | 3126902.765 | 691126.892 | 262.110 | | |
| TCP-082 | 28°15'18.2916"N | 76°56'54.8506"E | 3126998.690 | 691155.712 | 260.056 | | |
| TCP-083 | 28°15'32.5066"N | 76°56'21.7602"E | 3127421.762 | 690246.788 | 259.226 | | |
| TCP-084 | 28°15'34.3650"N | 76°56'24.1917"E | 3127480.027 | 690312.141 | 257.216 | | |
| TCP-085 | 28°15'52.5120"N | 76°55'53.0335"E | 3128025.036 | 689454.013 | 259.620 | | |
| TCP-086 | 28°15'55.2536"N | 76°55'55.6864"E | 3128110.581 | 689524.965 | 258.329 | | |
| TCP-087 | 28°16'11.0478"N | 76°55'26.5575"E | 3128584.097 | 688723.376 | 258.667 | | |
| TCP-088 | 28°16'13.5955"N | 76°55'27.8330"E | 3128663.075 | 688756.888 | 257.003 | | |
| TCP-089 | 28°16'33.0663"N | 76°54'57.7123"E | 3129249.383 | 687926.545 | 256.936 | | |
| TCP-090 | 28°16'35.3419"N | 76°54'59.4766"E | 3129320.192 | 687973.514 | 252.996 | | |
| TCP-091 | 28°16'58.1919"N | 76°54'38.4368"E | 3130014.477 | 687389.057 | 256.735 | | |
| TCP-092 | 28°16'59.1606"N | 76°54'42.0278"E | 3130045.843 | 687486.435 | 254.180 | | |
| TCP-093 | 28°17'27.8720"N | 76°54'20.4598"E | 3130920.345 | 686884.805 | 255.939 | | |
| TCP-094 | 28°17'29.7514"N | 76°54'21.8008"E | 3130978.772 | 686920.431 | 256.329 | | |
| TCP-095 | 28°17'57.4427"N | 76°54'00.7114"E | 3131822.106 | 686332.417 | 263.020 | | |
| TCP-096 | 28°17'59.4644"N | 76°54'04.6478"E | 3131886.023 | 686438.683 | 258.503 | | |
| TCP-097 | 28°18'28.6195"N | 76°53'47.4042"E | 3132776.079 | 685954.805 | 253.132 | | |
| TCP-098 | 28°18'29.6459"N | 76°53'49.6679"E | 3132808.641 | 686015.977 | 252.571 | | |
| TCP-099 | 28°19'00.8854"N | 76°53'42.2393"E | 3133767.067 | 685798.517 | 267.264 | | |
| TCP-100 | 28°19'01.2164"N | 76°53'44.2060"E | 3133778.095 | 685851.931 | 264.187 | | |
| TCP-101 | 28°19'36.3274"N | 76°53'25.5125"E | 3134850.886 | 685325.802 | 258.351 | | |
| TCP-102 | 28°19'39.8222"N | 76°53'26.5136"E | 3134958.888 | 685351.382 | 258.279 | | |
| TCP-103 | 28°20'00.9454"N | 76°53'07.5761"E | 3135601.025 | 684825.425 | 255.750 | | |
| TCP-104 | 28°20'01.9312"N | 76°53'09.9570"E | 3135632.384 | 684889.796 | 256.456 | | |
| TCP-105 | 28°20'26.6062"N | 76°52'58.9299"E | 3136387.228 | 684577.617 | 254.448 | | |
| TCP-106 | 28°20'26.6381"N | 76°53'00.7694"E | 3136388.992 | 684627.698 | 254.540 | | |
| TCP-107 | 28°21'02.7798"N | 76°52'53.2526"E | 3137498.297 | 684405.637 | 259.513 | | |
| TCP-108 | 28°21'05.0330"N | 76°52'55.7444"E | 3137568.714 | 684472.409 | 260.368 | | |
| TCP-109 | 28°21'33.4984"N | 76°52'42.2721"E | 3138439.205 | 684091.900 | 250.940 | | |
| TCP-110 | 28°21'33.7066"N | 76°52'45.7096"E | 3138447.074 | 684185.399 | 251.315 | | |



4. LIST OF CHARTED UTILITIES

Nil

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GEOTECHNICAL INVESTIGATION REPORT FOR TUNNEL

Prepared & Submitted By

M/s. S. M. Consultants

GEOTECHNICAL ENGINEER

GEOLOGIST

SENIOR CONSULTANT

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×

For S.M. Consultants

| PD/GC | |
|--------------|--|
| DPD/GC/CIVIL | |
| | |

| Client | | | | |
|---------------------|--|--|--|--|
| CPM/HRIDCL | | | | |
| DGM/CIVIL/S/ HRIDCL | | | | |
| EXE/CIVIL/ HRIDCL | | | | |
| | | | | |

Client:

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1

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HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED. Consultant:



S.M. CONSULTANTS, S.M.TOWER, PLOT NO.-130, MANCHESWAR INDUSTRIAL ESTATE, RASULGARH, BHUBANESWAR-751010

| | Consultant: | Geo Investig | technical ation Report | Client: |
|--------------|------------------|-----------------|---------------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

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| Project: | |
| | |

| | Consultant: | Geo Investig | technical ation Report | Client: |
|--------------|------------------|-----------------|---------------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

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1 CHAPTER: INTRODUCTION

This report presents results of sub-soil Exploration work for "Exploring alternate alignments, final location survey, geological mapping, geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project". This work was performed by M/s. S. M. Consultants, Bhubaneswar which was assigned by Haryana Rail Infrastructure Development Corporation Ltd. At the proposed site twenty-two numbers of bore holes were drilled to explore the sub-strata. The findings of work presented in this report are based on the subsurface conditions encountered at exploration site and results of laboratory testing of soil and rock samples. The properties of sub-strata should not be extrapolated to other areas without our prior review.

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2 CHAPTER: LOCATION MAP AND TOPOGRAPHY



2.1 Locality:

Figure 1 Geographical location of study area

The area in the report lies within the district of Gurgaon of Haryana. The concerned region is a part of survey of India toposheet No. 53H/04 and spanned between longitude $77^{\circ}58'36''$ $77^{\circ}06'00''$ and latitude $28^{\circ}14'0''$ & $28^{\circ}10'30''$.

2.2 Accessibility:

The area is 20km away from Gurgaon. The important towns in the area are Sohna,Gurgaon, Palwal. These towns are connected with important cities of the state and Delhi byNameExploring alternate alignments, final location survey, geological mapping, geo-
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metaled roads. Delhi Bombay National Highway (NH-6) passes through Gurgaon State Highway No 43 passes through Sohna. Gurgaon is a railway station on Delhi Rewari section of the meter gauge line of the Northern Railway whereas Faridabad and Palwal are on Delhi Bombay broad gauge line. Most of the villages in the area are connected by all-weather metaled roads

2.3 Flora and Fauna:

The vegetation is sparse in the area mainly composed of bushes and shrubs, palm trees can be seen at places where nalas emerge from hills. Among the common fauna found in the area are Nilgai (Becephalus tragecamelus), Hare (Lepus sp). Common bird species in the area include sparrow (Passer Domestica) Pigeon (Colomba Livia) spotted dove (Straptopelia Chinensism), House crow (Corvus splenders), Indian Parrot (Psittacula eupatria), Mynah (Acidotheras), Vultures, Owls etc. Migratory water birds are also found in the area.

2.4 <u>Climate:</u>

The area has semi-arid type of climate. Summer are extremely hot with the temperature shooting up to 47°C. The winters are quite cold. The minimum temperature recorded in Gurgaon during 1968-70 was 2.0°C. The related humidity is maximum in August (above 80%) and minimum in June (above 35%). In the month of November, the wind velocity in the morning remains about 2.5km whereas in June it is generally 8 km Per hour. The general wind direction is westerly. Summ





hour. The general wind direction is westerly. Summer monsoon starts by the end of June or early July and lasts up to September. Rainfall is generally

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restricted to this monsoon, though winter months also get some scanty rains Average annual rainfallis about 600 mm.

Climatic condition of the area is much varied characterized by hot and moist subhumid climate. It has mainly 4 seasons. The summer season is from March to Mid-June, the period from Mid-June to September is the Rainy season, October and November constitute the post monsoon season and winter is from December to February. The best time to visit this district is during winter.

Ministry of housing and urban affair, Government of India has done vulnerability mapping for Haryana state which includes multiple hazard zonation maps. The results are given below:

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2.5 <u>Seismicity:</u>

According to National Center for Seismology the state of Haryana comprises three earthquake zone. The western part comes under zone II, the central part zone III and the eastern- south-eastern part in zone IV. The region around the site of construction comes under the zone IV of earthquake. Being within the earthquake zone IV the area of interest is at high risk with reference to the seismic activity. This region is liable to MSK VIII on Medvedev–Sponheuer–Karnik Scale, a macro seismic intensity scale or lower and is classified as the High Damage Risk Zone.



Figure 5: Seismic map of state Haryana (adopted from National Centre for seismology)

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3 CHAPTER: SITE GEOLOGY: Geological Investigation of Rock and Soil

3.1 <u>Regional Geology:</u>

The rocks exposed in the area consist of Mesoproterozoic rocks of the North Delhi Fold belt which occur as long, linear, discontinuous chain of hills. The overall Delhi fold belt shows a NE-SW trend and extends from Gujrat (Deri- Ambaji) in the south to Delhi in the north. In the north and south the belt is overlain by Indo-Gangatic alluvium with sparse outcrop jutting out from the plain. Towards west it shows an unconformable contact with Marwar craton along a Phulad lineament and in the east the belt shows a faulted contact with Banded Gneissic Complex of pre-Delhi origin along Kaliguman lineament. The North Delhi Fold Belt has been divided into two groups by Heron (1935): the lower arenaceous Alwar Group and the upper argellaceous Ajabgarh Group. The Alwar Group comprises arkosic schists, phyllites, quartzites and meta- conglomerates whereas, the Ajabgarh Group comprises calc-schists, biotite schists, calc-silicates and marbles.

The regional structure of Delhi fold belt is considered as a broad synclinorium having N to NNE trend (Heron 1953) with core occupied by Delhi group, within the broad synclinorium four generations of deformation (D1 – D4) (Fig. 6) are seen in Delhi fold belt (Naha and Mohanty 1988). D1 and D2 are ubiquitous in all scales while D3 and D4 are seen only in some sectors. D1 folds are tight to isoclinal with a pervasive axial planar cleavage (S1). There are multiple occurrences of boudinage in D1 fold, which are parallel to axial planer cleavage (Naha et al.,1984). D2 folds ranges from open to isoclinal with vertical axial plane striking NNE -SSW to NE-SW. A crenulation cleavage (S2) is developed parallel to axial planes of the fold. D2 fold is coaxial with DF1 fold. Due to D2 various superposed folds have been developed in DFB, most common is Ramsay Type III fold (non-planar cylindrical) (Roy and Das 1985). DF3 folds are kink folds with sub horizontal axial planes. It has affected S1 and S2 cleavages and axial surfaces of DF1 and DF2 folds. At some places DF3 has conjugate axial plane striking NE-SW and SE-NW. It is formed by vertical compression

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(Naha and Mohanty 1988). Due to interference from D3 fold there is development of Ramsay Type II fold (non-planer non-cylindrical fold) in the DF1 and Ramsay Type I fold (planer non-cylindrical fold) in DF2 (Roy and Das 1985).

DF4 fold are upright chevron fold, having NW-SE striking axial plane. They are formed by horizontal compression in an NE-SW direction (Naha and Mohanty 1988).

The different phase of deformation has led to metamorphism raging from greenschist to amphibolite facies.



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| Recent | | Alluvium and blown sand with thin Kankar bands at places |
|----------------|---------------------|---|
| Post Delhi) | | Quartz veins, pegmatites & Basalt, Intrusives) |
| | (Ajabgarh Formation | White, dull white to light brown, quartzite white gritty argillaceous intercalations and siltstone. |
| Delhi Group | (Alwar formation | Light to dark grey massive quartzite white gritty quartzite with subordinate amount of schist and phyllite |

3.2 <u>Stratigraphy of the Area:</u>

 Table 1 : Stratigraphy of North Delhi fold belt (after Roy 1988).

3.3 Local Geology:

The region around the site consists metamorphosed arenaceous rocks of Alwar group. The Lithology is dominated by Quartzites with some intercalations of phyllites near the southern portal.

The Quartzites are metasedimentary rocks comprises greater than 80% quartz along with feldspar and mica minerals, the mineral grains show an equigranular interlocking texture.

The phyllites are low grade metamorphic rocks, they have a marked fissility (a tendency to split into sheets or slabs) due to the parallel alignment of platy minerals; they have a sheen on its surfaces due to tiny plates of micas.

The quartzites near to surface showed high weathering and were highly friable and non-cohesive while as we move deeper (> 15 m) the quartzite becomes more resistive and less weathered. Quartz is a tectosilicate mineral which ranks 7 on Mohr hardness scale, since it crystallizes later according to Bowen reaction series it is also resistive to weathering. Feldspar on the other hand ranks 6 on Mohr hardness scale and crystallizes earlier thus is prone to weathering.

In the southern part intercalation of phyllites/schist along with quartzite are observed.

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3.3.1 Structural study of hard rock

The compositional change in quartzite beds defines the bedding in the area and the regional trend of bedding plane is NE-SW with a steep dip towards SE.

A superposed fold was observed at 28°12′33.57″, 77°02′57.08″. DF2 and DF3 deformation phases of Delhi group was observed in the area. DF1 is the prominent fold pattern which was super posed with DF2 folding phase. Signatures of later brittle shearing, possibly related to DF4 phase, was also observed near the proposed portal face. The fold showed Ramsay's Type III folding pattern i.e., non-planar cylindrical (Fig. 7), the fold hinge showed a plunge of 20° towards 220. The Type III fold pattern in rest of the Delhi system of rocks are result of superposition of DF2 over DF3 deformation. The portal face lies perpendicular to the axial plane of the fold. The earlier generation of fold is isoclinal in nature where both the limbs dip towards south.

Near the fold area some quartz tension gashes were observed. Gash veins open up when rock gets stretched due to shearing and the tension fractures forms oblique to the shear zone which is later filled with mineral precipitate. In the present area the gash veins indicate a dextral shearing (Fig. 8)

At location 28° 12' 20.93'', 77° 02' 40.50'' another evidence of brittle-ductile shear zone was observed within the quartzite outcrop (Fig. 9). Prominent en-echelon fractures were observed within the outcrop which were rotated to form a sigmoidal structure, the fractures were not filled with mineral precipitate. The shear plane was dipping towards NE with a normal slip where the eastern block was showing a downthrown movement and the western block an upthrown movement. The last phase of deformation DF4 has led to the formation of brittle shearing.

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Figure 8 : Gash veins showing a dextral slip.

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Orientation of the joints measured in field (Table 2) has been plotted on stereo net and contouring was done following Schimidt's 1% area rule (Figure 11).The diagram shows 6 distinct cluster of the poles to the joint planes, hence we designate the sets as J1, J2, J3, J4, J5, and J6 (Table 3).

Table 2: Orientation of the joints at places around the site.

| S. NO | Strike | Dip | Dip Direction |
|-------|---|--|---|
| 1. | 034 | 11 | NW |
| 2. | 028 | 13 | NW |
| 3. | 029 | 13 | NW |
| 4. | 027 | 15 | NW |
| 5. | 027 | 15 | NW |
| 6. | 026 | 16 | NW |
| 7. | 029 | 18 | NW |
| 8. | 033 | 18 | NW |
| 9. | 028 | 19 | NW |
| 10. | 032 | 19 | NW |
| 11. | 042 | 21 | NW |
| 12. | 040 | 22 | NW |
| 13. | 036 | 23 | NW |
| 14. | 041 | 24 | NW |
| 15. | 037 | 25 | NW |
| 16. | 036 | 26 | NW |
| 17. | 043 | 27 | NW |
| 18. | 040 | 28 | NW |
| 19. | 037 | 30 | NW |
| 20. | 038 | 30 | NW |
| 21. | 178 | 31 | W |
| 22. | 172 | 32 | W |
| 23. | 175 | 32 | W |
| 24. | 170 | 34 | W |
| 25. | 174 | 34 | W |
| 26. | 172 | 36 | W |
| 27. | 178 | 37 | W |
| 28. | 172 | 38 | W |
| 29. | 178 | 38 | W |
| 30. | 178 | 39 | W |
| 31. | 003 | 40 | W |
| lame | Exploring alternate alignments, final le technical investigation, detail design of if any and other ancillary work in Sohna | ocation survey, geolog tunnel & its approache a-Manesar Section of H | gical mapping, geo- s including Viaduct IORC project" |

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| S. NO | Strike | Dip | Dip Direction | |
|---|--------|-----|---------------|--|
| 32. | 006 | 40 | W | |
| 33. | 004 | 41 | W | |
| 34. | 005 | 43 | W | |
| 35. | 008 | 43 | W | |
| 36. | 119 | 45 | NE | |
| 37. | 008 | 46 | W | |
| 38. | 009 | 46 | W | |
| 39. | 119 | 46 | NE | |
| 40. | 008 | 47 | W | |
| 41. | 002 | 49 | W | |
| 42. | 116 | 49 | NE | |
| 43. | 007 | 50 | W | |
| 44. | 110 | 50 | NE | |
| 45. | 110 | 51 | NE | |
| 46. | 111 | 51 | NE | |
| 47. | 114 | 51 | NE | |
| 48. | 117 | 51 | NE | |
| 49. | 115 | 52 | NE | |
| 50. | 119 | 52 | NE | |
| 51. | 122 | 57 | NE | |
| 52. | 126 | 59 | NE | |
| 53. | 127 | 60 | NE | |
| 54. | 130 | 60 | NE | |
| 55. | 121 | 62 | NE | |
| 56. | 129 | 62 | NE | |
| 57. | 122 | 63 | NE | |
| 58. | 128 | 63 | NE | |
| 59. | 124 | 64 | NE | |
| 60. | 126 | 65 | NE | |
| 61. | 117 | 70 | NE | |
| 62. | 117 | 70 | NE | |
| 63. | 029 | 71 | SE | |
| 64. | 032 | 71 | SE | |
| 65. | 026 | 72 | SE | |
| 66. | 111 | 72 | NE | |
| 67. | 028 | 73 | SE | |
| 68. | 030 | 73 | SE | |
| 69. | 035 | 73 | SE | |
| 70. | 116 | 73 | NE | |
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| S. NO | Strike | Dip | Dip Direction |
|-------------------|---|------------------------|---------------------|
| 71. | 119 | 74 | NE |
| 72. | 117 | 75 | NE |
| 73. | 178 | 76 | Е |
| 74. | 030 | 76 | SE |
| 75. | 170 | 77 | E |
| 76. | 174 | 77 | E |
| 77. | 030 | 77 | SE |
| 78. | 110 | 77 | NE |
| 79. | 113 | 77 | NE |
| 80. | 171 | 79 | Е |
| 81. | 178 | 79 | Е |
| 82. | 179 | 79 | Е |
| 83. | 027 | 79 | SE |
| 84. | 032 | 79 | SE |
| 85. | 174 | 80 | Е |
| 86. | 176 | 80 | Е |
| 87. | 114 | 80 | NE |
| 88. | 116 | 80 | NE |
| 89. | 040 | 81 | SE |
| 90. | 042 | 81 | SE |
| 91. | 122 | 81 | NE |
| 92. | 171 | 82 | Е |
| 93. | 175 | 82 | Е |
| 94. | 045 | 82 | SE |
| 95. | 126 | 82 | NE |
| 96. | 039 | 83 | SE |
| 97. | 122 | 83 | NE |
| 98. | 125 | 83 | NE |
| 99. | 125 | 83 | NE |
| 100. | 005 | 84 | Е |
| 101. | 038 | 84 | SE |
| 102. | 001 | 85 | Е |
| 103. | 008 | 85 | Е |
| 104. | 129 | 85 | NE |
| 105. | 124 | 86 | NE |
| 106. | 127 | 86 | NE |
| 107. | 002 | 87 | E |
| 108. | 006 | 87 | Е |
| 109. | 037 | 87 | SE |
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| S. NO | Strike | Dip | Dip Direction |
|-------|--------|-----|---------------|
| 110. | 042 | 87 | SE |
| 111. | 127 | 87 | NE |
| 112. | 009 | 88 | E |
| 113. | 002 | 89 | E |
| 114. | 043 | 89 | SE |
| 115. | 130 | 89 | NE |
| 116. | 001 | 90 | E |
| 117. | 036 | 90 | SE |
| 118. | 040 | 90 | SE |
| 119. | 006 | 91 | E |
| 120. | 007 | 93 | E |
| 121. | 045 | 82 | SE |
| 122. | 126 | 82 | NE |
| 123. | 039 | 83 | SE |
| 124. | 122 | 83 | NE |
| 125. | 130 | 89 | NW |

 Table 3 : Average orientation of Joint sets

| Joint Set | Average Strike | Average True Dip amount | Average True Dip direction |
|-----------|----------------|----------------------------|-------------------------------|
| J1 | 035 | 80 | SE |
| J2 | 035 | 20 | NW |
| J3 | 000 | 84 | E |
| J4 | 000 | 40 | W |
| J5 | 300 | 55 | NE |
| J6 | 300 | 80 | NE |

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Figure 11: Rose and contour diagram of the orientation of the joint set.

3.3.2 <u>Geological study of unconsolidated material and soil:</u>

There are 4 types of soil were encountered along the tunnel alignment i.e., CL, ML, SM, ML-CL. From CH25800, the rock soil contact point in L-Section (Figure 19), upto CH26700 area were covered with ML type of soil. A very long patch of CL soil, from the boundary of ML at CH26700 up to CH28880, was present. A few small patches of ML and ML-CL soil were appeared within the large patch of CL. Two patches of ML soil, near CH27200 (around BH24) and near CH28560 (around BH29), and a patch of SM soil near CH 28500were found. Again, a portion of ML soil from CH2880 to CH29420 were found and rest of soil along the alignment were categorised into ML-CL type of soil.

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Presence of any hot spring, artesian well/ free flowing well was not found and further, no active fault was detected in soil region along the proposed tunnel alignment.

A detailed geological map in a scale 1:25000 (Figure 12) and in 1:2000 scale showing all structural elements which includes faults, thrusts, shear zones, folds, joints, lithological boundaries along with finalised tunnel alignment(Figure 13), L-Section (Figure 19) along the hilly terrain (1:25000 H and 1:2500 V) and detailed cross sections (Figure 20,Figure 21,Figure 22) of the portal face on the mountain front and in the soil are given below;

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Figure 12: Geological map of the area at 1:25000 scale.

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Figure 13: Detailed structural map of the major rocky area at 1:2000 scale. Joint sets are schematically drawn with their actual orientation. Average spacing between the joints are as follows J1: 3 J6:100cm.

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Figure 14: Detailed structural map of the major soil area at 1:2000 scale.

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Figure 15: Detailed structural map of the major soil area at 1:2000 scale.

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Figure 16: Detailed structural map of the major soil area at 1:2000 scale.

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| 284.88m 284.88m | | | ~~~ | VVVV | VVV | 7 7 7 | VVV | $\nabla \nabla \nabla$ | AAA | VVV | ~~ | VVV | VVV | VV | VV | ~ ~ ~ | VVV |
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Exploring alternate alignments, final location survey, geological mapping, geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project"

Name of Project:



Client:

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Exploring alternate alignments, final location survey, geological mapping, geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project"

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4 CHAPTER: EXPLORATORY DRILLING

As per the requirement of scope of work outlined in the terms of reference, 20 bore holes were drilled with a cumulative length of 4.6 Km (Approx) at different locations along the proposed alignment. Necessary care has been taken during drilling operations by deploying good quality diamond drill machines to obtain good core recovery to obtain RQD values. The locations of the boreholes were selected in such a way, so that these holes more or less intersect the envisaged ground/ strata conditions at different depths. The location and details of boreholes drilled; total depth of drillings is shown in table below.

| BH No. | Chainage No. | Ground Elevation, RL (m) | Total Depth (m) |
|--------|--------------|-----------------------------|-----------------|
| BH-13 | 25000 | 276.867 | 60 |
| BH-14 | 25195 | 294.218 | 75 |
| BH-15 | 25380 | 295.532 | 70 |
| BH-15A | 25488 | 276.442 | 50 |
| BH-16 | 25586 | 287.324 | 62 |
| BH-17 | 25785 | 282.461 | 62 |
| BH-18 | 25990 | 280.253 | 55 |
| BH-19 | 26210 | 278.116 | 50 |
| BH-20 | 26387 | 276.795 | 48 |
| BH-21 | 26587 | 274.993 | 45 |
| BH-22 | 26787 | 274.321 | 45 |
| BH-23 | 26980 | 274.85 | 45 |
| BH-24 | 27187 | 274.075 | 40 |

Table 4: Boreholes Details

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|---------------|-------------|-------------|--------------|----------------|---------------------------|--|
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| r | | I | | 1 | | |
| BH-25 | | 27410 | | | 273.565 | 40 |
| BH-26 | | 27550 | | | 273.112 | 35 |
| BH-27 | | 28050 | | | 272.210 | 30 |
| BH-28 | | 28350 | | | 272.799 | 45 |
| BH-29 | | 28550 | | | 269.964 | 30 |
| BH-30 | | 28750 | | | 270.808 | 45 |
| BH-31 | | 29050 | | | 267.159 | 20 |
| BH-32 | | 29550 | | | 266.684 | 30 |
| BH-33 | | 30125 | | | 265.581 | 20 |

4.1 Borehole Core Details :

4.1.1 Borehole Core details from Rock Region;

The homogenous rock mass of quartzite is found in boreholes from BH13- BH17 upto a maximum depth of 216m MSL. Rocks are weathered in a varying degree in this region. Only in BH16 at below 40m a very small amount of phyllitic rock was found.

4.1.2 Borehole Core details from Soil Region;

BH NO- 17

- From N.G.L to 18.0.0 m depth, a low-plastic, stiff to hard consistency Inorganic silty clayey soil stratum exists from which three UDS were collected at 1.50 m, 4.5 m & 9.0 m depth. The field SPT N values were found to be 12,16,26,21,37 and greater than 50 at 3.0 m,6.0 m,12.0 m,15.0 m ,16.50 m & 18.0 m depth respectively
- 2. From 18.0 m to 35.0 m depth, rock stratum was encountered.
- 3. From 35.0 m to 39.50 m depth, a non-plastic, very dense compacted silty sand stratum exists. The field SPT N values were found to be greater than 50 at 36.50 m,38.0 m & 39.50 m depth
- 4. From 39.50 m to 62.0 m (max. explored) depth, rock stratum was encountered.

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- From N.G.L to 15.0.0 m depth, a non-plastic, medium compacted clayey silts with none to low plasticity stratum exists from which one DS & three UDS were collected at 0.5 m, 1.5 m, 4.50 m, & 9.0 m depth. The field SPT N values were found to be 11,20 & 24 at3.0 m,6.0 m, & 12.0 m depth.
- 2. From 15.0 m to 24.0 m depth, low plastic, hard consistency Inorganic silty clayey soil stratum exists. The field SPT N values were found to be 31,35 & 40 at 15.0 m,18.0 m, & 21.0 m depth.
- 3. From 24.0 m to 55.0 m (max. explored) depth, a non-plastic, dense to very dense compacted clayey silts with none to low plasticity stratum exists. The field SPT N values were found to be 47,49,57,64,69,77,84 and greater than 50 at 24.0m,27.0 m,30.0 m,33.0 m,36.0 m,39.0 m,42.0 m,45.0 m,47.0 m,50. 0 m,53.0 m & 55.0 m depth

BH NO- 19

- From N.G.L to 33.0 m depth, a non-plastic, medium to dense compacted clayey silts with none to low plasticity stratum exists from which one DS & six UDS were collected at 0.5 m, 3.0 m, 6.0 m, 12.0 m, 18.0 m, 24.0 m & 30.0 m depth. The field SPT N values were found to be 17, 23, 30, 35, 35 & 39 at 1.50 m, 4.50 m, 9.0 m, 15.0 m, 21.0 m, & 27.0 m depth.
- 2. From 33.0 m to 50.0 m (max. explored) depth, a non-plastic, dense to very dense compacted Silty sand stratum exists.

BH NO- 20

- 1. From N.G.L to 12.0 m depth, a non-plastic, dense compacted clayey silts with none to low plasticity stratum exists from which one DS & two UDS were collected at 0.5 m, 3.0 m & 6.0 m depth. The field SPT N values were found to be 18, 32 & 48 at 1.50 m, 4.50 m & 9.0 m depth.
- 2. From 12.0 m to 15.0 m depth, a non-plastic, Silty sand stratum exists.
- 3. From 15.0 m to 18.0 m depth, a non-plastic, very dense compacted clayey silts with none to low plasticity stratum exists. The Field SPT N values was found to be 60 at 15.0 m Depth.
- 4. From 18.0 m to 21.0 m depth, a non-plastic, Silty sand stratum exists.

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- 5. From 21.0 m to 27.0 m depth, non-plastic, very dense compacted clayey silts with none to low plasticity stratum exist. The Field SPT N values were found to be 67 & 76 at 21.0 m & 24.0 m Depth.
- 6. From 27.0 m to 48.0 m (max. explored) depth, medium-plastic, hard consistency silt & clay with low compressibility stratum exist from which four UDS sample were collected at 27.0 m, 33.0 m,39.0 m & 45.0 m depth. The field SPT N values were found to be 58, 67, 75 & 79 at 30.0 m, 36.0 m, 42.0 m & 48.0 m depth respectively

- From N.G.L to 18.0 m depth, a non-plastic, medium to dense compacted clayey silts with none to low plasticity stratum exists from which one DS & three UDS were collected at 0.5 m, 3.0 m, 6.0 m & 12.0 m depth. The field SPT N values were found to be 14, 20, 31 & 38 at 1.50 m, 4.50 m 9.0 m & 15.0 m depth.
- 2. From 18.0 m to 39.0 m depth, fragmented rock stratum encountered.
- 3. From 39.0 m to 45.0 m (max. explored) depth, non-plastic, very dense compacted stratum exists from which two DS sample was collected at 39.0 m and 45.0 m depth. The field SPT N values was found to be 77 at 42.0 m depth respectively.

BH NO- 22

- 1. From N.G.L to 1.50 m depth, a medium-plastic silt & clay with low compressibility stratum exists from which one DS was collected at 0.5 m depth.
- 2. From 1.50 m to 12.0 m depth, a non-plastic, medium compacted clayey silts with none to low plasticity stratum exists from which two UDS were collected at 3.0 m & 6.0 m depth.
- 3. From 12.0 m to 42.0 m depth Fragmented Rock stratum encountered.
- 4. From 42.0 m to 45.0 m (max. explored) depth, medium-plastic, hard consistency silt & clay with low compressibility stratum exist. from which one DS sample was collected at 42.0 m depth. The field SPT N value was found to be 91 at 45.0 m depth.

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- From N.G.L to 9.0 m depth, a medium-plastic, stiff to very stiff consistency silt & clay with low compressibility stratum exists from which one DS & two UDS were collected at 0.5 m, 3.0 m & 6.0 m depth. The field SPT N values were found to be 16 & 23 at 1.50 m & 4.50 m depth.
- 2. From 9.0 m to 12.0 m depth, a non-plastic, dense compacted clayey silts with none to low plasticity stratum exists. The Field SPT N value was found to be 34 at 9.0 m Depth.
- 3. From 12.0 m to 21.0 m depth, a medium-plastic, hard consistency silt & clay with low compressibility stratum exists. The field SPT N value was found to be 38 at 21.0 m depth.
- 4. From 21.0 m to 24.0 m depth, a non-plastic, dense compacted Silty sand stratum exists. The field SPT N value was found to be 50 at 15.0 m depth.
- 5. From 24.0 m to 27.0 m depth, medium-plastic, silt & clay with low compressibility stratum exist from which one UDS was collected at 24.0 m depth.
- 6. From 27.0 m to 30.0 m depth, a non-plastic, very dense compacted Silty sand stratum exists. The field SPT N value was found to be 63 at 27.0 m depth.
- 7. From 30.0 m to 33.0 m depth, a non-plastic, clayey silts with none to low plasticity stratum exists from which one UDS was collected at 30.0 m depth.
- 8. From 33.0 m to 36.0 m depth, medium-plastic, hard consistency silt & clay with low compressibility stratum exist. The field SPT N value was found to be 73 at 33.0 m depth.
- 9. From 36.0 m to 39.0 m depth, a non-plastic, Silty sand stratum exists from which one UDS was collected at 36.0 m depth.
- 10. From 39.0 m to 45.0 m (max. explored) depth, medium-plastic, hard consistency silt & clay with low compressibility stratum exist from which one UDS sample was collected at 42.0 m depth. The field SPT N values were found to be 77 & 85 at 39.0 m & 45.0 m depth respectively.

BH NO- 24

From N.G.L to 24.0 m depth, a non-plastic, medium compacted clayey silts with none to low plasticity stratum exists from which one DS & four UDS were collected at 0.5 m, 3.0 m, 6.0 m, 12.0 m & 18.0 m depth. The field SPT N values were found to be 14,21,27,33 & 43 at 1.50 m, 4.50 m, 9.0 m, 15.0 m & 21.0 m depth.

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2. From 24.0 m to 40.0 m (max. explored) depth, medium-plastic, hard consistency silt & clay with low compressibility stratum exist from which four UDS sample were collected at 24.0 m,30.0 m,36.0 m & 40.0 m depth. The field SPT N values were found to be 58, 72 & 89 at 27.0 m, 33.0 m & 39.0 m depth respectively.

BH NO- 25

- From N.G.L to 40.0 m (max. explored) depth, medium-plastic, stiff to hard consistency silt & clay with low compressibility stratum exist from which one DS & eight UDS sample were collected at 0.5 m,3.0 m,6.0 m,12.0 m,18.0 m,24.0 m,30.0 m,36.0 m & 40.0 m depth. T
- The field SPT N values were found to be 13,20,30,31,33,48,68 & 81 at 1.50 m,4.50 m,9.0 m,15.0 m,21.0 m,27.0 m, 33.0 m & 39.0 m depth respectively.

BH NO- 26

- From N.G.L to 35.0 m (max. explored) depth, medium-plastic, stiff to hard consistency silt & clay with low compressibility stratum exist from which one DS & seven UDS sample were collected at 3.0 m,6.0 m,12.0 m,18.0 m,24.0 m,30.0 m & 35.0 m depth.
- The field SPT N values were found to be 11,19,28,34,41,53 & 65 at 1.50 m,4.50 m,9.0 m,15.0 m,21.0 m,27.0 m & 33.0 m depth respectively.

BH NO- 27

- From N.G.L to 6.0 m depth, a medium-plastic, stiff to very stiff consistency, silt and clay with low compressibility stratum exists from which one DS & one UDS were collected at 0.5 m & 3.0 m, depth. The field SPT N values were found to be 14 & 24 at 1.50 m, & 4.50 m depth.
- 2. From 6.0 m to 9.0 m depth, non-plastic, clayey silts with none to low plasticity stratum exists from which one UDS was collected at 6.0 m depth,
- 3. From 9.0 m to 18.0 m depth, a medium-plastic, very stiff to hard consistency, silt and clay with low compressibility stratum exists from which one UDS was collected at 12.0 m, depth. The field SPT N values were found to be 27 & 36 & 9.0 m, & 15.0 m depth.
- 4. From 18.0 m to 21.0 m depth, non-plastic, clayey silts with none to low plasticity stratum exists from which one UDS was collected at 18.0 m depth,

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5. From 21.0 m to 30.0 m (max. explored) depth, medium-plastic, hard consistency silt & clay with low compressibility stratum exist from which two UDS sample were collected at 24.0 m & 30.0 m depth. The field SPT N values were found to be 45 & 54 at 21.0 m & 27.0 m depth respectively.

BH NO- 28

- 1. From N.G.L to 1.50 m depth, non-plastic, clayey silts with none to low plasticity stratum exists from which one DS was collected at 0.5 m depth,
- 2. From 1.50 m to 3.0 m depth, a medium-plastic, medium consistency, silt and clay with low compressibility stratum exists. The field SPT N values was found to be 12 at 1.5 m depth.
- 3. From 3.0 to 6.0 m depth, non-plastic, medium compacted clayey silts with none to low plasticity stratum exists from which one UDS was collected at 3.0 m depth. The field SPT N Values Was found to be 21 & 4.50 m depth.
- 4. From 6.0 to 9.0 m depth, non-plastic, silty sand stratum exists from which one UDS was collected at 6.0 m depth.
- 5. From 9.0 to 18.0 m depth, non-plastic, medium to dense compacted clayey silts with none to low plasticity stratum exists from which one UDS was collected at 12.0 m depth. The field SPT N Values Was found to be 28 & 38 at 9.0 & 15.0 m depth.
- 6. From 18.0 m to 30.0 m depth, a medium-plastic, hard consistency, silt and clay with low compressibility stratum exists from which two UDS were collected at 18.0 m & 24.0 m depth. The field SPT N values were found to be 47 & 53 at 21.0 m & 27.0 m depth.
- 7. From 30.0 to 33.0 m depth, non-plastic, very dense compacted clayey silts with none to low plasticity stratum exists from which one UDS was collected at 30.0 m depth.
- From 33.0 m to 39.0 m depth, a medium-plastic, hard consistency, silt and clay with low compressibility stratum exists from which one UDS was collected at 36.0 m depth. The field SPT N values were found to be 70 at 33.0 m depth.
- 9. From 39.0 m to 45.0 m (max. explored) depth, non-plastic very dense compacted clayey silts with none to low plasticity stratum exist from which one UDS sample was collected at 39.0 m depth. The field SPT N values were found to be 81 & 92 at 39.0 m & 45.0 m depth respectively.

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- 1. From N.G.L to 3.0 m depth, non-plastic, medium compacted, clayey silts with none to low plasticity stratum exists from which one DS was collected at 0.5 m depth. The field SPT N value was found to be 12 at 1.5 m depth.
- From 3.0 m to 12.0 m depth, a low-plastic, very stiff consistency, consistency Inorganic silty clayey stratum exists from which two UDS were collected at 3.0 m & 6.0 m depth. The field SPT N values were found to be 14 & 27 at 4.5 m & 9.0 m depth.
- 3. From 12.0 to 15.0 m depth, non-plastic, silty sand stratum exists from which one UDS was collected at 12.0 m depth.
- 4. From 15.0 to 24.0 m depth, non-plastic, dense compacted, clayey silts with none to low plasticity stratum exists from which one UDS was collected at 18.0 m depth. The field SPT N Values were found to be 38 & 47 at 15.0 m & 21.0 m depth respectively.
- 5. From 24.0 to 27.0 m depth, non-plastic, silty sand stratum exists from which one UDS was collected at 24.0 m depth.
- 6. From 27.0 m to 30.0 m (max. explored) depth, a low-plastic, hard consistency Inorganic silty clayey stratum exists from which one UDS was collected at 27.0 m depth. The field SPT N values was found to be 61 at 27.0 m depth.

BH NO- 30

- From N.G.L to 4.5 m depth, non-plastic, medium compacted, clayey silts with none to low plasticity stratum exists from which one DS and one UDS was collected at 0.5 m & 3.0 m depth. The field SPT N value was found to be 17 at 1.5 m depth.
- From 4.50 m to 12.0 m depth, a low-plastic, very stiff consistency, Inorganic silty clayey stratum exists from which two UDS were collected at 3.0 m & 6.0 m depth. The field SPT N values were found to be 22 & 30 at 4.5 m & 9.0 m depth.
- 3. From 12.0 to 18.0 m depth, medium-plastic, hard consistency, silt & clay with low compressibility stratum exists from which one UDS was collected at 12.0 m depth. The field SPT N values was found to be 38 at 15.0 m depth.
- 4. From 18.0 to 21.0 m depth, non-plastic, clayey silts with none to low plasticity stratum exists from which one UDS was collected at 18.0 m depth.

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- 5. From 21.0 to 24.0 m depth, medium-plastic, hard consistency, silt & clay with low compressibility stratum exists. The field SPT N values were found to be 44 at 21.0 m depth.
- 6. From 24.0 to 27.0 m depth, non-plastic, silty sand stratum exists from which one UDS was collected at 24.0 m depth.
- 7. From 27.0 to 45.0 m depth, non-plastic, very dense compacted, clayey silts with none to low plasticity stratum exists from which three UDS were collected at 30.0 m,36.0 m & 42.0 m depth respectively.
- 8. From 45.0 m (max. explored) depth, a low-plastic, hard consistency Inorganic silty clayey stratum exists. The field SPT N values were found to be 84 at 45.0 m depth.

- 1. From N.G.L to 3.0 m depth, medium-plastic, stiff consistency, silt and clay with low compressibility stratum exists from which one DS was collected at 0.5 m depth. The field SPT N value was found to be 16 at 1.5 m depth.
- 2. From 3.0 to 4.50 m depth, non-plastic, silty sand stratum exists from which one UDS was collected at 3.0 m depth.
- 3. From 4.50 m to 12.0 m depth, a non-plastic, medium to dense compacted, clayey silts with none to low plasticity stratum exists from which one UDS was collected at 6.0 m depth. The field SPT N values were found to be 23 & 32 at 4.5 m & 9.0 m depth.
- 4. From 12.0 m to 20.0 m (max. explored) depth, a low-plastic, hard consistency Inorganic silty clayey stratum exists from which two UDS were collected at 12.0 m & 18.0 m The field SPT N values were found to be 40 & 51 at 15.0 m & 20.0 m depth respectively.

BH NO-32

- From N.G.L to 30 m depth, a low-plastic, hard consistency Inorganic silty clayey stratum exists from which one DS was collected at 0.5 m depth and six UDS were collected at 3.0 m, 6.0 m, 12.0 m, 18.0 m, 24.0m & 30.0m.
- The field SPT N values were found to be 17, 27, 35, 44, 54 & 63 at 1.5m, 4.5m, 9.0m, 15.0m, 21.0m & 27.0 m depth respectively.
- 3. The plasticity index of the soil throughout the borehole is ranging between 10% 12%.
- 4. The plastic limit of the soil throughout the borehole is ranging between 19% 22%.

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1. From N.G.L to 30 m depth, a low-plastic, hard consistency Inorganic silty clayey stratum exists from which one DS was collected at 0.5 m depth and four UDS were collected at 3.0 m, 6.0 m, 12.0 m & 18.0 m.

2. The field SPT N values were found to be 11, 28, 39, 50 & 63 at 1.5m, 4.5m, 9.0m, 15.0m & 20.0m depth respectively.

3. The plasticity index of the soil throughout the borehole is ranging between 9% - 13%.

4. The plastic limit of the soil throughout the borehole is ranging between 18% - 20%.

4.2 <u>Permeability Test in Bed Rock</u>

The packer test method was carried out as per IS 5529 (Part 2): 2006 to determine the permeability of the rock strata at site.

4.2.1 <u>Packer test method:</u>

In the packer method, water is pumped under pressure into the test section of bedrock through drill hole. The single and double packer methods are normally conducted in exploratory holes.

Single packer method:

In this method, one packer is used in the drill hole. The test section is between the bottom of the bore hole and the packer.

Double packer method:

In this method, two packers are used in the drill hole. The test section is between the two packers.

Procedure:

The procedure adopted consists of pumping water into the 'test section' and is therefore called 'pumping-in type'. Packers are employed for conducting these tests and depending upon the use of one packer or two packers the method is designated as single or

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double packer method respectively. Examination of the drill cores and the results of water tests, obtained during drilling will usually indicate whether a double packer test in any isolated section or sections of the drill hole is required. The tests are based on measuring the amount of water accepted by the 'test section' (of the hole) confined by a packer/packer while water is pumped into it.

After completion of the full arrangement for the test, the water pumped in to the section under pressure. The pressure should be maintained until the readings of water intake at intervals of 5 min show a nearly constant reading of water intake for one particular pressure at the collar. The constant rate of water intake should be noted. It is recommended that the tests to be commenced with a low pressure at the collar and increased limited to the availability of suitable rock cover to prevent uplift or till a maximum pressure equivalent to H + x (where H is the hydraulic head to which the strata would be subjected to due to the contemplated structure and x is the loss due to the friction) is achieved. In our case, 1, 2 and 3 kg/cm2 pressure were applied in every case.

The water loss (due to permeability inside the rock) is expressed in Lugeons. A Lugeon is defined as the water loss in litre/min./m of the drill hole under is pressure of 10 atmospheres maintained for 10 min in a drill hole of 46 mm to 76 mm diameter.

| BH No. | Packer te | st section 1 | a o | Packer test section 2 | | n a |
|--------|-------------------|-------------------|----------------|-----------------------|-------------------|----------------|
| | Upper part (m) | Lower part (m) | Lugeo Value | Upper part (m) | Lower part (m) | Lugeo Value |
| BH-13 | 36 | 39 | 30.20 | 48 | 51 | 25.62 |
| BH-14 | 54 | 57 | 24.46 | 63 | 66 | 21.88 |
| BG-15 | 55 | 58 | 24.34 | 64 | 67 | 18.42 |
| BH-16 | 44 | 47 | 27.38 | 56 | 59 | 21.14 |
| BH-17 | 41 | 44 | 24.52 | 50 | 53 | 22.78 |
| | | | | | | |

 Table 5 Parker test results

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5 CHAPTER: GEOMECHANICAL CLASSIFICATION OF GEOLOGICAL UNITS

5.1 <u>Rock Quality Designation (RQD)</u>

Rock Quality Designation (RQD) is a measure of quality of rock core taken from a borehole. RQD signifies the degree of jointing or fracture in a rock mass measured in percentage, where RQD of 75% or more shows good quality hard rock and less than 50% show low quality weathered rocks. RFQ is calculated by taking a rock core sample from a borehole and lengths of all sound rock pieces which are minimum 100 mm long are summed up and are divided by the length of the core run. Only those pieces of rocks are considered which are hard and good quality. Weathered rocks which do not meet soundness requirements and whose lengths are not greater than 100mm are not considered for calculation of RQD. The length of core pieces is measured along center line of the pieces. RFQ test provides assessment of soundness of the rock and damages caused due to

| GORE RECOVERY | RQD | | |
|---------------|--|----------------------------|----------------|
| CALCULATION | SALLVLATEN | Rock Quality | RQD (%) |
| L = 250 min | C = 250 mm | | |
| | free and the second sec | Very poor (Completely | <25% |
| L = 200 mm | L = 0 Highly Westwood Doos not neel Soundness Requirement | weathered rock) | |
| | L+0 | Poor (weathered rocks) | 25 to 50% |
| L = 250 mm | Centerize Process < 100 mm and Highly Weathered g | Fair (Moderately weathered | 51 to 75% |
| | Hurt for | rocks) | |
| L⊴199.mm | \; L = 190 mm B | Good (Hard Rock) | 76 to 90% |
| L = 69 mm | L = D < 100 mm | | |
| L = 50 mm | | Very Good (Fresh rocks) | 91 to |
| L = 120 mm | L = 250 mm | | 100% |
| L = 0 mm | i. + 0 No Recovery W | eathering. | |

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5.1.1 <u>Rocks Core Recovery and RQD Calculations:</u>

Core recovery (CR) is calculated by following formula:

$$CR = \left[\frac{\text{total length of rock recovered}}{\text{Total core run length}} \times 100\right]\%$$

| - ח ח | [Length of core pieces > 10cm | v 100 | 0/6 |
|-----------------|-------------------------------|-------|-----|
| $\Lambda Q D =$ | Total core run length | ^ 100 | 70 |

| ROO | CK CLASSIFICATION BASED ON RQD | Joint Frequency | RQD (%) |
|-----|--------------------------------|---------------------------------|---------|
| А | VERY POOR ROCK | >27 joints per m ³ | 0-25 |
| В | POOR | 20-27 joints per m ³ | 25-50 |
| C | FAIR | 13-19 joints per m ³ | 50-75 |
| D | GOOD | 8-12 joints per m ³ | 75-90 |
| Е | EXCELLENT | 0-7 joints per m ³ | 90-100 |

Note:

i) Where RQD is reported or measured as ≤ 10 (including 0) the value 10 is used to evaluate the Q-value

ii) RQD-intervals of 5, i.e. 100, 95, 90, etc., are sufficiently accurate.

5.1.2 <u>Methodology:</u>

The drill cores (NX & NQ size) were properly logged and stored in the GI core boxes specifically designed as per the standard specifications. The cores are aligned systematically according to the core run and all the relevant information regarding the core recovery, Rock Quality Designation (RQD), fracture pattern was observed from the geotechnical logging of

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the drilled holes. The details of the rock type obtained from each drill hole runs were systematically recorded and summarized in the standard Geotechnical logging format. Table, given below, summarized the percentage of RQD as obtained during the drilling of bore holes. For detail table refer Annexure.

| BH NO. | AVERAGE RQD, % | MINIMUM RQD, % | MAXIMUM RQD, % | | | |
|--------|----------------|----------------|----------------|--|--|--|
| BH-13 | 6.5 | 0 | 28.6 | | | |
| BH-14 | 5.9 | 0 | 24.0 | | | |
| BH-15 | 5.9 | 0 | 27.0 | | | |
| BH-15A | 10.7 | 0 | 32.0 | | | |
| BH-16 | 16.0 | 0 | 51.3 | | | |
| BH-17 | 10.9 | 0 | 41.5 | | | |

Table 7: Average, Minimum & Maximum Value of RQD.

Core samples were collected from the drill holes at different depth intervals to represent the envisaged strata conditions of the proposed crown and invert portion of different tunnel types. These samples were sent to IIT, Banaras Hindu University (BHU) and NABL accredited Laboratory at New Delhi for testing the Physico-mechanical properties.

The assessment of rock mass has been carried out based on the geotechnical investigation, observation of the core logs, joint orientation with reference to the proposed tunnel orientation and physico -mechanical properties of rock cores. The rock mass is classified in to Q-classification system (Q tunnelling index) developed by Barton. N. (1976), Norwegian Geotechnical Institute and RMR Geo-mechanics Classification system.

The data, thus obtained from geotechnical inputs has been analysed by using both the standard Rock Mass Classification systems. Pre-investigations for underground excavations often include core-logging. The Q-parameters were evaluated with a relatively high degree of accuracy.

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However, special attention has been addressed to the following aspects:

Only a small section of each joint surface will usually be available, particularly for joints intersecting the borehole at an obtuse angle. Evaluation of the roughness coefficient (Jr) may therefore be difficult. Particularly the large and medium scale undulation may be difficult to estimate. As water is used during drilling, fillings like clay minerals may be washed out, making it difficult to evaluate in some cases.

The drilling direction of the borehole influences the number of joints that are intersected by the borehole. Sub-parallel joints to the borehole will be under represented in the cores, and this will give too high RQD-values and too low Jn values. Whereas, RQD is often calculated for every meter, Jn must usually be estimated for sections of several meters.

In massive rock it is impossible to estimate SRF (Stress Reduction Factor) from drill cores. However, in rock intersected by weakness zones, it may be possible to give some suggestions about SRF. In massive rock, SRF can be estimated partially based on the overburden, height of a mountain side, stress measurements carried out in the borehole, or experiences from nearby construction sites.

In general, a core log should only contain data obtained from the cores or measurements carried out in the borehole itself. However, by using the log data combined with estimates of J_w and SRF, it will be possible to get a rough impression of the Q-values of the cores, and these could be helpful during planning phase. Water-loss tests are often carried out during core drilling. The results are normally given in Lugeon (Lugeon = the loss of water in litters per minute and per meter borehole at an over-pressure of 1 MPa), and form the basis for evaluation of the J_w -value. One also has to take into account whether the rock mass is going to be grouted or not in order to estimate the Q-value as a basis for rock support after excavation.

It is always important to evaluate how representative the cores are. Boreholes are often drilled just in order to investigate particular zones. It is then imperative to consider how much of the total rock masses these zones represent. If a borehole is orientated along a fracture zone, the parameter values for this zone will be determined.

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5.2 <u>Rock Mass Rating Index (RMR):</u>

Bieniawski (1976) published the details of a rock mass classification called the Geomechanics Classification or the Rock Mass Rating (RMR) system. Over the years, this system has been successively re- fined as more case records have been examined and the reader should be aware that Bieniawski has made significant changes in the ratings assigned to different parameters. The discussion which follows is based upon the 1989 version of the classification (Bieniawski, 1989). The following six parameters are used to classify a rock mass using the RMR system:

- i) Uniaxial compressive strength of rock material.
- ii) Rock Quality Designation (RQD).
- iii) Spacing of discontinuities.
- iv) Condition of discontinuities.
 - a) Length, persistence
 - b) Separation
 - c) Smoothness
 - d) Infilling
 - e) Alteration / weathering
- v) Groundwater conditions.
- vi) Orientation of discontinuities.

All of these are measurable in the field and can also be obtained from borehole data. The rating of each of these parameters is summarized to give a value of RMR. All parameters are measurable in the field and some of them may also be obtained from borehole data.

To apply the RMR classification, the rock mass along a tunnel route is divided into a number of structural regions, i.e., zones in which certain geological feature are more or less uniform. The above six classification parameters are determined for each structural region from measurements in the field. Once the classification parameters are determined, the ratings are assigned to each parameter according to Table 7.

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| | | PARAMETER | | Ra | nge of values // | / ratings | | | |
|---|--------------------|------------------------------------|----------------|--------------------|-----------------------|------------------------|---------------------|---|------------|
| | Strength of intact | Point-load strength index | > 10 MPa | 4 - 10 MPa | 2 - 4 MPa | 1 - 2 MPa | Fo Uni streng | For this low ran Uniaxial compr. strength is preferre | |
| 1 | rock material | Uniaxial com- pressive strength | > 250 MPa | 100 - 250 MPa | 50 - 100 MPa | 25 - 50 MPa | 5 - 25 MPa | 1 -5 MPa | < 1 MPa |
| | | RATING | 15 | 12 | 7 | 4 | 2 | 1 | 0 |
| | Dr | ill core quality RQD | 90 - 100% | 75 - 90% | 50 - 75% | 25 - 50% | 1 | < 25% | |
| 2 | | RATING | 20 | 17 | 13 | 8 | | 5 | |
| | Spac | cing of discontinuities | > 2 m | 0.6 - 2 m | 200 - 600 mm | 60 - 200 mm | | < 60 | mm |
| 3 | | RATING | 20 | 15 | 10 | 8 | | 5 | |
| | | Length, persistence | < 1 m | 1 - 3 m | 3 - 10 m | 10 - 20 m | | > 20 m | |
| | | Rating | 6 | 4 | 2 | 1 | | 0 | |
| | Se | Separation | None | < 0.1 mm | 0.1 - 1 mm | 1 - 5 mm | | > 5 | mm |
| | uitie | Rating | 6 | 5 | 4 | 1 | | 0 | |
| | ontin | Roughness | very rough | Rough | slightly rough | smooth | | Slicken | sided |
| | lisco | Rating | 6 | 5 | 3 | 1 | | 0 | |
| | tion of c | tion of c | None | Hard filling | | Soft filling | | | |
| 4 | Jondi | initing (gouge) | - | < 5 mm | > 5 mm | < 5 mm | | > 5 | mm |
| 4 | 0 | Rating | 6 | 4 | 2 | 2 | | 0 | |
| | | Weathering | unweathered | slightly w. | moderately w. | highly w. | | Decom | posed |
| | | Rating | 6 | 5 | 3 | 1 | | 0 | |
| | | Inflow per 10 m tunnel length | None | < 10 litres/min | 10 - 25 litres/min | 25 - 125 litres/min | > 1 | 125 litre | s /min |
| | Ground | p _w / l | 0 | 0 - 0.1 | 0.1 - 0.2 | 0.2 - 0.5 | | > 0.5 | |
| 5 | water | General conditions | completely dry | Damp | Wet | dripping |] | Flowing | 5 |
| | | RATING | 15 | 10 | 7 | 4 | | 0 | |

In this respect the typical, rather than the worst conditions, are evaluated. Furthermore, it should be noted that the ratings, which are given for discontinuity spacing, apply to rock masses having three sets of discontinuities. Thus, when only two sets of discontinuities are present, a conservative assessment is obtained.

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| Table 9: Rating Adjustment for Discontinuity Orientations | | | | | | | |
|--|-------------|---|----|-----|-----|-----|--|
| Very favorable Favorable Fair Unfavorable Very unfavorable | | | | | | | |
| RATINGS | Tunnels | 0 | -2 | -5 | -10 | -12 | |
| | Foundations | 0 | -2 | -7 | -15 | -25 | |
| | Slopes | 0 | -5 | -25 | -50 | -60 | |

Table 10: Rock Mass Classes Determined from Total Ratings

| Rating | 100 - 81 | 80 - 61 | 60-41 | 40 - 21 | < 20 |
|-------------|-----------|---------|-------|---------|-----------|
| Class No. | Ι | II | III | IV | V |
| Description | VERY GOOD | GOOD | FAIR | POOR | VERY POOR |

Table 10: Significance of Rock Mass Classes

| Class No. | Ι | II | III | IV | V |
|---------------------------------|---------------------------|--------------------------|------------------------|----------------------------|----------------------------|
| Average stand-up time | 10 years for 15 m span | 6 months for 8 m span | 1 week for 5 m span | 10 hours for 2.5 m span | 30 minutes for 1 m span |
| Cohesion of the rock mass | > 400 kPa | 300 - 400 kPa | 200 - 300 kPa | 100 - 200 kPa | < 100 kPa |
| Friction angle of the rock mass | $< 45^{\circ}$ | 35 - 45° | 25 - 35° | 15 - 25° | < 15° |

Table 11: RMR Classification Guide for Excavation and Support in Rock Tunnels

| D 1 | | Support | | | |
|--------------------|-------------------------------------|-----------------------|-------------------|---------------------|--|
| Rock mass class | Excavation | Rock bolts (20 mm | Shotcrete | Steel sets | |
| | | diam., fully bonded) | | | |
| 1. Very good rock | Full face: | Generally, no support | required except f | for occasional spot | |
| RMR: 81-100 | 3 m advance | bolting | | | |
| 2. Good rock | Full face: | Locally bolts in | 50 mm in | None | |
| RMR: 61-80 | 1.0-1.5 m advance; Complete support | crown, 3 m long, | crown | | |
| | 20 m from face | spaced 2.5 m with | where | | |
| | | occasional wire mesh | required | | |
| 3. Fair rock | Top heading and bench: 1.5-3 m | Systematic bolts 4 m | 50-100 mm in | None | |
| RMR: 41-60 | advance in top heading; | long, spaced 1.5-2 m | crown, | | |
| | Commence support after each blast; | in crown and walls | and 30 | | |
| | Commence support 10 m from face | with wire mesh in | mm in | | |
| | | crown | sides | | |
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| D 1 | | | Support | |
|-------------------|-----------------------------------|----------------------|------------|---------------------|
| Rock mass | Excavation | Rock bolts (20 mm | Shotcrete | Steel sets |
| class | | diam., fully bonded) | | |
| 4. Poor rock | Top heading and bench: 1.0-1.5 m | Systematic bolts 4-5 | 100-150 mm | Light ribs spaced |
| RMR: 21-40 | advance in top heading; | m long, spaced 1-1.5 | in | 1.5 m |
| | Install support concurrently with | m in crown and walls | crown and | where |
| | excavation - 10 m from face | with wire mesh | 100 mm in | required |
| | | | sides | |
| 5. Very poor rock | Multiple drifts: | Systematic bolts 5-6 | 150-200 mm | Medium to heavy |
| RMR < 21 | 0.5-1.5 m advance in top heading; | m long, spaced 1-1.5 | in | ribs spaced 0.75 |
| | Install support concurrently with | m in crown and walls | crown, 150 | m with steel |
| | excavation; shotcrete as soon as | with wire mesh. Bolt | mm in | lagging and fore |
| | possible after blasting | invert | sides, and | poling if required. |
| | | | 50 mm on | Close invert |
| | | | face | |

In applying this classification system, the rock mass is divided into a number of structural regions and each region is classified separately. The boundaries of the structural regions usually coincide with a major structural feature such as a fault or with a change in rock type. In some cases, significant changes in discontinuity spacing or characteristics, within the same rock type, may necessitate the division of the rock mass into a number of small structural regions or domains. The Rock Mass Rating system is presented in Table 12, giving the ratings for each of the six parameters listed above. These ratings are summed to give a value of RMR.

For detail table refer Annexure

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| BH | AVERAGE RMR | MAXIMUM RMR | MINIMUM RMR |
|------------|-------------|-------------|-------------|
| NO. | VALUE | VALUE | VALUE |
| BH-13 | 34.95 | 40 | 31 |
| BH-14 | 34.18 | 38 | 31 |
| BG-15 | 33.23404 | 40 | 24 |
| BH- 15A | 29.47059 | 43 | 27 |
| BH-16 | 37.61905 | 48 | 30 |
| BH-17 | 41.2 | 47 | 32 |

 Table 12 Average, Maximum, Minimum RMR of borehole (Follow Annexure -A for detailed information)

Based on the average RMR value of the rock mass it falls into "Poor" category

5.3 <u>The Unified Soil Classification System (USCS)</u> :

Though RMR classification provide great insight to classify the different types hard rocks of with reference to the tunnel designing, but it loses its reliability in classification soil or highly weathered rock. The main problem with using RMR for weak rock mass classification is that ratings are not sensitive to changes in rock quality designation (RQD) when RQD <25% and and fracture spacing is <2.4 inch (60 mm). For example, the RQD and fracture frequency ratings for sound rock with 24 % RQD and fracture spacing of 2.3 in. (59 mm) would receive the same Bin-RMR89 ratings as clay, 3 and 5, respectively. Hence classification of soil is provided using The Unified Soil Classification System (USCS) [ASTM (2011, 2009) D2487 and D2488].

The USCS provides good insight into behavior of material especially in the presence of water; however, it gives no indication of the relative strength of the material. In addition to USCS soil classification, civil-geotechnical engineering investigations usually include

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relative density or consistency estimates which are considered in the design process. (Parker 1996). However, in contrast to RMR system, USCS system uses letters to classify soil like material for general engineering purposes.



Figure 23: USCS Classification of coarse-grained soil.

| (50% cr.mo | FINE- re of mater | GRAINED SOILS ial is smaller than No. 200 sieve size.) |
|---|----------------------|---|
| SILTS | ML | Inorganic silts and very fine sands, rock flour, sitty of dayey fine sands or clayey sitts with slight plasticity |
| AND CLAYS Liquid Imit less than 50% | CL | Inorganic clays of low to medium plasticity, gravally clays, sandy clays, sity clays, lean clays |
| | A DL | Organic sits and organic sity days of low plasticity |
| SILTS | мн | Inorganic sits, micaceous or diatomeceous fine sandy or sitty soils, elastic sitts |
| CLAYS Liquid limit | CH | Inerganic clays of high plasticity, fat clays |
| or greater | он | Organic clays of medium to high plasticity, organic sits |
| HIGHLY ORGANIC SOILS | 한 11 PT 11 | Peat and other highly organic sols |

Figure 24: USCS Classification of fine-grained soil

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Soils are broadly classified into three divisions:

- i. **Coarse grained soils:** 50% or more of the total material by weight is larger than 75 micron IS sieve size.
- ii. Fine grained soils: 50% or more of the total material by weight is smaller than 75 micron IS sieve size.
- ii. **Highly organic soils and other miscellaneous soil materials:** These soils contain large percentage of fibrous organic matter, such as peat, and the particles of decomposed vegetation. In addition, certain soils containing shells, cinders and other non-soil materials in sufficient quantities are also grouped in this division.

5.3.1 Coarse grained Soils

Coarse grained soils are further divided into two sub-divisions:

- a) **Gravels** (**G**): In these soils more than 50% of the coarse fraction (+75 micron) is larger than 4.75 mm sieve size. This sub-division includes gravels and gravelly soil, and is designated by symbol G.
- b) Sands (S): In these soils, more than 50% of the coarse fraction is smaller than 4.75mm IS sieve size. This sub-division includes sands and sandy soils.

Each of the above sub-divisions are further divided into four groups depending upon grading and inclusion of other materials.

- 1. W: Well Graded
- 2. C : Clay binder
- 3. P : Poorly graded
- 4. M : Containing fine materials not covered in other groups.

These symbols used in combination to designate the type of grained soils.

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Example, GC: Clayey Gravels.

5.3.2 Fine grained soils

Fine grained soils are further divided into three sub-divisions:

- a) Inorganic silts and very fine sands: M
- b) Inorganic clays: C
- c) Organic silts and clays and organic matter: O.

The fine-grained soils are further divided into the following groups on the basis of the following arbitrarily selected values of liquid limit which is a good index of compressibility:

i) Silts and clays of low compressibility:

Having a liquid limit less than 35 and represented by symbol L.

ii) Silts and clays of medium compressibility:

Having a liquid limit greater than 35 and less than 50 and represented by symbol I.

iii) Silts and clays of high compressibility:

Having a liquid limit greater than 50 and represented by a symbol H.

Combination of these symbols indicates the type of fine-grained soil. For example, ML means inorganic silt with low to medium compressibility.

5.4 USCS & RMR Correlation:

In spite of being an advantageous classification system, USCS also have some disadvantages due to its descriptive format of classification using letters. Any numerical and statistical analysis of materials classified in USCS using spreadsheets are really





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difficult. Warren (2016) gives a numerical correlation between USCS and RMR which have been used to calculate equivalent RMR of soil in this report. Equivalent RMR is determined only by taking USCS Classification and ground water conditions of the soil material.

| BH | | Maximum Eq-RMR | Minimum Eq-RMR |
|-------|----------------------|----------------|----------------|
| NO. | Average Eq-RMR value | value | value |
| BH-18 | 16.5 | 20 | 15 |
| BH-19 | 16.75 | 20 | 15 |
| BH-20 | 15.26 | 20 | 15 |
| BH-21 | 15.6 | 20 | 15 |
| BH-22 | 15.64 | 20 | 15 |
| BH-23 | 15.789 | 20 | 15 |
| BH-24 | 15 | 15 | 15 |
| BH-25 | 15 | 15 | 15 |
| BH-26 | 15 | 15 | 15 |
| BH-27 | 15 | 15 | 15 |
| BH-28 | 15.34 | 20 | 15 |
| BH-29 | 15 | 15 | 15 |
| BH-30 | 15 | 15 | 15 |
| BH-31 | 15.34 | 20 | 15 |
| BH-32 | 15 | 15 | 15 |
| BH-33 | 15 | 15 | 15 |

Table 11: Avg., Maximum, minimum of Eq-RMR for soil.

Figure 26 Graph showing correlation between USCS classification and RMR Classification. (Warren, 2016)

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For other detailed soil properties like S.P.T N Value, Atterberg's Limit, Field Moisture Content, Natural density, Dry density, Cohesion, Angle of shearing resistance, Specific gravity, Void ratio along with results of Hydrometer Analysis, Grain size analysis, Triaxial test, Consolidation test please refer ANNEXURE –G.

5.5 <u>Q System (NGI Tunneling Index):</u>

The Q-system is developed to classify rock masses around an underground opening, as well as for field mapping. Based on estimation of six rock mass parameters, a Q-value for a rock mass can be calculated. This value gives a description of the rock mass quality. The Q-value depends on the underground opening and its geometry, and is therefore not an independent characterization of the rock mass. The Q-value in an undisturbed rock mass may be different.

The different Q-values are related to different types of permanent support by means of a schematic support chart. This means that by calculating the Q-value it is possible to find the type and quantity of support that has been applied previously in rock masses of the similar qualities. The Q-system can therefore be used as a guideline in rock support design decisions and for documentation of rock mass quality.

The Q-system was developed at NGI between 1971 and `74 (Barton et al. 1974). Since the introduction of the Q-system in 1974 there has been a considerable development within support philosophy and technology in underground excavations. Several new types of rock bolts have been introduced, and the continuous development of fibre reinforced technology has in many ways changed the support procedure. Application of sprayed concrete has gained acceptance even for good quality rocks masses due to demands for a higher level of safety during the recent years. Reinforced ribs of sprayed concrete have replaced cast concrete structures to a large extent.

Since the introduction of the system in 1974, two revisions of the support chart have been carried out and published in conference proceedings. An extensive updating in 1993 was based on 1050 examples mainly from Norwegian underground excavations (Grimstad and Barton, 1993). In 2002, an updating was made based on more than 900 new examples from

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underground excavations in Norway, Switzerland and India. This update also included analytical research with respect to the thickness, spacing and reinforcement of reinforced ribs of sprayed concrete (RRS) as a function of the load and the rock mass quality (Grimstad et al. 2002).

Calculation of Q value:

Q index value can be calculated from RMR using different empirical equation proposed by different author (Bieniawski;1984, Rutledge and Preston;1978, Moreno Tallon; 1980, Cameron-Clarke and Budavari;1981, Abad J et all;1987). These equations provide rapid determination of Q index from RMR index of corresponding rock. In reference with these equations, Q index shares logarithmic relation with RMR index value

"RMR = a . LnQ + b"

The value of 'a' and 'b' are different for different equation purposed by different author and they vary over a range of value.





"*RMR* = 9 *LnQ* + 44" Bieniawski;1984

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"RMR = 5.9 LnQ + 43" Rutledge and Preston;1978

"*RMR* = 5.4 *LnQ* + 55.2" Moreno Tallon; 1980

"RMR = 10.5 LnQ + 41" Cameron-Clarke and Budavari;1981

"RMR = 5 LnQ + 60.8" Abad J et all;1987

All of these equations tend to give similar result for conversion between Q and RMR for a median value of respective indexes, but at extreme end of the values of indexes, the conversion by these empirical equations is not reliable due to variation.

The true Q-value at the level of underground excavation can only be observed in the excavation itself, and Q-values obtained by above methods will be more uncertain. The number of joint sets may be underestimated from drill cores and estimations of the parameters Jw and SRF may be cumbersome without actual observations on site. From surface mapping it may be uncertain as joint filling may be washed out at the surface, and other joint parameters may be difficult to observe. In such cases it may be an advantage to use histograms to visualize variations in the data by using maximum and minimum values for

| LnQ | Classification |
|----------|--------------------|
| 0-0.01 | Exceptionally Poor |
| 0.01-0.1 | Extremely Poor |
| 0.1-1 | Very Poor |
| 1-7 | Poor |
| 7-10 | Fair |
| 10-70 | Good |
| 70-100 | Very Good |
| 100-700 | Extremely Good |
| 700-1000 | Exceptionally Good |

Table 12: Rock Mass classification based on their Q Value on logarithm scale (after Bieniawski,1976) each parameter.

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Absolute value of Q index is determined based on a numerical assessment of the rock mass quality using six different parameters;

1. RQD.

2. Number of joint sets.

- 3. Roughness of the most unfavorable joint or discontinuity.
- 4. Degree of alteration or filling along the weakest joint.
- 5. Water inflow.
- 6. Stress condition.

These six parameters are grouped into three quotients to give the overall rock mass quality Q as follows:

$$Q = \frac{RQD}{j_n} \times \frac{j_r}{j_a} \times \frac{j_w}{SRF}$$

Where:
$$RQD = Rock Quality Designation$$
$$j_n = Joint set number$$
$$j_r = Joint roughness number$$
$$j_a = Joint alteration number$$

 RQD/J_n = Degree of jointing (or block size)

 J_r/J_a =Joint Friction (inter block shear

strength)

J_w/SRF=Active Stress

The rock quality can range from Q = 0.001 to Q = 1000 on a logarithmic rock mass quality scale. The above equation gives absolute value of Q index for a rock mass by taking abovesaid 6 parameters in account.

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Table 13: Description & Rating for Jn

| | 2. Joint Set Number (J _n) | | | |
|-----|---|---------|--|--|
| A | Massive, no or few joints | 0.5-1.0 | | |
| В | One joint set | 2 | | |
| С | One joint set plus random joint | 3 | | |
| D | Two joint sets | 4 | | |
| E | Two joint sets plus random joints | 6 | | |
| F | Three joint sets | 9 | | |
| G | Three joint sets plus random joints | 12 | | |
| Н | Four or more joint sets, random heavily jointed "sugar cube", etc | 15 | | |
| J | Crushed rock, earth like | 20 | | |
| Not | Note: i) For tunnel intersections, use 3 x Jn | | | |
| | ii) For portals, use 2 x Jn | | | |

Table 14 Description & Rating for $J_{\rm r}$

| 3. Joint Roughness Number (J _r) | | |
|---|---|-----|
| Rock-wall | contact, and Rock-wall contact before 10 cm of shear movement | |
| A | Discontinuous joints | 4 |
| В | Rough or irregular, undulating | 3 |
| C | Smooth, undulating | 2 |
| D | Slickensided, undulating | 1.5 |
| E | Rough, irregular, planar | 1.5 |

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| F | Smooth, planar | | 1 | |
|---------------|--|------------|--------|--|
| G | Slickensided, planar | | 0.5 | |
| Note: i) De | Note: i) Description refers to small scale features and intermediate scale features, in that order | | | |
| No rock-w | all contact when sheared | | | |
| Н | Zone containing clay minerals thick enough to prevent rock- | | 1 | |
| | wall contact when sheared | | | |
| Note: ii) A | dd 1 if the mean spacing of the relevant joint set is greater than 3 m (dep | pendent o | on the | |
| size of the | underground opening) | | | |
| iii) Jr = 0.5 | 5 can be used for planar slickensided joints having lineation, provided th | e lineatio | on are | |
| oriented in | the estimated sliding direction | | | |
| | Table 15 Description & Rating for Ja | | | |
| | Joint Alteration Number J _a | Ra | nting | |
| a) Rock-w | vall contact (no mineral fillings, only coatings) | | | |
| A | Tightly healed, hard, non-softening, impermeable filling, | 0 | .75 | |
| | i.e., quartz or epidote. | | | |
| В | Unaltered joint walls, surface staining only. | | 1 | |
| C | Slightly altered joint walls. Non-softening mineral | | 2 | |
| | coatings; sandy particles, clay-free disintegrated rock, etc. | | | |
| D | Silty or sandy clay coatings, small clay fraction (non- | | 3 | |
| | softening). | | | |
| | Softening or low friction clay mineral coatings, i.e., kaolinite | | | |
| Е | or mica. | | 4 | |
| | Also chlorite, talc gypsum, graphite, etc., and small quantities | | | |
| | of swelling clays. | | | |
| b) Rock-v | vall contact before 10 cm shear (thin mineral fillings) | | | |
| | | | | |

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| | Rating | |
|-----------|--|------|
| F | Sandy particles, clay-free disintegrated rock, etc. | 4 |
| G | Strongly over-consolidated, non-softening, clay mineral fillings | 6 |
| | (continuous, but <5 mm thickness). | |
| Н | Medium or low over-consolidation, softening, clay mineral | 8 |
| | fillings (continuous, but <5 mm thickness). | |
| | Swelling-clay fillings, i.e., montmorillonite (continuous, but | |
| J | <5 mm thickness). Value of Ja depends on percent of swelling | 8-12 |
| | clay-size particles. | |
| c) No roc | ek-wall contact when sheared (thick mineral fillings) | |
| K | Zones or bands of disintegrated or crushed rock. Strongly over- | 6 |
| | consolidated. | |
| L | Zones or bands of clay, disintegrated or crushed rock. | 8 |
| | Medium or low over-consolidation or softening fillings. | |
| | Zones or bands of clay, disintegrated or crushed rock. | |
| М | Swelling clay. Ja depends on percent of swelling clay-size | 8-12 |
| | particles. | |
| N | Thick continuous zones or bands of clay. Strongly over- | 10 |
| | consolidated. | |
| 0 | Thick, continuous zones or bands of clay. Medium to low over- | 13 |
| | consolidation. | |
| | Table 16 Description & Rating for J. | |

| | Joint Water Reduction Factor J_w | Rating |
|---|--|--------|
| А | Dry excavations or minor inflow (humid or a few drips) | 1.0 |

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| В | Medium inflow, occasional out wash of joint fillings (many drips/"rain") | |
|-------|--|-----------|
| | | 0.66 |
| С | Jet inflow or high pressure in competent rock with unfilled joints | 0.5 |
| D | Large inflow or high pressure, considerable out wash of joint fillings | 0.33 |
| E | Exceptionally high inflow or water pressure decaying with time. Causes out wash of | |
| | material and perhaps cave in. | 0.2-0.1 |
| F | Exceptionally high inflow or water pressure continuing without noticeable decay. | |
| | Causes out wash of material and perhaps cave in. | 0.1- |
| | | 0.05 |
| Note: | i) Factors C to F are crude estimates. Increase Jw if the rock is drained or grouting is car | rried out |

ii) Special problems caused by ice formation are not considered

Table 17 Description & Rating for Stress Reducing Factor (SRF)

| | Stress Reduction Factor | SRF |
|-------|---|------------------------|
| a) We | ak zones intersecting the underground opening, which may cause loosenin | g of rock mass |
| | Multiple occurrences of weak zones within a short section containing clay or chemically disintegrated, very loose surrounding rock (any | |
| A | depth), or long sections within competent (weak) rock (any depth). For Squeezing conditions, | 10 |
| В | Multiple shear zones within a short section in competent clay-free rock with loose surrounding rock (any depth) | 7.5 |
| С | Single weak zones with or without clay or chemical disintegrated rock $(depth \le 50m)$ | 5 |
| D | Loose, open joints, heavily jointed or "sugar cube", etc. (any depth) | 5 |
| E | Single weak zones with or without clay or chemical disintegrated rock (depth > 50m) | 2.5 |
| Note: | i) Reduce these values of SRF by 25-50% if the weak zones only influence | e but do not intersect |

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| the un | derground opening. | | | | |
|--------------------------|--|---|---------------------|-------------------|--|
| b) Coi | npetent, mainly massive rock, stress problems | σ_c/σ_1 | σ_c/σ_2 | SRF | |
| F | Low stress, near surface, open joints | <0.01 | 2.5 | | |
| G | Medium stress, favourable stress condition | 200-10 | 0.01-0.3 | 1 | |
| | High stress, very tight structure. Usually favourable | + | | | |
| | to stability. | | | 0.5-2 | |
| Н | May also be unfavorable to stability dependent on | 10-5 | 0.3-0.4 | 2-5* | |
| | the orientation of stresses compared to | | | | |
| | jointing / weakness planes* | | | | |
| J | Moderate spalling and/or slabbing after > 1 hour in | 5-3 | 0.5-0.65 | 5-50 | |
| | massive rock | | | | |
| K | Spalling or rock burst after a few minutes in | 3-2 | 0.65-1 | 50-200 | |
| | massive rock | | | | |
| L | Heavy rock burst and immediate | <2 | >1 | 200-400 | |
| | dynamic deformation in massive rock | | | | |
| Note: | For strongly anisotropic virgin stress field (if measure | ed): when $5 \leq \sigma 1 / \sigma 3 < \sigma 1 / \sigma 1 < \sigma $ | ≤ 10 , reduce | e σc to | |
| 0.75 o | ic. When $\sigma 1 / \sigma 3 > 10$, reduce σc to 0.5 σ_c , where $\sigma_c =$ | unconfined compress | sion strengt | h, $\sigma 1$ and | |
| σ3 are | the major and minor principal stresses, and $\sigma 1\sigma 2=m$ | aximum tangential st | tress (estima | ated from | |
| elastic | theory) | | | | |
| When | the depth of the crown below the surface is less than | the span; suggest SR | F increase f | from 2.5 to | |
| 5 for such cases (see F) | | | | | |
| c) Squ | σc | | | | |
| influe | nce of high pressure | | | SRF | |
| М | Mild squeezing rock pressure | | 1-5 | 5-10 | |
| N | Heavy squeezing rock pressure | | >5 | 10-20 | |
| Note: | iv) Determination of squeezing rock conditions must | be made according to | o relevant li | terature | |

(i.e., Singh et al., 1992 and Bhasin and Grimstad, 1996)

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| d) Swe | lling rock: chemical swelling activity depending on the presence of | SRF |
|--------|---|-------|
| water | | |
| 0 | Mild swelling rock pressure | 5-10 |
| Р | Heavy swelling rock pressure | 10-15 |

The individual parameters are determined during geological mapping using tables that give numerical values to be assigned to a described situation. Paired, the six parameters express the three main factors which describe the stability in underground openings

The Q values for the samples are given in table below. For detail table refer Annexure.

| BH NO. | AVERAGE Q VALUE | MAXIMUM Q VALUE | MINIMUM Q VALUE |
|--------|-----------------|-----------------|-----------------|
| BH-13 | 4.54 | 6.69 | 1.5 |
| BH-14 | 1.74 | 3.6 | 1.5 |
| BG-15 | 1.7 | 4.05 | 1.5 |
| BH- | | | |
| 15A | 2.17 | 4.8 | 1.5 |
| BH-16 | 2.7 | 7.69 | 1.5 |
| BH-17 | 0.2 | 0.83 | 0.2 |

Table 18 Average, Maximum, and Minimum Q-Value from Borehole (Follow annexure A for detailed information)

Based on the average Q value of the rock mass it falls into "Very Poor" to "Poor" category

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6 CHAPTER: Engineering properties of the rock / soil

6.1 Laboratory Testing of Rock Mass

Laboratory tests were also carried out on rock samples, the details of different laboratory tests conducted as part of the project are given in the table below

| | 1. Unconfined Compressive Strength, |
|-------------------------------------|-------------------------------------|
| | 2. Point Load Index Test |
| | 3. Tensile Strength |
| | 4. Specific Gravity |
| Laboratory tasts conducted for reak | 5. Modulus of elasticity |
| Laboratory tests conducted for fock | 6. Water absorption |
| | 7. Poisons' ratio |
| | 8. Triaxial Test |
| | 9. Hardness test |
| | 10. Abrasive test |

| Table 19: | The la | boratory | tests | conducted | for rock. |
|------------|----------|------------|-------|-----------|-----------|
| I HOIC I/. | I IIC IU | ioor acory | COUD | conducted | IOI IOCIM |

6.1.1 Selection of Core Sample

Representative core samples (NX and NQ size) are collected for covering the crown and invert section and other portions above the crown. The samples were properly labelled and packed carefully and sent NABL accredited Bhubaneswar laboratory for determining the physico-mechanical properties.

The physico-mechanical properties like unit weight, water absorption, porosity, specific gravity, point load index, uniaxial compressive strength (UCS), tri-axial compressive strength, tensile strength (TS), modulus of elasticity, Poisson's ratio is determined. Simultaneously, the specific heat, thermal diffusivity, thermal conductivity, hydraulic conductivity and petrography tests are also conducted on the rock samples representing to the tunnel influence zone. The following laboratory tests have been conducted to determine intact rock properties.

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6.1.2 <u>Tensile Strength</u>

Brazilian test is intended to measure the tensile strength of a rock sample in the form of specimens of regular geometry. The test is mainly intended for strength classification and characterization of intact rock. The test specimens are right circular cylinders having a length to diameter (L: D) ratio approximately equal to 0.5 and a diameter shall not be less than 45 mm. This method of determining tensile strength is an indirect method, and is popularly known as Brazilian method. The indirect tensile strength is calculated as follows:

$$\sigma_t = \frac{2P}{\pi Dt}$$

Where:

 σ_t = Brazilian tensile strength (MPa); D = Diameter of the core sample (mm);

P = Maximum failure load (N); t = Thickness or Length of the sample (mm)

Figure 28 and Table 20 below provides a summary of Tensile strength for the all the core samples from different boreholes.



Figure 28: Tensile Strength of rock mass from entire borehole length vs RL. (Refer to Annexure B in Geotechnical Report for detail).

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| Table 20: Result of Tensile strength (Follow annexure B for detailed information) | | | | |
|---|---|---|---|--|
| BH NO. | Minimum tensile strength value (MPa) | Maximum tensile strength value (MPa) | Average tensile strength value (MPa) | |
| BH-13 | 13.34 | 22.99 | 17.10 | |
| BH-14 | 14.78 | 24.93 | 18.44 | |
| BG-15 | 14.66 | 19.2 | 16.51 | |
| BH-15A | 14.91 | 18.78 | 16.70 | |
| BH-16 | 15.39 | 27.77 | 21.67 | |
| BH-17 | 8.77 | 26.58 | 18.03 | |

6.1.3 <u>Unconfined Compressive Strength</u>

UCS test is intended to determine the unconfined compressive strength of a rock sample in the form of specimens of regular geometry. The length to diameter ratio of cylindrical specimen shall preferably be 2 to 3. If the ratio is less than 2, usual correction shall be applied taking standard slenderness ratio as 2. Load on the specimen shall be applied continuously at a constant stress rate such that failure will take place in about 5 to 15 minutes of loading. Alternatively, the stress rate shall be within the limits of 0.5 MPa/s to 1 MPa/s. The unconfined compressive strength of the specimen has been calculated by dividing the maximum load carried by the specimen during the test, by the average original cross-sectional area.

Figure 29 and Table 21 below provides a summary of UCS values for the all the samples. For detail table refer Annexure.

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Figure 29: Unconfined Compressive Strength (UCS) of rock mass from entire borehole length vs RL (Refer to Annexure C in Geotechnical Report for detail).

| BH NO. | Minimum UCS value (MPa) | Maximum UCS value (MPa) | Average UCS value (MPa) |
|--------|----------------------------|----------------------------|----------------------------|
| BH-13 | 41.06 | 70.33 | 63.49 |
| BH-14 | 45.15 | 69.54 | 56.49 |
| BG-15 | 61.45 | 70.44 | 67.05 |
| BH-15A | 60.42 | 69.38 | 65.12 |
| BH-16 | 44.8 | 70.8 | 64.16 |
| BH-17 | 61.24 | 70.85 | 67.76 |

| Table 21 | : Result | of UCS Tes | t (Follow | annexure C for | r detailed | information) |
|----------|----------|-------------|--------------|----------------|------------|--------------|
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6.1.4 Density, Specific Gravity, Water Absorption

These tests are performed as per relevant standard. The Bulk volume is obtained by buoyancy technique and the pore volume is obtained by water saturation. It may also be applied to a sample in the form of specimen of irregular geometry.

Based on the tests conducted, the unit weight has been calculated

Specific gravity has been estimated for core samples picked up from different borehole. The true specific gravity has been expressed as a numerical value and shall be based on average of three determinations.

The table below provides set of values calculated for Density, specific gravity, water absorption. For detail table refer Annexure.

| BH NO. | Minimum Density value (kN/m ³) | Maximum Density value (kN/m ³) | Average Density value (kN/m ³) |
|--------|---|---|---|
| BH-13 | 24.31 | 25.73 | 25.31 |
| BH-14 | 25.67 | 26.09 | 25.88 |
| BG-15 | 25.07 | 25.74 | 25.43 |
| BH-15A | 24.81 | 25.69 | 25.30 |
| BH-16 | 25.3 | 26.52 | 25.97 |
| BH-17 | 24.23 | 26.21 | 25.42 |

 Table 22: Result of Density, Specific Gravity, Water absorption (Follow annexure D for detailed information).

Table 23: Result of Specific Gravity (Follow annexure D for detailed information).

| BH NO. | Minimum Specific gravity value | Maximum Specific gravity value | Average Specific gravity value |
|--------|-----------------------------------|-----------------------------------|-----------------------------------|
| BH-13 | 2.47 | 2.61 | 2.57 |
| BH-14 | 2.61 | 2.65 | 2.63 |

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| BH NO. | Minimum Specific gravity value | Maximum Specific gravity value | Average Specific gravity value |
|--------|-----------------------------------|-----------------------------------|-----------------------------------|
| BG-15 | 2.54 | 2.61 | 2.58 |
| BH-15A | 2.52 | 2.60 | 2.57 |
| BH-16 | 2.56 | 2.69 | 2.64 |
| BH-17 | 2.45 | 2.67 | 2.58 |

Table 24: Result of Water absorption (Follow annexure D for detailed information).

| BH NO. | Minimum Water absorption value % | Maximum Water absorption value % | Average Water absorption value % |
|--------|-------------------------------------|-------------------------------------|-------------------------------------|
| BH-13 | 0.14 | 0.51 | 0.39 |
| BH-14 | 0.15 | 0.57 | 0.32 |
| BG-15 | 0.46 | 0.63 | 0.52 |
| BH-15A | 0.16 | 0.75 | 0.47 |
| BH-16 | 0.25 | 0.70 | 0.50 |
| BH-17 | 0 | 1.18 | 0.56 |

6.1.5 Point Load Strength Index

Point Load test is intended to determine the diametrical and axial point load strength index of rock core. The core specimens with length to diameter ratio of 0.3 to 1 are suitable for axial testing. The point load strength index shall be calculated from the following formula:

$$I_l(50) = \frac{P}{(Dd)^{0.75} \times \sqrt{D_{50}}}$$

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Where: $I_1(50) = Point Load strength Index (MPa); D = Distance between the platen (mm);$

P = Maximum failure load (N); d = Diameter of test specimen (mm);

 $D_{50} =$ Standard core diameter (mm)

Figure 30 and table below provides point load index value, for detail table refer Annexure.



Figure 30: Point Load Index (PLI) of rock mass from entire borehole length vs RL. (Refer to Annexure E in Geotechnical Report for detail).

Table 25: Result of point load index test (Follow annexure E for detailed information).

| BH NO. | Minimum Point load index value (MPa) | Maximum Point load index value (MPa) | Average Point load index value (MPa) |
|--------|---|---|---|
| BH-13 | 1.01 | 3.20 | 2.18 |
| BH-14 | 2.27 | 3.62 | 2.99 |
| BG-15 | 2.53 | 3.85 | 3.37 |
| BH-15A | 2.86 | 3.40 | 3.14 |
| BH-16 | 2.06 | 3.84 | 3.07 |

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| BH NO. | Minimum Point load | Maximum Point load | Average Point load index |
|--------|--------------------|--------------------|--------------------------|
| | index value (MPa) | index value (MPa) | value (MPa) |
| BH-17 | 2.82 | 3.02 | 2.93 |

6.1.6 Modulus of Elasticity and Poisson's Ratio

This test is intended to determine the Modulus of Elasticity & Poisson's Ratio of cylindrical rock specimen in compression. Circumferential and axial deformations or strains may be determined from data obtained by electrical resistance strain gauges, compress meters, optical devices or other suitable means. The design of the measuring device shall be such that the average of at least two circumferential and two axial strain measurements can be determined for each increment of load. Measuring positions shall be equally spaced around the circumference of the specimens close to the mid height. They should not fall within D/2 of the specimen ends, where D is the diameter.

6.1.6.1 <u>Calculation</u>

The axial strain (Ea) and the diametric strain (Ed) may be recorded directly from strain indicating equipment or may be calculated from the measured deformation depending upon the type of apparatus or instrument used.

The axial (Ea) and diametric (Ed) strains shall be calculated as follows:

$$\varepsilon a = \Delta I/I$$
$$\varepsilon d = \Delta d/d$$

Where l = original axial length before deformation,

d = original diameter before the deformation,

 Δl = change in measured axial length (positive for a decrease in length), and

 Δd = change in diameter (positive for an in increase in diameter).

*NOTE - It may be noted that circumferentially applied electrical resistance strain gauges also reflect diametric strain, the value necessary for computing Poisson's ratio.

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Since,

 $C = \pi d$ $\Delta c = \pi \Delta d$

The circumferential and diametric strains are related as follows:

 $\varepsilon c = \Delta c/c$ $= \pi \Delta d/\pi d$ $= \Delta d/d$ $= \varepsilon d$

Where, c and d are circumference and diameter of the specimen respectively. The compressive stress in the test specimen σ shall be calculated from compressive load P and the θ initially computed cross-sectional area A, as follows:

$$\sigma = \frac{P}{A}$$

The stress versus axial and lateral strain shall be plotted as a curve.

Figure 31 and table below shows Modulus of Elasticity values for all samples from boreholes.

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Figure 31: Modulus of Elasticity (E) of rock mass from entire borehole length vs RL. (Refer to Annexure F in Geotechnical Report for detail).

| BH NO. | Minimum Modulus of elasticity value (GPa) | Maximum Modulus of elasticity value (GPa) | Average Modulus of elasticity value (GPa) |
|--------|--|--|--|
| BH-13 | 31.4 | 53.6 | 43.9 |
| BH-14 | 33.7 | 53.0 | 42.8 |
| BG-15 | 41.2 | 52.4 | 47.5 |
| BH-15A | 42.9 | 50.1 | 46.7 |
| BH-16 | 39.7 | 55.5 | 48.4 |
| BH-17 | 41.6 | 49.3 | 44.9 |

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Poisson's Ratio (v) -

Poisson's ratio shall be calculated as the ratio of the total diametric strain εd to the total axial strain εa at any given stress level.

NOTE - When the terms 'Modulus' and 'Poisson's Ratio' are used without any qualification, they shall be taken to mean as the tangent modulus and the Poisson's ratio at 50percent of the ultimate stress.

Based on the tests conducted on core samples, the average Poisson's Ratio and Modulus of Elasticity has been estimated to be 0.13 and 45.89 GPa. Figure 32 and table below shows Poisson's ratio values for all samples, for detail table refer Annexure





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| | Table 27: Poisson's ratio (Follow annexure E for detailed information). | | | | | |
|--------|---|----------------------------------|----------------------------------|--|--|--|
| BH NO. | Minimum Poisson's ratio value | Maximum Poisson's ratio value | Average Poisson's ratio value | | | |
| BH-13 | 0.10 | 0.17 | 0.14 | | | |
| BH-14 | 0.11 | 0.16 | 0.14 | | | |
| BG-15 | 0.12 | 0.15 | 0.14 | | | |
| BH-15A | 0.09 | 0.13 | 0.11 | | | |
| BH-16 | 0.10 | 0.14 | 0.12 | | | |
| BH-17 | 0.08 | 0.13 | 0.11 | | | |

6.1.7 Triaxial Test

Triaxial test is intended to determine the Cohesion and angle of internal friction of a rock sample in the form of specimens of regular geometry. The length to diameter ratio of cylindrical specimen shall preferably be 2 to 3. Load on the specimen shall be applied continuously at a constant stress rate such that failure will take place in about 5 to 15 minutes of loading. Alternatively, the stress rate shall be within the limits of 0.5 MPa/s to 1 MPa/s.

6.1.7.1 Calculation

Using Parameter m and b, the angle of internal friction \emptyset and a value for the apparent cohesion C may be calculated using following formula.

$$\emptyset = \sin^{-1} \frac{m-1}{m+1}$$
$$C = b \times \frac{1 - \sin \emptyset}{2 \cos \emptyset}$$

Figure 33 and Table 28 below provides a summary of Triaxial Cohesion values for the all the samples. Figure 34 and Table 29 below provides a summary of phi values.

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Figure 33: Cohesive strength of rock mass from entire borehole length vs RL (Refer to Annexure F in Geotechnical Report for detail).

| PH NO | Minimum C value | Maximum C value | Average C value |
|--------------|-----------------|-----------------|-----------------|
| BH NO. | (MPa) | (MPa) | (MPa) |
| BH-13 | 15.13 | 20.88 | 17.97 |
| BH-14 | 17.66 | 24.39 | 20.19 |
| BH-15 | 13.78 | 13.78 | 13.78 |
| BH-15A | 15.71 | 16.54 | 16.13 |
| BH-16 | 14.50 | 14.75 | 14.63 |
| BH-17 | 13.58 | 19.44 | 17.30 |

 Table 28: Result of Cohesive Strength test (Follow annexure F for detailed information)

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Figure 34: Angle of internal friction of rock mass from entire borehole length vs RL (Refer to Annexure G in Geotechnical Report for detail).

Table 29: Result of angle of internal friction (Ø) Test (Follow annexure F for detailed information)

| BH NO. | Minimum Ø value in degree | Maximum Ø value in degree | Average Ø value in degree |
|--------|------------------------------|------------------------------|------------------------------|
| BH-13 | 60.02 | 65.23 | 62.75 |
| BH-14 | 56.48 | 62.80 | 60.45 |
| BH-15 | 66.39 | 66.39 | 66.39 |
| BH-15A | 64.08 | 64.67 | 64.38 |
| BH-16 | 65.63 | 65.63 | 65.63 |
| BH-17 | 66.36 | 69.96 | 67.69 |

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6.1.8 <u>Hardness Test</u>

Hardness test is intended to determine the hardness number of a rock sample. The length of the sample should be at least 60 mm. Test locations shall be separated by at least twice the diameter of the plunger.

6.1.8.1 <u>Calculation</u>

The correction factor is calculated as: Correction factor=

Specified standard value of the anvil Average of 10 reading on calibration anvil

The measured test values for the sample should be tabulated in descending order. The lower 50 percent of the values should be discarded and the average obtained of the upper 50 percent values. This average shall be multiplied by the correction factor

Figure 35 and Table 30 below provides a summary of Triaxial Cohesion values for the all the samples.



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| Та | Table 30: Result of Hardness Test (Follow Annexure G for detailed information). | | | | |
|--------|---|--------------------------------------|--------------------------------------|--|--|
| BH NO. | Minimum Hardness value in Numbers | Maximum Hardness value in Numbers | Average Hardness value in Numbers | | |
| BH-13 | 53.1 | 66.5 | 60.9 | | |
| BH-14 | 56.2 | 63.6 | 59.7 | | |
| BH-15 | 53.4 | 61.7 | 58.9 | | |
| BH-15A | 56.1 | 62.2 | 59.9 | | |
| BH-16 | 54.8 | 61.7 | 59.8 | | |
| BH-17 | 22.1 | 50.6 | 32.6 | | |

6.1.9 Abrasiveness Test

Abrasiveness test is intended to determine the wear or loss of material which the rock produces on contact with another material.

6.1.9.1 Calculation

Abrasiveness is calculated by following formula

CAI or CAIs=
$$\frac{1}{10 \in} \sum_{i=1}^{10} di$$

CAI or CAIs = Cerchar index for natural or saw cut surface respectively and d_i is diameter of the abraded flat area measured in units of 0.1 mm.

If Saw cut specimen is tested, then calculated CAIs of Eq. 1 it is advised to be normalized using Eq.2

CAI= 0.99 CAIs + 0.48

CAI = Cerchar index for natural surface; CAIs= Cerchar index for smooth surface

Table 31 and Figure 36below provides a summary of Triaxial Cohesion values for the all the samples

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Figure 36: Abrasiveness of rock mass from entire borehole length vs RL. (Refer to Annexure I in Geotechnical Report for detail).

| BH NO. | Minimum Abrasiveness | Maximum Minimum Abrasiveness | Average Minimum Abrasiveness | Classification (HRC=55) |
|--------|-------------------------|------------------------------------|---------------------------------|----------------------------|
| BH-13 | 2.62 | 3.37 | 2.88 | High Abrasiveness |
| BH-14 | 2.33 | 2.76 | 2.55 | High Abrasiveness |
| BH-15 | 2.88 | 3.43 | 3.15 | High Abrasiveness |
| BH-15A | 2.92 | 3.39 | 3.15 | High Abrasiveness |
| BH-16 | 2.94 | 3.31 | 3.17 | High Abrasiveness |
| BH-17 | 1.91 | 2.58 | 2.21 | High Abrasiveness |

Table 31: Result of Abrasiveness test (Follow annexure G for detailed information)

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6.1.10 Petrography Test

This test is performed to study the mineralogical, textural and micro-structural property of rock. The rock samples are cut up to 30-micron size and their optical properties are observed.

In the present test Grain size analysis is done to study the textural property of rock and the relative abundance of minerals are calculated to study the chemical and mineralogical property of the rock.

In order to get a holistic view, the samples are collected from different depth from each borehole as follows:

| BH ID | DEPTH |
|-------|-------|
| | 6 |
| | 10.5 |
| | 18 |
| | 24 |
| BH13 | 31.5 |
| | 39 |
| | 46.5 |
| | 52.5 |
| - | 55.5 |
| | 3 |
| | 10.5 |
| | 16.5 |
| BH14 | 25.5 |
| | 36 |
| | 49 |
| | 55.5 |

Table 32: Borehole wise details of collected sample for thin section.

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| BH ID | DEPTH | |
|--------|-------|--|
| | 67.5 | |
| | 1.5 | |
| | 12 | |
| | 22.5 | |
| D1115 | 31.5 | |
| DHIJ | 40.5 | |
| | 51 | |
| | 61.5 | |
| | 67.5 | |
| | 6 | |
| | 10.5 | |
| | 18 | |
| DU15 A | 22.5 | |
| DIIJA | 27 | |
| | 33 | |
| | 34.5 | |
| | 45 | |
| | 10.5 | |
| | 21 | |
| DU16 | 33 | |
| DHIO | 40.5 | |
| | 46.5 | |
| | 52 | |
| | 20.5 | |
| RH17 | 25.0 | |
| | 30.0 | |
| | 31.5 | |

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| BH ID | DEPTH |
|-------|-------|
| | 45.5 |
| | 51.5 |
| | 53.0 |
| | 61.0 |
| | 62.0 |
| | |

As per the grain size analysis of the rock the entire strata was found to be formed of Quartzite containing 80-90% quartz, only \geq 20% of feldspar and very little mica, representing a mineralogically matured parent rock. This rock is almost equigranular with an average grain diameter of 0.25mm, indicating the textural maturity of its provenance. Only in BH16 at below 40m a very small amount of mica rich garnetiferrous phyllite was found. Photomicrographs of the thin sections and the results of the respective grain size and mineralogical analyses are presented below.
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Name
ofExploring alternate alignments, final location survey, geological mapping, geo-
technical investigation, detail design of tunnel & its approaches including
Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC
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Figure 40: Borehole 15(A) Samples under optical microscope (cross polarized 5X).

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Figure 41: Borehole 16 sample under optical microscope (cross polarized 5X).

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Figure 42: Borehole 17 sample under optical microscope

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Figure 47: Borehole 16 Grain size analysis histogram.

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| Table 33: Mean, Median, Mode value of grain size analysis | | | | | |
|---|-------------|----------|----------------|-------|--|
| BHID | Depth(m) | | Grain size(mm) | | |
| BII.ID | Depth(III) | Mean | Median | Mode | |
| | 4.50-6.00 | 0.199803 | 0.19 | 0.12 | |
| | 9.00-10.50 | 0.201959 | 0.193 | 0.085 | |
| | 16.50-18.00 | 0.205468 | 0.1915 | 0.129 | |
| | 22.50-24.00 | 0.258223 | 0.241 | 0.273 | |
| BH13 | 30.00-31.50 | 0.206205 | 0.182 | 0.093 | |
| | 37.50-39.00 | 0.16483 | 0.1515 | 0.129 | |
| | 45.00-46.50 | 0.206281 | 0.205 | 0.203 | |
| | 51.00-52.50 | 0.212493 | 0.209 | 0.273 | |
| | 54.00-52.50 | 0.201959 | 0.205 | 0.273 | |
| | 1.50-3.00 | 0.18256 | 0.17 | 0.12 | |
| | 9.00-10.50 | 0.2053 | 0.193 | 0.128 | |
| | 15.00-16.50 | 0.203155 | 0.183 | 0.12 | |
| BH1/ | 24.00-25.50 | 0.256 | 0.239 | 0.23 | |
| DIII4 | 34.50-36.00 | 0.26 | 0.23 | 0.129 | |
| | 48.00-49.50 | 0.21 | 0.25 | 0.129 | |
| | 54.00-55.50 | 0.25 | 0.26 | 0.11 | |
| | 66.00-67.50 | 0.316289 | 0.26 | 0.26 | |
| | 0-1.5 | 0.177933 | 0.16 | 0.12 | |
| | 10.50-12.0 | 0.708647 | 0.6635 | 0.203 | |
| | 21.00-22.50 | 0.568245 | 0.436 | 0.375 | |
| BH15 | 30.00-31.50 | 0.246856 | 0.25 | 0.273 | |
| DIIIJ | 39.00-40.50 | 0.203155 | 0.183 | 0.12 | |
| | 49.50-51.00 | 0.236961 | 0.23 | 0.191 | |
| | 60.00-61.50 | 0.316289 | 0.1835 | 0.12 | |
| | 66.00-67.50 | 0.311211 | 0.246 | 0.252 | |
| BH15A | 4.50-6.00 | 0.201959 | 0.193 | 0.1 | |

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| RH ID | Denth(m) | | Grain size(mm) | |
|--------|-------------|----------|----------------|-------|
| DII.ID | Depin(iii) | Mean | Median | Mode |
| | 9.00-10.50 | 0.203155 | 0.183 | 0.12 |
| | 16.50-18.00 | 0.204089 | 0.2 | 0.23 |
| | 21.00-22.50 | 0.238725 | 0.222 | 0.129 |
| | 25.50-27.00 | 0.25 | 0.26 | 0.15 |
| | 31.50-33.00 | 0.213 | 0.224 | 0.23 |
| | 33.00-34.50 | 0.246253 | 0.243 | 0.222 |
| | 43.50-45.00 | 0.266062 | 0.2245 | 0.129 |
| | 9.00-10.50 | 0.204089 | 0.1915 | 0.085 |
| | 19.50-21.00 | 0.238725 | 0.222 | 0.129 |
| BH16 | 31.50-33.00 | 0.219092 | 0.184 | 0.093 |
| 51120 | 39.00-40.50 | 0.218842 | 0.197 | 0.129 |
| | 45.00-46.50 | 0.246253 | 0.2 | 0.222 |
| | 52.00-53.50 | 0.316289 | 0.26 | 0.16 |
| | 20.50-22.00 | 0.238725 | 0.224 | 0.23 |
| BH-17 | 25.00-26.50 | 0.21 | 0.25 | 0.129 |
| | 30.00-31.50 | 0.2456 | 0.23 | 0.191 |
| | 45.50-47.00 | 0.236961 | 0.23 | 0.191 |
| | 51.50-53.00 | 0.389 | 0.286 | 0.146 |
| | 61.00-62.00 | 0.311211 | 0.26 | 0.252 |

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BH-13(46.5 m)



BH-13(55.5m)

BH-13(52.5 m)

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6.2 Soil Laboratory Test:

Laboratory tests were also carried out on soil samples taken from borehole BH18-BH33, the details of different laboratory tests conducted as part of the project are given in the table below.

| Sl. No. | Laboratory tests | IS Codes |
|---------|----------------------------|--|
| 1 | Preparation of soil sample | IS: 2720(part-1)-1983 (Reaffirmed 2015) |
| 2 | Moisture Content | IS: 2720(part-2)-1973 (Reaffirmed 2015) |
| 3 | Specific Gravity | IS: 2720(part-3)(sec-1)-1980 (Reaffirmed 2016) |
| 4 | Grain Size Analysis | IS: 2720(part-4)-1985 (Reaffirmed 2015) |
| 5 | Atterberg's Limits | IS: 2720(part-5)-1985 (Reaffirmed 2015) |
| 6 | Bulk Density | |
| 7 | Triaxial Shear Strength | IS: 2720(part-11)-1993 (Reaffirmed 2016) |
| 8 | Direct Shear Strength | IS: 2720(part-13)-1986 (Reaffirmed 2016) |
| 9 | Consolidation Test | IS: 2720(part-15)-1986 (Reaffirmed 2016) |

6.2.1 Soil Types:

Soil mass encountered along the tunnel alignment has been categorised in two group i.e., 1) Noncohesive Soil comprising Silty Sand (SM) and Inorganic Silt (ML) and 2) Cohesive Soil comprising Inorganic clay (CL).

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6.2.2 <u>Cohesion Test:</u>

Cohesion values from all the all kinds of soil are found to 2 group. As shown in Figure 55 CL type soil mass has higher cohesion value (clustered green dots in graph) ranging between 25-35 kPa and other 3 types of soil are comprised of another group with values ranging from 4-12 kPa.



Figure 55: Variation in cohesion value of soil with RL.

| Soil Types | Minimum Cohesion value | Maximum Cohesion value | Average Cohesion value |
|---------------|---------------------------|---------------------------|------------------------|
| CL | 23.54 kPa | 35.30 kPa | 25 kPa |
| ML | 1.96 kPa | 18.63 kPa | 3 kPa |
| SC | 7.85 kPa | 19.61 kPa | 3 kPa |
| SM | 1.96 kPa | 3.92 kPa | 3 kPa |

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6.2.3 <u>Angle of Internal Friction:</u>

The figure below provides the summarized results of test conducted to determine the angle of internal friction of the soil sample taken from the boreholes.



Figure 56: Variation in phi value of soil with RL

| Table 35: Summery of angle of internal friction test | results for soil. |
|--|-------------------|
|--|-------------------|

| Soil Types | Minimum Phi value | Maximum Phi value | Average Phi value |
|---------------|-------------------|-------------------|-------------------|
| CL | 9° | 16° | 12° |
| ML | 28° | 36° | 32° |
| SC | 29° | 34° | 32° |
| SM | 29° | 32° | 32° |

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6.2.4 <u>Natural Weight:</u>

Density of all kind of soil found to be linearly increasing with depth. The trend of variation with depth is shown below in Figure 57.



Figure 57: Variation in density value of soil with RL

Table 36: Summery of density test results for soil

| Soil Types | Minimum Density value | Maximum Density value | Average Density value |
|---------------|------------------------|------------------------|------------------------|
| CL | 1604 kg/m ³ | 2018 kg/m ³ | 1852 kg/m ³ |
| ML | 1752 kg/m ³ | 2009 kg/m ³ | 1765 kg/m ³ |
| SC | 1802 kg/m^3 | 1879 kg/m ³ | 1851 kg/m ³ |
| SM | 1765 kg/m ³ | 1906 kg/m ³ | 1824 kg/m ³ |

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6.2.5 Modulus of Elasticity (E):

The drained modulus (E') values are determined based on the corrected SPT N value $-N_{60}$ as per CIRIA Report 143 for granular as well as cohesive soils. For cohesive soil- $E' = 1.2 \times N_{60}$ (MPa), and for cohesionless soil- $E' = 1.0 \times N_{60}$ (MPa). Modulus of elasticity was found to be increasing from 10 MPa to 15 MPa with depth up-to first 15 meter from the surface, after which it falls within a constant range of value around 30 ± 1 MPa up-to the floor of the tunnel.



Figure 58: graph for Modulus of elasticity for soil vs RL.

| Table 37: 5 | Summery of | of Modulus | of E | values | for | soil |
|-------------|------------|------------|------|--------|-----|------|
|-------------|------------|------------|------|--------|-----|------|

| Soil Types | Minimum E value | Maximum E value | Average E value |
|---------------|-----------------|-----------------|-----------------|
| CL | 7.64 MPa | 35.19 MPa | 24.10 MPa |
| ML | 6.94 MPa | 38.58 MPa | 24.67 MPa |
| SM | 26.54 MPa | 30.87 MPa | 30.14 MPa |

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7 CHAPTER: SUMMARY

The Geotechnical investigation is an integral part of the assessment of subsurface strata conditions before the commencement of underground excavation and design methodology. For this purpose, 20 nos. of bore holes (BH-13 to BH-33) were drilled at the site covering the entire area. The bore holes were planned in such a way to intersect the proposed tunnel layouts throughout its proposed alignment. Geological mapping has been carried out based on the surface exposure of different rock types. The attitude (strike and dip) of these different formations were measured in the field at appropriate places.

7.1 <u>Structure</u>

Based on the available surface information and close observation of the drilled cores from the litho-logs, it has been observed that after crossing the soil the tunnel will enter into a folded rock mass where the axis of the tunnel will be perpendicular to the fold axis, thus favourably oriented with respect to the folded bedding planes. However, the folded rock layer has suffered extreme level of later brittle fracturing, which has been testified by the presence of 6 sets of joints of different orientation and a few late brittle discrete shear zones (which is certainly not active in nature). These joints and the fractures have significantly reduced the strength of the otherwise sufficiently cohesive metamorphic rock mass.

7.2 Lithology

Out of 4.26 km length of the tunnel it was found that 1.1 km of tunnel will be within the quartzite rock mass of Delhi Supergroup and rest of the 3.16 km will run through soil.

7.2.1 Rock Mass

The rock core samples extracted from the drilled holes, at regular intervals along depth, were utilized for the estimation of strength parameters, rock mass characterization, basic support design, and prediction of envisaged strata conditions. The testing of cores for

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the determination of strength properties performed at NABL recognized laboratories. The tests include uniaxial compressive test, triaxial strength test, tensile strength, permeability, porosity, Point Load strength index, hardness, abrasiveness, petrographic analysis. The test results regarding the engineering properties for the rock mass are given in Annexures.

7.2.2 <u>Soil</u>

Geotechnical Investigation were carried out by drilling 15 no of boreholes i.e., BH No-18 to 33. The subsoil predominantly consists of silt of low plasticity to clay of low plasticity. The ranges of engineering properties such as, cohesive strength, phi value, natural weight, Modulus of elasticity for **CL** type soil is 23.54-35.30 kPa, 9°-16°, 1604-2018 kg/m3, 7.64 MPa; for **ML** type Soil is 1.96-18.36 kPa, 28°-36°, 1752-2009 kg/m3, 6,94-38.58 MPa; for **SM** type soil is 1.96-3.92 kPa, 29°-32°, 1765-1906 kg/m3, 26.54-30.87 MPa respectively

7.3 <u>Hydrogeological Conditions</u>

None of the boreholes reached the ground water table. Therefore, based on the preliminary survey, it can be predicted that the tunnel will not face any difficulty due to encounter of ground water table during the construction. However, the overlying rock strata having significant nos. of joint set is quite capable of percolating rain waters during the rainy seasons. There is also a ditch around CH 24800, which is situated almost 31.87m above the roof of the tunnel. This ditch may be connected to a perched water table with a limited water resource. The joint sets and the ditch could act as efficient path ways of rainwater recharge into the tunnel during the rainy season. Therefore, it is recommended that suitable drainage system should be designed along with the tunnel to drain out that percolated water to avoid water logging during and after the construction of the tunnel.

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9 ANNEXURES

| | Consultant: | Geotechnical I | nvestigation Report | Client: | |
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ANNEXURE –A Geological Log, RQD, Q value

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| BH No. | Chainage No. | Ground Elevation, RL (m) | Total Depth (m) |
|--------|--------------|--------------------------|-----------------|
| BH-13 | 25000 | 276.867 | 60 |
| BH-14 | 25195 | 294.218 | 75 |
| BH-15 | 25380 | 295.532 | 70 |
| BH-15A | 25488 | 276.442 | 50 |
| BH-16 | 25586 | 287.324 | 62 |
| BH-17 | 25785 | 282.461 | 62 |
| BH-18 | 25990 | 280.253 | 55 |
| BH-19 | 26210 | 278.116 | 50 |
| BH-20 | 26387 | 276.795 | 48 |
| BH-21 | 26587 | 274.993 | 45 |
| BH-22 | 26787 | 274.321 | 45 |
| BH-23 | 26980 | 274.85 | 45 |
| BH-24 | 27187 | 274.075 | 40 |
| BH-25 | 27410 | 273.565 | 40 |
| BH-26 | 27550 | 273.112 | 35 |
| BH-27 | 28050 | 272.210 | 30 |
| BH-28 | 28350 | 272.799 | 45 |
| BH-29 | 28550 | 269.964 | 30 |
| BH-30 | 28750 | 270.808 | 45 |
| BH-31 | 29050 | 267.159 | 20 |
| BH-32 | 29550 | 266.684 | 30 |
| BH-33 | 30125 | 265.581 | 20 |

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| BORE HOLE ID : | 13 | LONGIT UDE | 77°2 97'' | 2'41.3 E | LOCATION: | Sohna | STRUCTU | Tunnal |
|--------------------------|------------|----------------------------|---------------------------------------|---------------|----------------------------|----------------------------|----------------|-------------------|
| CHAINAG E (Km) | 25000 | LATTIT UDE | 28° 991 | 12'25. ''N | TOTAL DEPTH: | 60m | RE | I unnei |
| START DATE | 25-08-2021 | GROUND ELEVATI MSL : | ON | 276.8 67 | TYPE OF CORE BARREL: | Double Tube Core Barrel | TYPE OF BIT | Diamond Bit |
| COMPLET ED DATE | 06-09-2021 | ANGLE W HORIZON | /ITH NT: 9 | 00 | DEPTH OF WATER TABLE | Not Found | CASING | NX up to 3.0 m |
| BORING TYPE&SIZ E: | | DRILLI AGENC | DRILLING AGENCY S.M Consultants | | WATER TABLE RECORD DATE | 07-09-2021 | | |
| | | S.M Con | | | NAME OF GEOLOGIST | Gaurav Chunekar | | |

| | Bh-13; Total Depth 60m | | | | | | | | | | |
|---------|------------------------|-----------|---|---|----------------------------|-----|--------|-----------------------|---------------------------|------------------------------------|-------------|
| on (m) | De (r | pth n) | Lithological | conditions | :onditions of covery | | | RMR | Samples | | ALUE |
| Elevati | Тор | Bottom | Description | Structural | % Core-Re | % R | Rating | Class | Depth of sample (m) | Type of Sample Collecte d | Q VA |
| 28 0 | 0 | 1.5 | Slightly Weathered, Light Grey,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 18 | 0 | 33 | CLASS 3(FAIR ROCK) | 0.00-1.50 | Core Rock | 1.5 |
| 27 8 | 1.5 | 3 | Slightly Weathered,Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Moderat ely Fractured and Jointed | 28.6 | 0 | 33 | CLASS 3(FAIR ROCK) | 1.50-3.00 | Core Rock | 1.5 |

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|--------------|------------------|--------------|----------------------|--|--|
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| | - | | - | Bh | -13; To | tal D | epth | 60m | | | - |
|---------|-----|-----------|--|---------------------------------------|---------------|-------|--------|-----------------------|---------------------------|------------------------------------|------------|
| (ш) De | | pth n) | Lithological | conditions | of ecovery | QD | | RMR | Samı | oles | VLUE |
| Elevati | Тор | Bottom | Description | Structural | % Core-Re | % R | Rating | Class | Depth of sample (m) | Type of Sample Collecte d | Q VA |
| 27 7 | 3 | 4.5 | Slightly Weathered, Light Grey to Light Brown,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 44.6 | 0 | 33 | CLASS 3(FAIR ROCK) | 3.00-4.50 | Core Rock | 6.69 |
| 27 5 | 4.5 | 6 | Highly Weathered, Light Grey,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 21.3 3 | 0 | 31 | CLASS 3(FAIR ROCK) | 4.50-6.00 | Core Rock | 3.199 5 |
| 27 | 6 | 7.5 | Slightly Weathered, Light Grey,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 25.3 3 | 10 | 35 | CLASS 3(FAIR ROCK) | 6.00-7.50 | Core Rock | 3.799 5 |
| 27 2 | 7.5 | 9 | Highly Weathered, Highly Fractured, Highly Jointed, White to Light | Highly Fractured and Jointed | 37.3 3 | 0 | 31 | CLASS 3(FAIR ROCK) | 7.50-9.00 | Core Rock | 5.599 5 |
| 27 1 | 9 | 11 | Brown,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 34 | 0 | 31 | CLASS 3(FAIR ROCK) | 9.00- 10.50 | Core Rock | 5.1 |

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| | | | | Bh | -13; To | tal D | epth | 60m | | | - | |
|---------|----------------------|--------|--|---------------------------------------|---------------|-------|--------|-----------------------|---------------------------|------------------------------------|------------|--|
| ion (m) | ြို့ Depth ဗြ (m) | | Lithological | conditions | of ecovery | ROD | | a Ma | Sam | ples | ALUE | |
| Elevati | Тор | Bottom | Description | Structural | % Core-Ri | ж | Rating | Solution | Depth of sample (m) | Type of Sample Collecte d | Q | |
| 26 9 | 11 | 12 | Moderately Weathered, Highly Fractured, Highly Jointed, Grey,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 28 | 17 | 33 | CLASS 3(FAIR ROCK) | 10.50- 12.00 | Core Rock | 4.2 | |
| 26 8 | 12 | 14 | Highly Weathered, White to Light Grey,Fine Grained, | Highly Fractured and Jointed | 21.3 3 | 0 | 33 | CLASS 3(FAIR ROCK) | 12.00- 13.50 | Core Rock | 3.199 5 | |
| 26 6 | 14 | 15 | Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 34 | 0 | 35 | CLASS 3(FAIR ROCK) | 13.50- 15.00 | Core Rock | 5.1 | |
| 26 5 | 15 | 17 | Slightly Weathered, Reddish Brown to Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 32 | 0 | 35 | CLASS 3(FAIR ROCK) | 15.00- 16.50 | Core Rock | 4.2 | |
| 26 3 | 17 | 18 | Slightly Weathered, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 32.8 5 | 0 | 35 | CLASS 3(FAIR ROCK) | 16.50- 18.00 | Core Rock | 3.199 5 | |
| 26 2 | 18 | 20 | Slightly Weathered, Grey, Fine Grained, Interlocking Texture, Iron | Highly Fractured and Jointed | 30 | 9 | 35 | CLASS 3(FAIR ROCK) | 18.00- 19.50 | Core Rock | 5.1 | |

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| Bh-13; Total Depth 60m | | | | | | | | | | | |
|------------------------|--------------|--------|---|---------------------------------------|---------------|-----|--------|-----------------------|---------------------------|------------------------------------|------------|
| on (m) | Depth (m) | | Lithological | conditions | of ecovery | QD | RMR | | Sam | Samples | |
| Elevati | Тор | Bottom | Description | Structural | % Core-R | Я Ж | Rating | Class | Depth of sample (m) | Type of Sample Collecte d | Q V |
| 26 0 | 20 | 21 | Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 39.3 3 | 0 | 35 | CLASS 3(FAIR ROCK) | 19.50- 21.00 | Core Rock | 4.8 |
| 25 9 | 21 | 23 | | Highly Fractured and Jointed | 33.3 3 | 0 | 35 | CLASS 3(FAIR ROCK) | 21.00- 22.50 | Core Rock | 4.927 5 |
| 25 7 | 23 | 24 | | Highly Fractured and Jointed | 39.3 3 | 0 | 38 | CLASS 3(FAIR ROCK) | 22.50- 24.00 | Core Rock | 4.5 |
| 25 6 | 24 | 26 | | Highly Fractured and Jointed | 28.6 6 | 9 | 38 | CLASS 3(FAIR ROCK) | 24.00- 25.50 | Core Rock | 5.899 5 |
| 25 4 | 26 | 27 | Slightly | Highly Fractured and Jointed | 34 | 18 | 38 | CLASS 3(FAIR ROCK) | 25.50- 27.00 | Core Rock | 4.999 5 |
| 25 3 | 27 | 29 | Weathered,Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very | Highly Fractured and Jointed | 34 | 24 | 38 | CLASS 3(FAIR ROCK) | 27.00- 28.50 | Core Rock | 5.899 5 |
| 25 1 | 29 | 30 | Hard, Quartzite | Highly Fractured and Jointed | 40 | 20 | 38 | CLASS 3(FAIR ROCK) | 28.50- 30.00 | Core Rock | 4.299 |
| 25 0 | 30 | 32 | | Highly Fractured and Jointed | 31.3 3 | 0 | 35 | CLASS 3(FAIR ROCK) | 30.00- 31.50 | Core Rock | 5.1 |

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| Bh-13; Total Depth 60m | | | | | | | | | | | |
|------------------------|--------------|--------|---|---------------------------------------|---------------|-----|--------|-----------------------|---------------------------|------------------------------------|------------|
| Elevation (m) | Depth (m) | | Lithological | conditions | of ecovery | QD | RMR | | Samples | | ALUE |
| | Top | Bottom | Description | Structural | % Core-R | H % | Rating | Class | Depth of sample (m) | Type of Sample Collecte d | ν Q |
| 24 8 | 32 | 33 | | Highly Fractured and Jointed | 33.3 3 | 9 | 35 | CLASS 3(FAIR ROCK) | 31.50- 33.00 | Core Rock | 5.1 |
| 24 7 | 33 | 35 | | Highly Fractured and Jointed | 24 | 11 | 35 | CLASS 3(FAIR ROCK) | 33.00- 34.50 | Core Rock | 6 |
| 24 5 | 35 | 36 | Slightly Weathered, Grey, Fine Grained, | Highly Fractured and Jointed | 35.3 3 | 8 | 35 | CLASS 3(FAIR ROCK) | 34.50- 36.00 | Core Rock | 4.699 5 |
| 24 4 | 36 | 38 | Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 32.6 | 8 | 35 | CLASS 3(FAIR ROCK) | 36.00- 37.50 | Core Rock | 4.999 5 |
| 24 2 | 38 | 39 | | Highly Fractured and Jointed | 26.6 6 | 0 | 35 | CLASS 3(FAIR ROCK) | 37.50- 39.00 | Core Rock | 3.6 |
| 24 1 | 39 | 41 | Slightly | Highly Fractured and Jointed | 32 | 9 | 35 | CLASS 3(FAIR ROCK) | 39.00- 40.50 | Core Rock | 5.299 5 |
| 23 9 | 41 | 42 | Weathered, Grey, Fine Grained, Interlocking Texture, Iron | Highly Fractured and Jointed | 43.3 3 | 9 | 35 | CLASS 3(FAIR ROCK) | 40.50- 42.00 | Core Rock | 4.89 |
| 23 8 | 42 | 44 | Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 26 | 8 | 35 | CLASS 3(FAIR ROCK) | 42.00- 43.50 | Core Rock | 3.999 |
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| | Bh-13; Total Depth 60m | | | | | | | | | | |
|---------|------------------------|-----------|--|---------------------------------------|---------------|-----|--------|-----------------------|---------------------------|------------------------------------|------------|
| on (m) | De (r | pth n) | Lithological | conditions | of ecovery | QD | | MM MM | Sam | ples | ALUE |
| Elevati | Тор | Bottom | Description | Structural | % Core-R | Ж К | Rating | Class | Depth of sample (m) | Type of Sample Collecte d | Q VI |
| 23 6 | 44 | 45 | | Highly Fractured and Jointed | 33.3 3 | 16 | 35 | CLASS 3(FAIR ROCK) | 43.50- 45.00 | Core Rock | 4.8 |
| 23 5 | 45 | 47 | | Highly Fractured and Jointed | 30 | 0 | 35 | CLASS 3(FAIR ROCK) | 45.00- 46.50 | Core Rock | 6.499 5 |
| 23 3 | 47 | 48 | Slightly | Highly Fractured and Jointed | 22.6 6 | 19 | 35 | CLASS 3(FAIR ROCK) | 46.50- 48.00 | Core Rock | 3.9 |
| 23 2 | 48 | 50 | Weathered, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very | Highly Fractured and Jointed | 34 | 29 | 40 | CLASS 3(FAIR ROCK) | 48.00- 49.50 | Core Rock | 4.999 5 |
| 23 0 | 50 | 51 | Hard, Quartzite | Highly Fractured and Jointed | 27.3 3 | 0 | 35 | CLASS 3(FAIR ROCK) | 49.50- 51.00 | Core Rock | 4.5 |
| 22 9 | 51 | 53 | | Highly Fractured and Jointed | 26 | 0 | 35 | CLASS 3(FAIR ROCK) | 51.00- 52.50 | Core Rock | 3.399 |
| 22 7 | 53 | 54 | | Highly Fractured and Jointed | 34 | 0 | 35 | CLASS 3(FAIR ROCK) | 52.50- 54.00 | Core Rock | 5.1 |
| 22 6 | 54 | 56 | | Highly Fractured and Jointed | 34 | 0 | 35 | CLASS 3(FAIR ROCK) | 54.00- 55.50 | Core Rock | 4.099 5 |

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| | | | | Bh | -13; To | tal D | epth | 60m | | | |
|---------|----------|-----------|---|---------------------------------------|---------------|-------|--------|-----------------------|---------------------------|------------------------------------|------|
| on (m) | De (r | pth n) | Lithological | conditions | of ecovery | QD | | RMR | Sam | oles | VLUE |
| Elevati | Тор | Bottom | Description | Structural | % Core-Re | Ж Ж | Rating | Class | Depth of sample (m) | Type of Sample Collecte d | QVP |
| 22 4 | 56 | 57 | | Highly Fractured and Jointed | 26.6 6 | 9 | 35 | CLASS 3(FAIR ROCK) | 55.50- 57.00 | Core Rock | 3.9 |
| 22 3 | 57 | 59 | | Highly Fractured and Jointed | 28 | 8 | 35 | CLASS 3(FAIR ROCK) | 57.00- 58.50 | Core Rock | 5.1 |
| 22 | 59 | 60 | Slightly Weathered, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 22 | 13 | 35 | CLASS 3(FAIR ROCK) | 58.50- 60.00 | Core Rock | 5.1 |

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| BORE HOLE ID : | 14 | LONGIT UDE | 77°2 27''] | 2'37.4 E | LOCATION: | Sohna | STRUCTU | Truesd |
|--------------------------|------------|----------------------------|----------------|---------------|----------------------------|----------------------------|----------------|-------------------|
| CHAINAG E (Km) | 25195 | LATTIT UDE | 28°1 483' | l2'31. ''N | TOTAL DEPTH: | 75m | RE | Tunner |
| START DATE | 11-08-2021 | GROUND ELEVATI MSL : | ON | 294.2 18 | TYPE OF CORE BARREL: | Double Tube Core Barrel | TYPE OF BIT | Diamond Bit |
| COMPLET ED DATE | 23-08-2021 | ANGLE W HORIZON | /ITH \T: 9(| 00 | DEPTH OF WATER TABLE | Not found | CASING | NX up to 3.0 m |
| BORING TYPE&SIZ E: | | DRILLI | NG | | WATER TABLE RECORD DATE | 24-08-2021 | | |
| | | S.M Con | r sultai | nts | NAME OF GEOLOGIST | Gaurav Chunekar | | |

| Elevati on (m) | Dep To p | oth (m) Botto m | Lithology | Structura I conditio ns | % of Core- Recove ry | % RQ D | Rati | RMR Class | Samı Depth of sample (m) | oles Type of Sample Collecte d | Q VAL UE |
|-------------------|----------------|-----------------------|---|--|-------------------------------|--------------|------|-----------------------|-----------------------------------|--|----------------|
| 294.21 8 | 0.0 | 1.5 | Moderat ely Weather ed, , Light Grey, Fine | Highly Fracture d and Jointed | 30 | 0 | 33 | CLASS 3(FAIR ROCK) | 0.00-1.50 | Core Rock | 1.5 |
| 292.71 8 | 1.5 | 3.0 | Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 48 | 0 | 33 | CLASS 3(FAIR ROCK) | 1.50-3.00 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati on (m) | Dep | oth (m) | | Structura I conditio | % of Core- Recove | % RQ | | RMR | Samı | oles | Q VAL |
|-------------------|---------|------------|--|--|-------------------------|---------|------------|-----------------------|---------------------------|-------------------------|----------|
| | To p | Botto m | Lithology | ns | ry | D | Rati ng | Class | Depth of sample (m) | Sample Collecte d | UE |
| 291.21 8 | 3.0 | 4.5 | Highly Weather ed Light Grey, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Moderat ely Fracture d and Jointed | 38 | 0 | 33 | CLASS 3(FAIR ROCK) | 3.00-4.50 | Core Rock | 1.5 |
| 289.71 8 | 4.5 | 6.0 | Quartz vein Slightly Weather ed, Light Grey, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 66 | 24 | 33 | CLASS 3(FAIR ROCK) | 4.50-6.00 | Core Rock | 3.6 |
| 288.21 | 6.0 | 7.5 | Highly Weather ed Light Grey, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Moderatl ey Fracture d and Jointed | 45 | 0 | 35 | CLASS 3(FAIR ROCK) | 6.00-7.50 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati on (m) | Dep To p | oth (m) Botto m | Lithology | Structura I conditio ns | % of Core- Recove ry | % RQ D | Rati | RMR Class | Samı Depth of sample (m) | oles Type of Sample Collecte d | Q VAL UE |
|-------------------|----------------|-----------------------|--|--|-------------------------------|--------------|------|-----------------------|-----------------------------------|--|----------------|
| 286.71 8 | 7.5 | 9.0 | Slightly Weather d, Light Grey, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard, Quartzite (fine grain muscovit e) | Highly Fracture d and Jointed | 50 | 18 | 35 | CLASS 3(FAIR ROCK) | 7.50-9.00 | Core Rock | 2.7 |
| 285.21 8 | 9.0 | 10.5 | Slightly to Moderat ely Weather d, Light Grey, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Moderat ely Fracture d and Jointed | 51 | 0 | 33 | CLASS 3(FAIR ROCK) | 9.00- 10.50 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|----------------|----------------|---------------------|--|
| S. M. C. | SM CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati on (m) | Der To | oth (m) Botto | | Structura I conditio ns | % of Core- Recove ry | % RQ D | Rati | RMR | Samı Depth of sample | oles Type of Sample Collecte | Q VAL UE |
|-------------------|-----------|------------------|---|--|-------------------------------|--------------|------|-----------------------|----------------------------|---------------------------------------|----------------|
| | р | m | Lithology | | | | ng | Class | (m) | d | |
| 283.71 8 | 10. 5 | 12.0 | Moderat ely Weather d, Light | Highly Fracture d and Jointed | 40 | 21 | 38 | CLASS 3(FAIR ROCK) | 10.50- 12.00 | Core Rock | 3.15 |
| 282.21 8 | 12. 0 | 13.5 | Fine Grained, Interlocki | Highly Fracture d and Jointed | 34 | 15 | 33 | CLASS 3(FAIR ROCK) | 12.00- 13.50 | Core Rock | 2.25 |
| 280.71 8 | 13. 5 | 15.0 | I exture, Iron Leaching , Very Hard | Highly Fracture d and Jointed | 21 | 0 | 31 | CLASS 3(FAIR ROCK) | 13.50- 15.00 | Core Rock | 1.5 |
| 279.21 8 | 15. 0 | 16.5 | Quartzite | Highly Fracture d and Jointed | 29 | 0 | 31 | CLASS 3(FAIR ROCK) | 15.00- 16.50 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati on (m) | Der To | oth (m) Botto | Lithology | Structura I conditio ns | % of Core- Recove ry | % RQ D | Rati | RMR | Sam Depth of sample (m) | oles Type of Sample Collecte d | Q VAL UE |
|-------------------|-----------|------------------|---|--|-------------------------------|--------------|------|-----------------------|----------------------------------|--|----------------|
| 277.71 | 16. 5 | 18.0 | Moderat ely Weather d, Light Grey, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 28 | 9 | 31 | CLASS 3(FAIR ROCK) | 16.50- 18.00 | Core Rock | 1.5 |
| 276.21 8 | 18. 0 | 19.5 | | Highly Fracture d and Jointed | 34 | 6 | 35 | CLASS 3(FAIR ROCK) | 18.00- 19.50 | Core Rock | 1.5 |
| 274.71 | 19. 5 | 21.0 | Slightly Weather ed, Light Grey, | Highly Fracture d and Jointed | 23 | 0 | 35 | CLASS 3(FAIR ROCK) | 19.50- 21.00 | Core Rock | 1.5 |
| 273.21 8 | 21. 0 | 22.5 | Fine Grained, Interlocki ng Texture, | Highly Fracture d and Jointed | 28 | 13 | 35 | CLASS 3(FAIR ROCK) | 21.00- 22.50 | Core Rock | 1.95 |

| | Consultant: | Geotechnical I | Investigation Report | Client: |
|--------------|------------------|----------------|----------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati on (m) | Der To | oth (m) Botto | | Structura l conditio ns | % of Core- Recove ry | % RQ D | Rati | RMR | Samı Depth of sample | oles Type of Sample Collecte | Q VAL UE |
|-------------------|-----------|------------------|--|--|-------------------------------|--------------|------|-----------------------|----------------------------|---------------------------------------|----------------|
| | р | m | Lithology | | | | ng | Class | (m) | d | |
| 271.71 8 | 22. 5 | 24.0 | Iron Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 23 | 6 | 35 | CLASS 3(FAIR ROCK) | 22.50- 24.00 | Core Rock | 1.5 |
| 270.21 8 | 24. 0 | 25.5 | | Highly Fracture d and Jointed | 20 | 0 | 35 | CLASS 3(FAIR ROCK) | 24.00- 25.50 | Core Rock | 1.5 |
| 268.71 8 | 25. 5 | 27.0 | | Highly Fracture d and Jointed | 25 | 9 | 35 | CLASS 3(FAIR ROCK) | 25.50- 27.00 | Core Rock | 1.5 |
| 267.21 8 | 27. 0 | 28.5 | | Highly Fracture d and Jointed | 28 | 0 | 38 | CLASS 3(FAIR ROCK) | 27.00- 28.50 | Core Rock | 1.5 |
| 265.71 8 | 28. 5 | 30.0 | | Highly Fracture d and Jointed | 25 | 18 | 35 | CLASS 3(FAIR ROCK) | 28.50- 30.00 | Core Rock | 2.7 |
| 264.21 8 | 30. 0 | 31.5 | Slightly Weather ed, Light Grey, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 28 | 14 | 35 | CLASS 3(FAIR ROCK) | 30.00- 31.50 | Core Rock | 2.1 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati | Dep | oth (m) | | Structura I | % of Core- | % 80 | | RMR | | ples | Q |
|-------------|----------|------------|--|--|---------------|---------|------------|-----------------------|---------------------------|------------------------------------|-----|
| on (m) | To p | Botto m | Lithology | conditio ns | Recove ry | D | Rati ng | Class | Depth of sample (m) | Type of Sample Collecte d | UE |
| 262.71 8 | 31. 5 | 33.0 | Moderat ely Weather ed, , Gery, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Moderat ely Fracture d and Jointed | 28 | 18 | 33 | CLASS 3(FAIR ROCK) | 31.50- 33.00 | Core Rock | 2.7 |
| 261.21 8 | 33. 0 | 34.5 | Moderat | Highly Fracture d and Jointed | 22 | 6 | 31 | CLASS 3(FAIR ROCK) | 33.00- 34.50 | Core Rock | 1.5 |
| 259.71 8 | 34. 5 | 36.0 | ely Weather ed, Grey, Fine | Highly Fracture d and Jointed | 25 | 0 | 31 | CLASS 3(FAIR ROCK) | 34.50- 36.00 | Core Rock | 1.5 |
| 258.21 8 | 36. 0 | 37.5 | Interlocki ng Texture, Iron | Highly Fracture d and Jointed | 29 | 10 | 31 | CLASS 3(FAIR ROCK) | 36.00- 37.50 | Core Rock | 1.5 |
| 256.71 8 | 37. 5 | 39.0 | , Very Hard Quartzite | Highly Fracture d and Jointed | 28 | 7 | 31 | CLASS 3(FAIR ROCK) | 37.50- 39.00 | Core Rock | 1.5 |
| 255.21 8 | 39. 0 | 40.5 | | Highly Fracture d and Jointed | 30 | 0 | 31 | CLASS 3(FAIR ROCK) | 39.00- 40.50 | Core Rock | 1.5 |
| 253.71 8 | 40. 5 | 42.0 | Moderat ely | Highly Fracture d and Jointed | 28 | 7 | 31 | CLASS 3(FAIR ROCK) | 40.50- 42.00 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati | Dep | oth (m) | | Structura I conditio | % of Core- Recove | % RQ | | RMR | | Samples Type of | |
|-------------|----------|------------|--|--|-------------------------|---------|------------|-----------------------|---------------------------|-------------------------|-----|
| | To p | Botto m | Lithology | ns | ry | D | Rati ng | Class | Depth of sample (m) | Sample Collecte d | UE |
| 252.21 8 | 42. 0 | 43.5 | Weather ed, Gery, Fine Grained, Interlocki ng Texture, Iron Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 25 | 0 | 35 | CLASS 3(FAIR ROCK) | 42.00- 43.50 | Core Rock | 1.5 |
| 250.71 8 | 43. 5 | 45.0 | | Highly Fracture d and Jointed | 26 | 6 | 35 | CLASS 3(FAIR ROCK) | 43.50- 45.00 | Core Rock | 1.5 |
| 249.21 8 | 45. 0 | 46.5 | Slightly Weather ed, Grey, | Highly Fracture d and Jointed | 24 | 0 | 35 | CLASS 3(FAIR ROCK) | 45.00- 46.50 | Core Rock | 1.5 |
| 247.71 8 | 46. 5 | 48.0 | Fine Grained, Interlocki ng Texture, | Highly Fracture d and Jointed | 26 | 0 | 35 | CLASS 3(FAIR ROCK) | 46.50- 48.00 | Core Rock | 1.5 |
| 246.21 8 | 48. 0 | 49.5 | Iron Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 27 | 18 | 35 | CLASS 3(FAIR ROCK) | 48.00- 49.50 | Core Rock | 2.7 |
| 244.71 8 | 49. 5 | 51.0 | | Highly Fracture d and Jointed | 22 | 0 | 35 | CLASS 3(FAIR ROCK) | 49.50- 51.00 | Core Rock | 1.5 |
| 243.21 8 | 51. 0 | 52.5 | | Highly Fracture d and Jointed | 22 | 0 | 35 | CLASS 3(FAIR ROCK) | 51.00- 52.50 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati | Dep | oth (m) | | Structura | % of Core- | % 80 | | RMR | | Samples | |
|-------------|----------|------------|--|--|---------------|---------|------------|-----------------------|---------------------------|------------------------------------|------|
| on (m) | То p | Botto m | Lithology | conditio ns | Recove ry | D | Rati ng | Class | Depth of sample (m) | Type of Sample Collecte d | UE |
| 241.71 8 | 52. 5 | 54.0 | | Highly Fracture d and Jointed | 22 | 0 | 35 | CLASS 3(FAIR ROCK) | 52.50- 54.00 | Core Rock | 1.5 |
| 240.21 8 | 54. 0 | 55.5 | | Highly Fracture d and Jointed | 26 | 0 | 35 | CLASS 3(FAIR ROCK) | 54.00- 55.50 | Core Rock | 1.5 |
| 238.71 8 | 55. 5 | 57.0 | | Highly Fracture d and Jointed | 26 | 0 | 35 | CLASS 3(FAIR ROCK) | 55.50- 57.00 | Core Rock | 1.5 |
| 237.21 8 | 57. 0 | 58.5 | Slightly Weather ed, Grey, Fine | Highly Fracture d and Jointed | 22 | 10 | 35 | CLASS 3(FAIR ROCK) | 57.00- 58.50 | Core Rock | 1.5 |
| 235.71 8 | 58. 5 | 60.0 | Grained, Interlocki ng Texture, Iron | Highly Fracture d and Jointed | 21 | 0 | 35 | CLASS 3(FAIR ROCK) | 58.50- 60.00 | Core Rock | 1.5 |
| 234.21 8 | 60. 0 | 61.5 | Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 22 | 0 | 35 | CLASS 3(FAIR ROCK) | 60.00- 61.50 | | 1.5 |
| 232.71 8 | 61. 5 | 63.0 | | Highly Fracture d and Jointed | 22 | 0 | 35 | CLASS 3(FAIR ROCK) | 61.50- 63.00 | | 1.5 |
| 231.21 8 | 63. 0 | 64.5 | | Highly Fracture d and Jointed | 25 | 13 | 35 | CLASS 3(FAIR ROCK) | 63.05- 64.55 | | 1.95 |
| 229.71 8 | 64. 5 | 66.0 | | Highly Fracture d and Jointed | 28 | 11 | 35 | CLASS 3(FAIR ROCK) | 64.50- 66.00 | | 1.65 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevati | Dep | oth (m) | | Structura % of I Core- | | % 80 | | RMR | Sam | ples | Q |
|-------------|----------|------------|--|--|--------------|---------|------------|-----------------------|---------------------------|------------------------------------|-----|
| on (m) | To p | Botto m | Lithology | conditio ns | Recove ry | D | Rati ng | Class | Depth of sample (m) | Type of Sample Collecte d | UE |
| 228.21 8 | 66. 0 | 67.5 | | Highly Fracture d and Jointed | 28 | 0 | 35 | CLASS 3(FAIR ROCK) | 66.05- 67.55 | | 1.5 |
| 226.71 8 | 67. 5 | 69.0 | | Highly Fracture d and Jointed | 28 | 0 | 35 | CLASS 3(FAIR ROCK) | 67.50- 69.00 | | 1.5 |
| 225.21 8 | 69. 0 | 70.5 | | Highly Fracture d and Jointed | 26 | 8 | 35 | CLASS 3(FAIR ROCK) | 69.05- 70.55 | | 1.5 |
| 223.71 8 | 70. 5 | 72.0 | Slightly Weather ed, Grey, Fine | Highly Fracture d and Jointed | 27 | 14 | 35 | CLASS 3(FAIR ROCK) | 70.50- 72.00 | | 2.1 |
| 222.21 8 | 72. 0 | 73.5 | Grained, Interlocki ng Texture, Iron | Highly Fracture d and Jointed | 26 | 14 | 38 | CLASS 3(FAIR ROCK) | 72.05- 73.55 | | 2.1 |
| 220.71 8 | 73. 5 | 75.0 | Leaching , Very Hard Quartzite | Highly Fracture d and Jointed | 22 | 0 | 35 | CLASS 3(FAIR ROCK) | 73.50- 75.00 | | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: | |
|--|------------------|----------------|---------------------|--|--|
| | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail | |
| | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd | |

| BORE HOLE ID : | 15 | LONGIT UDE | 77°2 78'' | 2'32.8 E | LOCATION: | Sohna | STRUCT | U Tunnal |
|--------------------------|------------|---------------------------------------|--------------------|-------------------------|----------------------------|-------------------|----------------|-------------------|
| CHAINAG E (Km) | 25380 | LATTIT UDE | 28°2 141 | 12'36. ''N | TOTAL DEPTH: | 70m | RE | Tunner |
| START DATE | 12-08-2021 | GROUND 295.5 ELEVATION 32 MSL : | | TYPE OF CORE BARREL: | Double Tube Cor Barrel | re TYPE OF BIT | Diamond Bit | |
| COMPLET ED DATE | 28-08-2021 | ANGLE W HORIZON | /ITH NT: 9 | 0° | DEPTH OF WATE TABLE | ER 61.0m | CASING | NX up to 3.0 m |
| BORING TYPE&SIZ E: | | DRILLI AGENC | DRILLING AGENCY | | WATER TABLE RECORD DATE | 29-08-2021 | | |
| | | S.M Con | S.M Consultants | | NAME OF GEOLOGIST | Gaurav Chunek | ar | |

| ion (m) | Dept | :h (m) | | l conditions | s of tecovery | RQD | bo | RMR | | Samples | ALUE |
|---------|------|--------|---|------------------------------------|------------------|-----|--------|------------------------------|-------------------------|---------------------|------|
| Elevat | Тор | Bottom | Lithology | Structura | % Core-R | % | Rating | Class | Depth o sample (m | Sample Collected | ΔV |
| 295.532 | 0.0 | 1.5 | HighlyWeathered, | Highly Fractured and Jointed | 26 | 0 | 33 | CLASS 4 (POOR ROCK) | 0.00-1.50 | Core Rock | 1.5 |
| 294.03 | 1.5 | 3.0 | Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron | Highly Fractured and Jointed | 28 | 7 | 33 | CLASS 4 (POOR ROCK) | 1.50-3.00 | Core Rock | 1.5 |
| 292.528 | 3.0 | 4.5 | Hard, Quartzite | Highly Fractured and Jointed | 42 | 7 | 33 | CLASS 4 (POOR ROCK) | 3.00-4.50 | Core Rock | 1.5 |
| 291.026 | 4.5 | 6.0 | SightlyWeathered, Highly Fractured, Jointed, Light Grey, Fine Grained, | Highly Fractured and Jointed | 36 | 0 | 33 | CLASS 4 (POOR ROCK) | 4.50-6.00 | Core Rock | 1.5 |
| 289.524 | 6.0 | 7.5 | Interlocking Texture, Iron Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 46 | 0 | 33 | CLASS 4 (POOR ROCK) | 6.00-7.50 | Core Rock | 1.5 |

| | Consultant: | Geotechnical | Investigation Report | Client: | |
|--|------------------|--------------|----------------------|--|--|
| | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail | |
| | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd | |

| Elevation (m) | Dept d L | Bottom () 4: | Lithology | Structural conditions | % of Core-Recovery | % RQD | Rating | RMR Class | Depth of sample (m) | sampre Collected Samples | Q VALUE |
|---------------|----------------|--------------|--|------------------------------------|-----------------------|-------|--------|------------------------------|---------------------------|-----------------------------|---------|
| 288.022 | 7.5 | 9.0 | | Highly Fractured and Jointed | 24 | 7 | 33 | CLASS 4 (POOR ROCK) | 7.50-9.00 | Core Rock | 1.5 |
| 286.52 | 9.0 | 10.5 | | Highly Fractured and Jointed | 34 | 14 | 33 | CLASS 4 (POOR ROCK) | 9.00-10.50 | Core Rock | 2.1 |
| 285.018 | 10.5 | 12.0 | SightlyWeathered, Highly Fractured, Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, very Hard, Quartzite (Quartz vein) | Highly Fractured and Jointed | 20 | 0 | 33 | CLASS 4 (POOR ROCK) | 10.50-12.00 | Core Rock | 1.5 |
| 283.516 | 12.0 | 13.5 | HighlyWeathered, Highly Fractured, | Highly Fractured and Jointed | 23 | 0 | 33 | CLASS 4 (POOR ROCK) | 12.00-13.50 | Core Rock | 1.5 |
| 282.014 | 13.5 | 15.0 | Fine Grained, Interlocking Texture, Iron Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 16 | 0 | 33 | CLASS 4 (POOR ROCK) | 13.50-15.00 | Core Rock | 1.5 |

| | Consultant: | Geotechnical | Investigation Report | Client: | |
|---------|------------------|--------------|----------------------|--------------------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail Infrastructure | |
| Ø | BHUBANESWAR | Report No.: | SMC/2050 | Development Corporation Ltd | |

| vation (m) | Dept | h (m) | | ural conditions | % of e-Recovery | % RQD | ting | RMR Se | n of ple (m) | ted Samples | Q VALUE |
|------------|------|-------|--|------------------------------------|--------------------|-------|------|------------------------------|--------------------|---------------|---------|
| Ele | | Bott | Lithology | Structu | Cor | | Rat | C | Depthsam | sam Collec | |
| 280.512 | 15.0 | 16.5 | SightlyWeathered, Highly Fractured, Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, very Hard, Quartzite (Quartz vein) | Highly Fractured and Jointed | 16 | 0 | 35 | CLASS 4 (POOR ROCK) | 15.00-16.50 | Core Rock | 1.5 |
| 279.01 | 16.5 | 18.0 | HighlyWeathered, Highly Fractured, Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 22 | 0 | 35 | CLASS 4 (POOR ROCK) | 16.50-18.00 | Core Rock | 1.5 |
| 277.508 | 18.0 | 19.5 | HighlyWeathered, Highly Fractured, Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 41 | 17 | 35 | CLASS 4 (POOR ROCK) | 18.00-19.50 | Core Rock | 2.55 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: | |
|---------|------------------|----------------|---------------------|--|--|
| S. M. C | S.M. CONSULTANTS | Job No.: 830 | | Haryana Rail | |
| | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd | |

| Elevation (m) | Dept d L | Bottom (m) H: | Lithology | Structural conditions | % of Core-Recovery | % RQD | Rating | RMR Class C | Depth of sample (m) | sampre Collected Samples | Q VALUE |
|---------------|----------------|------------------|---|------------------------------------|-----------------------|-------|--------|------------------------------|---------------------------|-----------------------------|---------|
| 276.006 | 19.5 | 21.0 | Slightly Weathered, Highly Fractured, Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 28 | 0 | 35 | CLASS 4 (POOR ROCK) | 19.50-21.00 | Core Rock | 1.5 |
| 274.504 | 21.0 | 22.5 | Slightly Weathered, Highly Fractured, Jointed, Light Grey, Fine Grained, Interlocking | Highly Fractured and Jointed | 26 | 0 | 35 | CLASS 4 (POOR ROCK) | 21.00-22.50 | Core Rock | 1.5 |
| 273.002 | 22.5 | 24.0 | Texture, Iron Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 36 | 18 | 35 | CLASS 4 (POOR ROCK) | 22.50-24.00 | Core Rock | 2.7 |
| 271.5 | 24.0 | 25.5 | | Highly Fractured and Jointed | 27 | 0 | 35 | CLASS 4 (POOR ROCK) | 24.00-25.50 | Core Rock | 1.5 |
| 269.998 | 25.5 | 27.0 | | Highly Fractured and Jointed | 36 | 0 | 35 | CLASS 4 (POOR ROCK) | 25.50-27.00 | Core Rock | 1.5 |
| 268.496 | 27.0 | 28.5 | | Highly Fractured and Jointed | 33 | 8 | 35 | CLASS 4 (POOR ROCK) | 27.00-28.50 | Core Rock | 1.5 |
| 266.994 | 28.5 | 30.0 | | Highly Fractured and Jointed | 20 | 0 | 35 | CLASS 4 (POOR ROCK) | 28.50-30.00 | Core Rock | 1.5 |
| 265.492 | 30.0 | 31.5 | | Highly Fractured and Jointed | 23 | 0 | 35 | CLASS 4 (POOR ROCK) | 30.00-31.50 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevation (m) | Dept do L | Bottom (m) y | Lithology | tructural conditions | % of Core-Recovery | % RQD | Rating | NMR Class | Depth of sample (m) | collected Samples | Q VALUE |
|---------------|-----------------|--------------|--|--|-----------------------|-------|--------|------------------------------|---------------------------|-------------------|---------|
| 263.99 | 31.5 | 33.0 | 2.0.0087 | Moderately Fractured and Jointed | 21 | 0 | 35 | CLASS 4 (POOR ROCK) | 31.50-33.00 | Core Rock | 1.5 |
| 262.488 | 33.0 | 34.5 | | Highly Fractured and Jointed | 30 | 7 | 35 | CLASS 4 (POOR ROCK) | 33.00-34.50 | Core Rock | 1.5 |
| 260.986 | 34.5 | 36.0 | | Highly Fractured and Jointed | 32 | 0 | 35 | CLASS 4 (POOR ROCK) | 34.50-36.00 | Core Rock | 1.5 |
| 259.484 | 36.0 | 37.5 | Slightly Weathered, Highly Fractured, Jointed, Light Grey, Eine Grained | Highly Fractured and Jointed | 31 | 0 | 35 | CLASS 4 (POOR ROCK) | 36.00-37.50 | Core Rock | 1.5 |
| 257.982 | 37.5 | 39.0 | Interlocking Texture, Iron Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 30 | 6 | 35 | CLASS 4 (POOR ROCK) | 37.50-39.00 | Core Rock | 1.5 |
| 256.48 | 39.0 | 40.5 | | Highly Fractured and Jointed | 25 | 0 | 38 | CLASS 4 (POOR ROCK) | 39.00-40.50 | Core Rock | 1.5 |
| 254.978 | 40.5 | 42.0 | | Highly Fractured and Jointed | 40 | 22 | 38 | CLASS 4 (POOR ROCK) | 40.50-42.00 | Core Rock | 3.3 |
| 253.476 | 42.0 | 43.5 | | Highly Fractured and Jointed | 28 | 8 | 38 | CLASS 4 (POOR ROCK) | 42.00-43.50 | Core Rock | 1.5 |
| 251.974 | 43.5 | 45.0 | | Highly Fractured and Jointed | 30 | 6 | 35 | CLASS 4 (POOR ROCK) | 43.50-45.00 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| (m) no | Dept | :h (m) | | al conditions | | QD | | RMR | | Samples | ALUE |
|---------|------|--------|---|------------------------------------|--------------|----|--------|------------------------------|---------------------------|---------------------|------|
| Elevati | Тор | Bottom | Lithology | Structural | % Core-Re | Ж | Rating | Class | Depth of sample (m) | sample Collected | Q VI |
| 250.472 | 45.0 | 46.5 | | Highly Fractured and Jointed | 26 | 0 | 35 | CLASS 4 (POOR ROCK) | 45.00-46.50 | Core Rock | 1.5 |
| 248.97 | 46.5 | 48.0 | | Highly Fractured and Jointed | 38 | 27 | 40 | CLASS 4 (POOR ROCK) | 46.50-48.00 | Core Rock | 4.05 |
| 247.468 | 48.0 | 49.5 | | Highly Fractured and Jointed | 29 | 10 | 35 | CLASS 4 (POOR ROCK) | 48.00-49.50 | Core Rock | 1.5 |
| 245.966 | 49.5 | 51.0 | Slightly Weathered, | Highly Fractured and Jointed | 22 | 0 | 35 | CLASS 4 (POOR ROCK) | 49.50-51.00 | Core Rock | 1.5 |
| 244.464 | 51.0 | 52.5 | Highly Fractured, Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron | Highly Fractured and Jointed | 26 | 15 | 35 | CLASS 4 (POOR ROCK) | 51.00-52.50 | Core Rock | 2.25 |
| 242.962 | 52.5 | 54.0 | Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 20 | 10 | 35 | CLASS 4 (POOR ROCK) | 52.50-54.00 | Core Rock | 1.5 |
| 241.46 | 54.0 | 55.5 | | Highly Fractured and Jointed | 26 | 0 | 35 | CLASS 4 (POOR ROCK) | 54.00-55.50 | Core Rock | 1.5 |
| 239.958 | 55.5 | 57.0 | | Highly Fractured and Jointed | 20 | 0 | 35 | CLASS 4 (POOR ROCK) | 55.50-57.00 | Core Rock | 1.5 |
| 238.456 | 57.0 | 58.5 | | Highly Fractured and Jointed | 25 | 0 | 35 | CLASS 4 (POOR ROCK) | 57.00-58.50 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Elevation (m) | Dept d L | Bottom (m) | Lithology | structural conditions | % of Core-Recovery | % RQD | Rating | AWR Class C | Depth of sample (m) | sampie Collected Samples | Q VALUE |
|---------------|----------------|------------|---|------------------------------------|-----------------------|-------|--------|------------------------------|---------------------------|-----------------------------|---------|
| 236.954 | 58.5 | 60.0 | | Highly Fractured and Jointed | 34 | 0 | 35 | CLASS 4 (POOR ROCK) | 58.50-60.00 | Core Rock | 1.5 |
| 235.452 | 60.0 | 61.5 | | Highly Fractured and Jointed | 28 | 24 | 24 | CLASS 4 (POOR ROCK) | 60.00-61.50 | | 3.6 |
| 233.95 | 61.5 | 63.0 | | Highly Fractured and Jointed | 20 | 8 | 24 | CLASS 4 (POOR ROCK) | 61.50-63.00 | | 1.5 |
| 232.448 | 63.0 | 64.5 | Slightly Weathered, Highly Fractured, Jointed, Light Grey, Fine Grained, | Highly Fractured and Jointed | 32 | 16 | 24 | CLASS 4 (POOR ROCK) | 63.00-64.50 | | 2.4 |
| 230.946 | 64.5 | 66.0 | Interlocking Texture, Iron Leaching, very Hard, Quartzite | Highly Fractured and Jointed | 31 | 14 | 24 | CLASS 4 (POOR ROCK) | 64.50-66.00 | | 2.1 |
| 229.444 | 66.0 | 67.5 | | Highly Fractured and Jointed | 27 | 9 | 24 | CLASS 4 (POOR ROCK) | 66.00-67.50 | | 1.5 |
| 227.942 | 67.5 | 69.0 | | Highly Fractured and Jointed | 28 | 8 | 24 | CLASS 4 (POOR ROCK) | 67.50-69.00 | | 1.5 |
| 226.44 | 69.0 | 70.0 | | Highly Fractured and Jointed | 57 | 10 | 24 | CLASS 4 (POOR ROCK) | 69.00-70.00 | | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| BORE HOLE ID : | 15(A) | LONGIT UDE | 77°2 32'' | 2'30.0 E | LOCATION: | Sohna | STRUCTU | Tunnel | |
|--------------------------|------------|----------------------------|---------------|---------------|----------------------------|----------------------------|----------------|----------------|--|
| CHAINAG E (Km) | 25488 | LATTIT UDE | 28°1 555 | 12'38. ''N | TOTAL DEPTH: | 50.0m | RE | | |
| START DATE | 15-09-2021 | GROUND ELEVATI MSL : | ON | 276.4 42 | TYPE OF CORE BARREL: | Double Tube Core Barrel | TYPE OF BIT | Diamond Bit | |
| COMPLET ED DATE | 01-10-2021 | ANGLE W HORIZON | /ITH NT: 9 | 0° | DEPTH OF WATER TABLE | 10.0 m | CASING | | |
| BORING TYPE&SIZ E: | | DRILLI AGENC | NG Y | | WATER TABLE RECORD DATE | 02-10-2021 | | | |
| | | S.M Con | sulta | nts | NAME OF GEOLOGIST | Gaurav Chunekar | | | |

| | Bh-15(A) Ch. No. 24820 Total Depth 50m | | | | | | | | | | | |
|---------------|--|--------|--|---------------------------------------|--------------|-------|--------|--------------------|------------------------|-----------|---------|--|
| | Dept | h (m) | | | > | | | RMR | Samples | | | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | Core-Recover | ada % | Rating | Class | Depth of sample (m) | Collected | Q VALUE | |
| 276.442 | 0.0 | 1.5 | | Highly Fractured and Jointed | 28 | 0 | 36 | CLASS 3(FAIR ROCK) | 0.00-1.50 | Core Rock | 1.5 | |
| 274.94 | 1.5 | 3.0 | Moderately Weathered, Grey, Fine Grained, Interlocking | Highly Fractured and Jointed | 39 | 10 | 36 | CLASS 3(FAIR ROCK) | 1.50-3.00 | Core Rock | 1.5 | |
| 273.438 | 3.0 | 4.5 | Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 32 | 21 | 36 | CLASS 3(FAIR ROCK) | 3.00-4.50 | Core Rock | 3.15 | |
| 271.936 | 4.5 | 6.0 | | Highly Fractured and Jointed | 35 | 0 | 36 | CLASS 3(FAIR ROCK) | 4.50-6.00 | Core Rock | 1.5 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | | | | Bh-15(A) | Ch. No. | 24820 | Tota | l Depth 50m | | | |
|---------------|------|--------|--|---------------------------------------|----------------------|-------|--------|--------------------|------------------------|-----------|---------|
| | Dept | h (m) | | | > | | | RMR | Samples | | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | % of Core-Recover | % RQD | Rating | Class | Depth of sample (m) | Collected | Q VALUE |
| 270.434 | 6.0 | 7.5 | | Highly Fractured and Jointed | 45 | 28 | 43 | CLASS 3(FAIR ROCK) | 6.00-7.50 | Core Rock | 4.2 |
| 268.932 | 7.5 | 9.0 | | Highly Fractured and Jointed | 21 | 0 | 38 | CLASS 3(FAIR ROCK) | 7.50-9.00 | Core Rock | 1.5 |
| 267.43 | 9.0 | 10.5 | | Highly Fractured and Jointed | 50 | 30 | 43 | CLASS 3(FAIR ROCK) | 9.00-10.50 | Core Rock | 4.5 |
| 265.928 | 10.5 | 12.0 | Slightly Weathered, Grey, Fine Grained, | Highly Fractured and Jointed | 35 | 22 | 27 | CLASS 3(FAIR ROCK) | 10.50-12.00 | Core Rock | 3.3 |
| 264.426 | 12.0 | 13.5 | Interlocking Texture, Iron Leaching, Very Hard, Ouartzite | Highly Fractured and Jointed | 32 | 8 | 27 | CLASS 3(FAIR ROCK) | 12.00-13.50 | Core Rock | 1.5 |
| 262.924 | 13.5 | 15.0 | Qualizite | Highly Fractured and Jointed | 47 | 32 | 32 | CLASS 3(FAIR ROCK) | 13.50-15.00 | Core Rock | 4.8 |
| 261.422 | 15.0 | 16.5 | | Highly Fractured and Jointed | 28 | 8 | 27 | CLASS 3(FAIR ROCK) | 15.00-16.50 | Core Rock | 1.5 |
| 259.92 | 16.5 | 18.0 | | Highly Fractured and Jointed | 41 | 7 | 27 | CLASS 3(FAIR ROCK) | 16.50-18.00 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|-----------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \otimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | Bh-15(A) Ch. No. 24820 Total Depth 50m | | | | | | | | | | | |
|---------------|--|--------|--|---------------------------------------|----------------------|-------|--------|--------------------|------------------------|-----------|---------|--|
| | Dept | h (m) | | | > | | | RMR | Samples | | | |
| Elevation (m) | Тор | Bottom | Lithology | Structural conditions | % of Core-Recover | % RQD | Rating | Class | Depth of sample (m) | Collected | Q VALUE | |
| 258.418 | 18.0 | 19.5 | | Highly Fractured and Jointed | 36 | 16 | 27 | CLASS 3(FAIR ROCK) | 18.00-19.50 | Core Rock | 2.4 | |
| 256.916 | 19.5 | 21.0 | | Highly Fractured and Jointed | 45 | 20 | 27 | CLASS 3(FAIR ROCK) | 19.50-21.00 | Core Rock | 3 | |
| 255.414 | 21.0 | 22.5 | | Highly Fractured and Jointed | 30 | 15 | 27 | CLASS 3(FAIR ROCK) | 21.00-22.50 | Core Rock | 2.25 | |
| 253.912 | 22.5 | 24.0 | Slightly | Highly Fractured and Jointed | 36 | 0 | 27 | CLASS 3(FAIR ROCK) | 22.50-24.00 | Core Rock | 1.5 | |
| 252.41 | 24.0 | 25.5 | Weathered, Grey, Fine Grained, Interlocking Texture, | Highly Fractured and Jointed | 27 | 0 | 27 | CLASS 3(FAIR ROCK) | 24.00-25.50 | Core Rock | 1.5 | |
| 250.908 | 25.5 | 27.0 | Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 40 | 15 | 27 | CLASS 3(FAIR ROCK) | 25.50-27.00 | Core Rock | 2.25 | |
| 249.406 | 27.0 | 28.5 | | Highly Fractured and Jointed | 32 | 23 | 27 | CLASS 3(FAIR ROCK) | 27.00-28.50 | Core Rock | 3.45 | |
| 247.904 | 28.5 | 30.0 | | Highly Fractured and Jointed | 34 | 0 | 27 | CLASS 3(FAIR ROCK) | 28.50-30.00 | Core Rock | 1.5 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|----------------|----------------|---------------------|--|
| S. M. | SM CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | Bh-15(A) Ch. No. 24820 Total Depth 50m | | | | | | | | | | | |
|---------------|--|--------|--|---------------------------------------|-----------------------|-------|--------|--------------------|------------------------|-----------|---------|--|
| | Dept | h (m) | | | ~ | | | RMR | Samples | | | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | % of Core-Recovery | % RQD | Rating | Class | Depth of sample (m) | Collected | Q VALUE | |
| 246.402 | 30.0 | 31.5 | | Highly Fractured and Jointed | 34 | 22 | 27 | CLASS 3(FAIR ROCK) | 30.00-31.50 | Core Rock | 3.3 | |
| 244.9 | 31.5 | 33.0 | Slightly Weathered, Grey, Fine Grained, Interlocking Texture, | Highly Fractured and Jointed | 30 | 15 | 27 | CLASS 3(FAIR ROCK) | 31.50-33.00 | Core Rock | 2.25 | |
| 243.398 | 33.0 | 34.5 | Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 30 | 8 | 27 | CLASS 3(FAIR ROCK) | 33.00-34.50 | Core Rock | 1.5 | |
| 241.896 | 34.5 | 36.0 | | Highly Fractured and Jointed | 36 | 0 | 27 | CLASS 3(FAIR ROCK) | 34.50-36.00 | Core Rock | 1.5 | |
| 240.394 | 36.0 | 37.5 | | Highly Fractured and Jointed | 37 | 23 | 27 | CLASS 3(FAIR ROCK) | 36.00-37.50 | Core Rock | 3.45 | |
| 238.892 | 37.5 | 39.0 | | Highly Fractured and Jointed | 40 | 7 | 27 | CLASS 3(FAIR ROCK) | 37.50-39.00 | Core Rock | 1.5 | |
| 237.39 | 39.0 | 40.5 | | Highly Fractured and Jointed | 50 | 10 | 27 | CLASS 3(FAIR ROCK) | 39.00-40.50 | Core Rock | 1.5 | |
| 235.888 | 40.5 | 42.0 | | Highly Fractured and Jointed | 34 | 0 | 27 | CLASS 3(FAIR ROCK) | 40.50-42.00 | Core Rock | 1.5 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: | |
|--------------|------------------|----------------|---------------------|--|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail | |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd | |

| | Bh-15(A) Ch. No. 24820 Total Depth 50m | | | | | | | | | | | |
|---------------|--|--------|--|---------------------------------------|----------------------|-------|--------|--------------------|------------------------|-----------|---------|--|
| | Dept | h (m) | | | > | | | RMR | Samples | | | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | % of Core-Recover | % RQD | Rating | Class | Depth of sample (m) | Collected | Q VALUE | |
| 234.386 | 42.0 | 43.5 | Slightly Weathered, Grey, Fine Grained, | Highly Fractured and Jointed | 32 | 8 | 27 | CLASS 3(FAIR ROCK) | 42.00-43.50 | Core Rock | 1.5 | |
| 232.884 | 43.5 | 45.0 | Interlocking Texture, Iron Leaching, Very Hard, Quartzite | Highly Fractured and Jointed | 35 | 0 | 27 | CLASS 3(FAIR ROCK) | 43.50-45.00 | Core Rock | 1.5 | |
| 231.382 | 45.0 | 46.5 | Qualizite | Highly Fractured and Jointed | 30 | 0 | 27 | CLASS 3(FAIR ROCK) | 45.00-46.50 | Core Rock | 1.5 | |
| 229.88 | 46.5 | 48.0 | | Highly Fractured and Jointed | 36 | 7 | 27 | CLASS 3(FAIR ROCK) | 46.50-48.00 | Core Rock | 1.5 | |
| 228.378 | 48.0 | 49.5 | | Highly Fractured and Jointed | 40 | 8 | 27 | CLASS 3(FAIR ROCK) | 48.00-49.50 | Core Rock | 1.5 | |
| 226.876 | 49.5 | 50.0 | | Highly Fractured and Jointed | 40 | 0 | 27 | CLASS 3(FAIR ROCK) | 49.50-50.00 | Core Rock | 1.5 | |

| | Consultant: | Geotechnical | nvestigation Report | Client: | | |
|----------|------------------|--------------|---------------------|--|--|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail | | |
| \Im | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd | | |

| BORE HOLE ID : | 16 | LONGIT UDE | 77°2 39'' | 2'27.2 E | LOCATION: | Sohna | STRUCTU | Tunnol | |
|--------------------------|------------|----------------------------|---------------------------------------|-------------|----------------------------|----------------------------|----------------|-------------------|--|
| CHAINAG E (Km) | 25586 | LATTIT UDE | 28°1 66'' | 12'40. N | TOTAL DEPTH: | 62m | RE | Tunner | |
| START DATE | 26-08-2021 | GROUND ELEVATI MSL : | GROUND ELEVATION 287.3 MSL : 24 | | TYPE OF CORE BARREL: | Double Tube Core Barrel | TYPE OF BIT | Diamond Bit | |
| COMPLET ED DATE | 10-09-2021 | ANGLE W HORIZON | /ITH NT: 9 | 0° | DEPTH OF WATER TABLE | 50.0m | CASING | NX up to 3.0 m | |
| BORING TYPE&SIZ E: | | DRILLI AGENC | DRILLING AGENCY | | WATER TABLE RECORD DATE | 11-09-2021 | | | |
| | | S.M Con | S.M Consultants | | NAME OF GEOLOGIST | Gaurav Chunekar | - | | |

| | | | | Bh-16 ;Tc | otal Dept | h 62n | n | | | | |
|---------------|------|--------|--|---------------------------------------|-----------------------|-------|--------|--------------------------|------------------------|-----------------------------|---------|
| | Dept | h (m) | | | | | | RMR | Sampl | es | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | % of Core-Recovery | KQD | Rating | Class | Depth of sample (m) | Type of Sample Collected | Q VALUE |
| 287.324 | 0.0 | 1.5 | Moderately Weathered, , Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite (DS and DS Wash Collected) | Highly Fractured and Jointed | 16 | 0 | 33 | CLASS 3(FAIR ROCK) | 0.00-1.50 | Core Rock | 1.5 |
| 285.82 | 1.5 | 3.0 | Moderately Weathered, , Grey , Fine Grained, Interlocking | Highly Fractured and Jointed | 25 | 0 | 33 | CLASS 3(FAIR ROCK) | 1.50-3.00 | Core Rock | 1.5 |
| 284.316 | 3.0 | 4.5 | Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 32 | 0 | 33 | CLASS 3(FAIR ROCK) | 3.00-4.50 | Core Rock | 1.5 |
| 282.812 | 4.5 | 6.0 | | Highly Fractured and Jointed | 32 | 0 | 33 | CLASS 3(FAIR ROCK) | 4.50-6.00 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: | |
|--------------|------------------|----------------|---------------------|--|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail | |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd | |

| | | | | Bh-16 ;To | otal Dept | h 62n | n | | | | |
|---------------|------|--------|---|---------------------------------------|-----------------------|-------|--------|--------------------------|------------------------|-----------------------------|---------|
| | Dept | h (m) | | | | | | RMR | Sampl | es | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | % of Core-Recovery | % RQD | Rating | Class | Depth of sample (m) | Type of Sample Collected | Q VALUE |
| 281.308 | 6.0 | 7.5 | Moderately Weathered, , Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 30 | 0 | 33 | CLASS 3(FAIR ROCK) | 6.00-7.50 | Core Rock | 1.5 |
| 279.804 | 7.5 | 9.0 | | Highly Fractured and Jointed | 31 | 10 | 35 | CLASS 3(FAIR ROCK) | 7.50-9.00 | Core Rock | 1.5 |
| 278.3 | 9.0 | 10.5 | Slightly Weathered, Grey, Fine Grained, | Highly Fractured and Jointed | 30 | 0 | 35 | CLASS 3(FAIR ROCK) | 9.00- 10.50 | Core Rock | 1.5 |
| 276.796 | 10.5 | 12.0 | Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 34 | 0 | 35 | CLASS 3(FAIR ROCK) | 10.50- 12.00 | Core Rock | 1.5 |
| 275.292 | 12.0 | 13.5 | | Highly Fractured and Jointed | 31 | 15 | 38 | CLASS 3(FAIR ROCK) | 12.00- 13.50 | Core Rock | 2.2995 |
| 273.788 | 13.5 | 15.0 | Slightly Weathered, Grey, Fine | Highly Fractured and Jointed | 27 | 10 | 38 | CLASS 3(FAIR ROCK) | 13.50- 15.00 | Core Rock | 1.5 |
| 272.284 | 15.0 | 16.5 | Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 36 | 19 | 38 | CLASS 3(FAIR ROCK) | 15.00- 16.50 | Core Rock | 2.85 |
| 270.78 | 16.5 | 18.0 | Hard Quartzite | Highly Fractured and Jointed | 28 | 15 | 38 | CLASS 3(FAIR ROCK) | 16.50- 18.00 | Core Rock | 2.295 |

| | Consultant: | Geotechnical | nvestigation Report | Client: | |
|--------------|------------------|--------------|---------------------|--|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail | |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd | |

| | Bh-16 ;Total Depth 62m | | | | | | | | | | | |
|---------------|------------------------|--------|---|---------------------------------------|-----------------------|-------|--------|--------------------------|------------------------|-----------------------------|---------|--|
| | Dept | h (m) | | | , | | | RMR | Sampl | es | | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | % of Core-Recovery | % RQD | Rating | Class | Depth of sample (m) | Type of Sample Collected | Q VALUE | |
| 269.276 | 18.0 | 19.5 | | Highly Fractured and Jointed | 46 | 36 | 43 | CLASS 3(FAIR ROCK) | 18.00- 19.50 | Core Rock | 5.445 | |
| 267.772 | 19.5 | 21.0 | | Highly Fractured and Jointed | 48 | 0 | 38 | CLASS 3(FAIR ROCK) | 19.50- 21.00 | Core Rock | 1.5 | |
| 266.268 | 21.0 | 22.5 | Slightly Weathered, Grev Fine | Highly Fractured and Jointed | 44 | 14 | 38 | CLASS 3(FAIR ROCK) | 21.00- 22.50 | Core Rock | 2.1 | |
| 264.764 | 22.5 | 24.0 | Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 43 | 11 | 38 | CLASS 3(FAIR ROCK) | 22.50- 24.00 | Core Rock | 1.65 | |
| 263.26 | 24.0 | 25.5 | | Highly Fractured and Jointed | 42 | 28 | 43 | CLASS 3(FAIR ROCK) | 24.00- 25.50 | Core Rock | 4.2 | |
| 261.756 | 25.5 | 27.0 | | Highly Fractured and Jointed | 34 | 15 | 38 | CLASS 3(FAIR ROCK) | 25.50- 27.00 | Core Rock | 2.25 | |
| 260.252 | 27.0 | 28.5 | | Highly Fractured and Jointed | 53 | 47 | 43 | CLASS 3(FAIR ROCK) | 27.00- 28.50 | Core Rock | 7.05 | |
| 258.748 | 28.5 | 30.0 | | Highly Fractured and Jointed | 31 | 8 | 38 | CLASS 3(FAIR ROCK) | 28.50- 30.00 | Core Rock | 1.5 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: | |
|----------|------------------|----------------|---------------------|--|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: 830 | | Haryana Rail | |
| | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd | |

| | Bh-16 ;Total Depth 62m | | | | | | | | | | |
|---------------|------------------------|--------|--|---------------------------------------|----------------------|-------|--------|--------------------------|------------------------|-----------------------------|---------|
| | Dept | h (m) | | | | | | RMR | Sampl | es | |
| Elevation (m) | Тор | Bottom | Lithology | Structural conditions | % of Core-Recover | % RQD | Rating | Class | Depth of sample (m) | Type of Sample Collected | Q VALUE |
| 257.244 | 30.0 | 31.5 | | Highly Fractured and Jointed | 39 | 34 | 43 | CLASS 3(FAIR ROCK) | 30.00- 31.50 | Core Rock | 5.1 |
| 255.74 | 31.5 | 33.0 | | Highly Fractured and Jointed | 30 | 14 | 38 | CLASS 3(FAIR ROCK) | 31.50- 33.00 | Core Rock | 2.1 |
| 254.236 | 33.0 | 34.5 | Slightly Weathered, Grey, Fine Grained, Interlocking | Highly Fractured and Jointed | 36 | 25 | 43 | CLASS 3(FAIR ROCK) | 33.00- 34.50 | Core Rock | 3.75 |
| 252.732 | 34.5 | 36.0 | Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 30 | 22 | 38 | CLASS 3(FAIR ROCK) | 34.50- 36.00 | Core Rock | 3.3 |
| 251.228 | 36.0 | 37.5 | | Highly Fractured and Jointed | 37 | 22 | 38 | CLASS 3(FAIR ROCK) | 36.00- 37.50 | Core Rock | 3.3 |
| 249.724 | 37.5 | 39.0 | Slightly Weathered, Grey, Fine Grained, | Highly Fractured and Jointed | 30 | 8 | 38 | CLASS 3(FAIR ROCK) | 37.50- 39.00 | Core Rock | 1.5 |
| 248.22 | 39.0 | 40.5 | Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 34 | 20 | 38 | CLASS 3(FAIR ROCK) | 39.00- 40.50 | Core Rock | 3 |
| 246.716 | 40.5 | 42.0 | Slightly Weathered, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 36 | 0 | 38 | CLASS 3(FAIR ROCK) | 40.50- 42.00 | Core Rock | 1.5 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | Bh-16 ;Total Depth 62m | | | | | | | | | | | |
|---------------|------------------------|--------|---|---------------------------------------|-----------------------|-------|--------|--------------------------|------------------------|-----------------------------|---------|--|
| | Dept | h (m) | | | 1 | | | RMR | Sampl | es | | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | % of Core-Recovery | % RQD | Rating | Class | Depth of sample (m) | Type of Sample Collected | Q VALUE | |
| 245.212 | 42.0 | 43.5 | Slightly Weathered, Grey, Fine Grained, | Highly Fractured and Jointed | 42 | 17 | 38 | CLASS 3(FAIR ROCK) | 42.00- 43.50 | Core Rock | 2.49 | |
| 243.708 | 43.5 | 45.0 | Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 44 | 44 | 43 | CLASS 3(FAIR ROCK) | 43.50- 45.00 | Core Rock | 6.6 | |
| 242.204 | 45.0 | 46.5 | Slightly Weathered, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 37 | 0 | 38 | CLASS 3(FAIR ROCK) | 45.00- 46.50 | Core Rock | 1.5 | |
| 240.7 | 46.5 | 48.0 | Slightly | Highly Fractured and Jointed | 53 | 51 | 48 | CLASS 3(FAIR ROCK) | 46.50- 48.00 | Core Rock | 7.695 | |
| 239.196 | 48.0 | 49.5 | Weathered, , Grey, Fine Grained, Interlocking Texture, Iron | Highly Fractured and Jointed | 45 | 15 | 38 | CLASS 3(FAIR ROCK) | 48.00- 49.50 | Core Rock | 2.295 | |
| 237.692 | 49.5 | 51.0 | Hard Quartzite | Highly Fractured and Jointed | 38 | 27 | 43 | CLASS 3(FAIR ROCK) | 49.50- 51.00 | Core Rock | 3.99 | |
| 236.188 | 51.0 | 52.5 | Slightly Weathered, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very | Highly Fractured and Jointed | 40 | 29 | 43 | CLASS 3(FAIR ROCK) | 51.00- 52.50 | | 4.395 | |

| | Consultant: | Geotechnical | Investigation Report | Client: |
|--------------|------------------|--------------|----------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | Bh-16 ;Total Depth 62m | | | | | | | | | | | |
|---------------|------------------------|--------|--|---------------------------------------|-----------------------|-------|--------|--------------------------|------------------------|-----------------------------|---------|--|
| | Dept | h (m) | | | | | | RMR | Sampl | es | | |
| Elevation (m) | Top | Bottom | Lithology | Structural conditions | % of Core-Recovery | % RQD | Rating | Class | Depth of sample (m) | Type of Sample Collected | Q VALUE | |
| 234.684 | 52.5 | 54.0 | Hard, Quartzite (Weathered Medium Grained Garnet Grains, Contact of Phyllite Band Noticed) | Highly Fractured and Jointed | 43 | 16 | 38 | CLASS 3(FAIR ROCK) | 52.50- 54.00 | | 2.445 | |
| 233.18 | 54.0 | 55.5 | | Highly Fractured and Jointed | 43 | 21 | 38 | CLASS 3(FAIR ROCK) | 54.00- 55.50 | | 3.15 | |
| 231.676 | 55.5 | 57.0 | | Highly Fractured and Jointed | 31 | 8 | 38 | CLASS 3(FAIR ROCK) | 55.50- 57.00 | | 1.5 | |
| 230.172 | 57.0 | 58.5 | Slightly Weathered, , Grey, Fine Grained, | Highly Fractured and Jointed | 30 | 18 | 30 | CLASS 3(FAIR ROCK) | 57.00- 58.50 | | 2.64 | |
| 228.668 | 58.5 | 60.0 | Interlocking Texture, Iron Leaching, Very Hard Quartzite | Highly Fractured and Jointed | 25 | 20 | 30 | CLASS 3(FAIR ROCK) | 58.50- 60.00 | | 3 | |
| 227.164 | 60.0 | 61.5 | | Highly Fractured and Jointed | 32 | 24 | 30 | CLASS 3(FAIR ROCK) | 60.00- 61.50 | | 3.645 | |
| 225.66 | 61.5 | 62.0 | | Highly Fractured and Jointed | 66 | 9 | 30 | CLASS 3(FAIR ROCK) | 61.50- 62.00 | | 1.5 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| BORE HOLE ID : | BH 17 | LONGIT UDE | 77°2 32'' | 2'30.0 E | LOCATION: | Sohna | STRUCTU | Tunnol | |
|--------------------------|------------|----------------------------|----------------------|---------------|----------------------------|----------------------------|----------------|----------------|--|
| CHAINAG E (Km) | 25785 | LATTIT UDE | 28°1 555 | 12'38. ''N | TOTAL DEPTH: | 50.0m | RE | Tunner | |
| START DATE | 15-09-2021 | GROUND ELEVATI MSL : | ND 276.4 ATION 42 | | TYPE OF CORE BARREL: | Double Tube Core Barrel | TYPE OF BIT | Diamond Bit | |
| COMPLET ED DATE | 01-10-2021 | ANGLE W HORIZON | /ITH NT: 9 | 00 | DEPTH OF WATER TABLE | 10.0 m | CASING | | |
| BORING TYPE&SIZ E: | | DRILLI AGENC | DRILLING AGENCY | | WATER TABLE RECORD DATE | 02-10-2021 | | | |
| | | S.M Con | S.M Consultants | | NAME OF GEOLOGIST | Gaurav Chunekar | | | |

| | | | Bh-17 ;Total | Depth 75n | n | | | | |
|----------|-------|--|---|----------------|------|--------|-------|--------------------------------|------|
| (m) nd | (m) | conditions | | of covery | Q | RI | ٧R | Samples | LUE |
| Elevatio | Depth | Lithology | Structural c | % c Core-Re | % R(| Rating | Class | Type of Sample Collected | Q VA |
| 282.46 | 0 | | | 0 | 0 | NA | NA | | 0 |
| 280.961 | 1.5 | Brown colour, very fine to fine grained, clayey silt deposit | very fine to fine grained, clayey silt deposit | 0 | 0 | NA | NA | | 0 |
| 279.461 | 3 | to fine posit | | 0 | 0 | NA | NA | | 0 |
| 277.96 | 4.5 | very fine ey silt de | very fine to fine grained, clayey silt deposit | 0 | 0 | NA | NA | | 0 |
| 276.46 | 9 | n colour, ined, clay | | 0 | 0 | NA | NA | | 0 |
| 274.96 | 6 | Browi | | 0 | 0 | NA | NA | | 0 |
| 273.461 | 12 | Brown colour, very fine to fine grained, clayey silt with gravels | very fine to fine grained, clayey silt with gravels | 0 | 0 | NA | NA | | 0 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | | | Bh-17 ;Total | Depth 75n | n | - | | - | - |
|----------|-------|---|---|---------------|------|--------|---------------------------|--------------------------------|------|
| (m) nc | (ա) ւ | | conditions | of :covery | QD | RI | VIR | Samples | ILUE |
| Elevatio | Depth | Lithology | Structural (| % core-Re | % R | Rating | Class | Type of Sample Collected | Q VA |
| 271.96 | 15 | | | 0 | 0 | NA | NA | | 0 |
| 270.46 | 16.5 | | | 0 | 0 | NA | NA | | 0 |
| 268.961 | 18 | Brown colour, very fine to fine grained, sub angular to sub rounded pebbels with clayey silt. | It shows very fine to fine grained, sub angular to sub rounded pebbels clayey silt. | 0 | 0 | NA | NA | | 0 |
| 267.461 | 19.5 | vinted, Grey, Fine Grained, ing, Hard Quartzite. | Joints of 0°,45° | 17 | 0 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 265.961 | 20.5 | actured, Jc Iron Leachi | Closed Joint of 10° | 22 | 0 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 264.461 | 22 | , Highly Fr | It shows highly fractured weathered rock | 25 | 11.6 | 47 | CLASS 3(FAIR ROCK) | Core Rock | 0 |
| 262.961 | 23 | Veathered iterlocking | | 32 | 0 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 261.461 | 24.5 | Highly V Ir | | 33 | 0 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |

| | Consultant: | Geotechnical | Investigation Report | Client: |
|--------------|------------------|--------------|----------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | | | Bh-17 ;Total | Depth 75n | n | | | | |
|----------|-------|---|---|----------------|-------|--------|---------------------------|--------------------------------|------|
| (m) no | (ա) ւ | | conditions | of covery | Q | RI | MR | Samples | TUE |
| Elevatio | Depth | Lithology | Structural c | % (Core-Re | % R(| Rating | Class | Type of Sample Collected | Q VA |
| 259.961 | 25 | erately Fractured, terlocking Texture, d Quartzite. | Joints of 0°,10°,15° | 48 | 25 | 47 | CLASS 3(FAIR ROCK) | Core Rock | 1 |
| 258.461 | 26 | ered, Mod ŝrained, In , Very Har | Joints of 0°, 15°,80° | 59 | 32.6 | 43 | CLASS 3(FAIR ROCK) | Core Rock | 1 |
| 256.961 | 27.5 | ely Weath rey, Fine G n Leaching | Joints of 0°,10°,15°,20° | 44 | 12.66 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 255.461 | 28 | Moderat Jointed, G Iro | | 68 | 25.8 | 43 | CLASS 3(FAIR ROCK) | Core Rock | 1 |
| 253.961 | 29.5 | Highly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Hard Quartzite. | It shows highly fractured weathered rock | 58 | 7.6 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 252.461 | 30 | athered, Highly Fractured, y, Fine Grained, Interlocking Iron Leaching, Very Hard Quartzite | Joints of 0°,10°,15°, 70° | 70 | 0 | 47 | CLASS 3(FAIR ROCK) | Core Rock | 0 |
| 250.961 | 31 | Slightly We Jointed, Grey Texture, I | It shows highly angular fractured and jointed, weak strength | 47 | 17.13 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Bh-17 ;Total Depth 75m | | | | | | | | | |
|------------------------|-----------|---|---|----------------|-------|--------|-----------------------------------|--------------------------------|-------|
| (m) n | Depth (m) | | onditions | of covery | đ | RMR | | Samples | -UE |
| Elevatio | | Lithology | Structural c | % c Core-Re | % R(| Rating | Class | Type of Sample Collected | Q VAI |
| 249.461 | 32.5 | | | 64 | 0 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 247.961 | 33.5 | Slightly Weathered, Moderately Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | | 54 | 15.53 | 40 | CLASS 4 (POOR ROCK) | | 0 |
| 246.461 | 35 | Slightly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite.(crushed zone) | | 34.66 | 0 | 40 | CLASS 4 (POOR ROCK) | | 0 |
| 244.961 | 36.5 | se grained, ided) | Coarse grained, Sand. (SPT Rebounded) | 0 | 0 | 0 | CLASS 5 (VERY POOR ROCK) | | 0 |
| 243.461 | 38 | רססמר, Coar (SPT Rebour | | 0 | 0 | 0 | CLASS 5 (VERY POOR ROCK) | Core Rock | 0 |
| 241.961 | 39.5 | Light Browr Sand. | | 0 | 0 | 0 | CLASS 5 (VERY POOR ROCK) | Core Rock | 0 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: | | |
|--------------|------------------|----------------|---------------------|--------------------------------|--|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail | | |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Development Corporation Ltd | | |

| Bh-17 ;Total Depth 75m | | | | | | | | | |
|------------------------|-----------|----------------------------|--------------|----------------|------------------------|--------|---------------------------|--------------------------------|-------|
| Elevation (m) | Depth (m) | | onditions | of covery | Core-Recovery % RQD | RMR | | Samples | -UE |
| | | Lithology | Structural c | % c Core-Re | | Rating | Class | Type of Sample Collected | Q VAI |
| 240.461 | 41 | ned, Interlocking Texture, | | 32 | 11 | 47 | CLASS 3(FAIR ROCK) | Core Rock | 0 |
| 238.961 | 42.5 | , Fine Grai | | 41.33 | 19.33 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 237.461 | 44 | nted, Grey. rtzite | | 54 | 41.53 | 43 | CLASS 3(FAIR ROCK) | Core Rock | 1 |
| 235.961 | 45.5 | ttured, Joir Hard Qua | | 30 | 16.66 | 47 | CLASS 3(FAIR ROCK) | Core Rock | 0 |
| 234.461 | 47 | lighly Frac | | 37.33 | 0 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 232.961 | 48.5 | erately to H Iron Leac | | 41.33 | 21.06 | 47 | CLASS 3(FAIR ROCK) | Core Rock | 0 |
| 231.461 | 50 | rred, Mode | | 30 | 0 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 229.961 | 51.5 | ly Weathe | | 36.66 | 0 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 228.461 | 53 | ey to Slight | | 34.66 | 12 | 40 | CLASS 4 (POOR ROCK) | Core Rock | 0 |
| 226.961 | 54.5 | Moderate | | 33.33 | 6.8 | 47 | CLASS 3(FAIR ROCK) | Core Rock | 0 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: | | |
|----------|---------------------------------|-------------------------|---------------------|--|--|--|
| S. M. C. | S.M. CONSULTANTS BHUBANESWAR | Job No.: Report No.: | 830 SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | |

| | Bh-17 ;Total Depth 75m | | | | | | | | | |
|---------------|------------------------|-----------|-----------------------|-----------------------|-------|--------|---------------------------|--------------------------------|------|--|
| Elevation (m) | Depth (m) | | Structural conditions | % of Core-Recovery | % RQD | RMR | | Samples | LUE | |
| | | Lithology | | | | Rating | Class | Type of Sample Collected | Q VA | |
| 225.461 | 56 | | | 28 | 6.73 | 32 | CLASS 4 (POOR ROCK) | Core Rock | 0 | |
| 223.961 | 58 | | | 38 | 8 | 32 | CLASS 4 (POOR ROCK) | Core Rock | 0 | |
| 222.461 | 59.5 | | | 38.33 | 0 | 39 | CLASS 4 (POOR ROCK) | Core Rock | 0 | |
| 220.961 | 61 | | | 40.6 | 27.66 | 35 | CLASS 4 (POOR ROCK) | Core Rock | 1 | |
| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|----------|------------------|----------------|---------------------|--------------------------------|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| Ø | BHUBANESWAR | Report No.: | SMC/2050 | Development Corporation Ltd |

ANNEXURE –B Tensile Strength

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

Tensile Strength

| Sr.No. | BH NO. | Dep | oth | Tensile Strength Test |
|--------|--------|-------|-------|-----------------------|
| | | From | То | (MPa) |
| 1 | | 0.50 | 1.50 | 14.21 |
| 2 | | 1.50 | 3.00 | |
| 3 | | 3.00 | 4.50 | |
| 4 | | 4.50 | 6.00 | |
| 5 | | 6.00 | 7.50 | |
| 6 | | 7.50 | 9.00 | |
| 7 | | 9.00 | 10.50 | |
| 8 | | 10.50 | 12.00 | 14.12 |
| 9 | | 15.00 | 16.50 | |
| 10 | | 16.50 | 18.00 | |
| 11 | | 18.00 | 19.50 | |
| 12 | | 19.50 | 21.00 | 14.34 |
| 13 | | 21.00 | 22.50 | |
| 14 | BH-13 | 22.50 | 24.00 | |
| 15 | | 24.00 | 25.50 | 13.34 |
| 16 | | 25.50 | 27.00 | |
| 17 | | 27.00 | 28.50 | |
| 18 | | 28.50 | 30.00 | 20.71 |
| 19 | | 30.00 | 31.50 | |
| 20 | | 31.50 | 33.00 | |
| 21 | | 33.00 | 34.50 | |
| 22 | | 34.50 | 36.00 | 22.99 |
| 23 | | 36.00 | 37.50 | |
| 24 | | 37.50 | 39.00 | |
| 25 | | 39.00 | 40.50 | |
| 26 | | 40.50 | 42.00 | 21.08 |
| 27 | | 42.00 | 43.50 | |
| 28 | | 43.50 | 45.00 | |
| 29 | | 45.00 | 46.50 | |
| 30 | | 46.50 | 48.00 | |
| 31 | | 48.00 | 49.50 | |
| 32 | | 49.50 | 51.00 | |
| 33 | | 51.00 | 52.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Dep | oth | Tensile Strength Test |
|--------|--------|-------|-------|-----------------------|
| | | From | То | (MPa) |
| 34 | | 52.50 | 54.00 | |
| 35 | | 54.00 | 55.50 | |
| 36 | | 55.50 | 57.00 | |
| 37 | | 57.00 | 58.50 | 16 |
| 38 | | 58.50 | 60.00 | |
| | | | Min. | 13.34 |
| | | | Max. | 22.99 |
| | | | Avg. | 17.10 |
| 39 | | 1.50 | 3.00 | |
| 40 | | 3.00 | 4.50 | 15.77 |
| 41 | | 4.50 | 6.00 | |
| 42 | | 6.00 | 7.50 | |
| 43 | | 7.50 | 9.00 | |
| 44 | | 9.00 | 10.50 | |
| 45 | BH-14 | 10.50 | 12.00 | |
| 46 | | 12.00 | 13.50 | 17.78 |
| 47 | | 15.00 | 16.50 | |
| 48 | | 16.50 | 18.00 | |
| 49 | | 18.00 | 19.50 | |
| 50 | | 19.50 | 21.00 | 15.72 |
| 51 | | 21.00 | 22.50 | |
| 52 | | 22.50 | 24.00 | |
| 53 | | 24.00 | 25.50 | |
| 54 | | 25.50 | 27.00 | |
| 55 | | 27.00 | 28.50 | |
| 56 | | 28.50 | 30.00 | |
| 57 | | 30.00 | 31.50 | |
| 58 | | 31.50 | 33.00 | 21.25 |
| 59 | | 33.00 | 34.50 | |
| 60 | | 34.50 | 36.00 | |
| 61 | | 36.00 | 37.50 | |
| 62 | | 37.50 | 39.00 | |
| 63 | | 39.00 | 40.50 | 19.31 |
| 64 | | 40.50 | 42.00 | |
| 65 | | 42.00 | 43.50 | |
| 66 | | 43.50 | 45.00 | |
| 67 | | 45.00 | 46.50 | 24.93 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Dep | oth | Tensile Strength Test |
|--------|--------------|-------|-------|-----------------------|
| | | From | То | (MPa) |
| 68 | | 46.50 | 48.00 | |
| 69 | | 48.00 | 49.50 | |
| 70 | | 49.50 | 51.00 | |
| 71 | | 51.00 | 52.50 | |
| 72 | | 52.50 | 54.00 | |
| 73 | | 54.00 | 55.50 | |
| 74 | | 57.00 | 58.50 | 18.27 |
| 75 | | 58.50 | 60.00 | |
| 76 | | 60.00 | 61.50 | |
| 77 | | 63.00 | 64.50 | 19.68 |
| 78 | | 64.50 | 66.00 | |
| 79 | | 66.00 | 67.50 | |
| 80 | | 67.50 | 69.00 | |
| 81 | | 69.00 | 70.50 | 14.78 |
| 82 | | 70.50 | 72.00 | |
| 83 | | 72.00 | 73.50 | 16.94 |
| | | Min. | | 14.78 |
| | | Max. | | 24.93 |
| | | Avg. | | 18.44 |
| 84 | | 0.00 | 1.50 | |
| 85 | | 1.50 | 3.00 | |
| 86 | | 3.00 | 4.50 | 16.36 |
| 87 | | 4.50 | 6.00 | |
| 88 | | 6.00 | 7.50 | |
| 89 | | 7.50 | 9.00 | |
| 90 | | 9.00 | 10.50 | |
| 91 | | 10.50 | 12.00 | |
| 92 | RH_15 | 12.00 | 13.50 | |
| 93 | DII-13 | 15.00 | 16.50 | |
| 94 | | 16.50 | 18.00 | |
| 95 | | 18.00 | 19.50 | 14.89 |
| 96 | | 19.50 | 21.00 | |
| 97 | | 21.00 | 22.50 | |
| 98 | | 22.50 | 24.00 | |
| 99 | | 24.00 | 25.50 | |
| 100 | | 25.50 | 27.00 | |
| 101 | | 27.00 | 28.50 | 18.2 |

| | Consultant: | Geotechnical I | Investigation Report | Client: |
|--------------|------------------|----------------|----------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Dej | pth | Tensile Strength Test |
|--------|--------|-------|-------|-----------------------|
| | | From | То | (MPa) |
| 102 | | 28.50 | 30.00 | |
| 103 | | 30.00 | 31.50 | |
| 104 | | 31.50 | 33.00 | 17.81 |
| 105 | | 33.00 | 34.50 | |
| 106 | | 34.50 | 36.00 | |
| 107 | | 36.00 | 37.50 | 16.03 |
| 108 | | 37.50 | 39.00 | |
| 109 | | 39.00 | 40.50 | |
| 110 | | 40.50 | 42.00 | |
| 111 | | 42.00 | 43.50 | |
| 112 | | 43.50 | 45.00 | |
| 113 | | 45.00 | 46.50 | |
| 114 | | 46.50 | 48.00 | |
| 115 | | 48.00 | 49.50 | |
| 116 | | 49.50 | 51.00 | |
| 117 | | 51.00 | 52.50 | |
| 118 | | 52.50 | 54.00 | 14.66 |
| 119 | | 54.00 | 55.50 | |
| 120 | | 57.00 | 58.50 | |
| 121 | | 58.50 | 60.00 | 14.94 |
| 122 | | 60.00 | 61.50 | |
| 123 | | 61.50 | 63.00 | |
| 124 | | 64.50 | 66.00 | 16.49 |
| 125 | | 66.00 | 67.50 | |
| 126 | | 67.50 | 69.00 | 19.2 |
| 127 | | 69.00 | 70.00 | |
| | | Min. | | 14.66 |
| | | Max. | | 19.2 |
| | | Avg. | | 16.51 |
| 128 | | 0.00 | 1.50 | |
| 129 | | 1.50 | 3.00 | |
| 130 | BH-15A | 3.00 | 4.50 | |
| 131 | | 4.50 | 6.00 | 16.47 |
| 132 | | 6.00 | 7.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Tensile Strength Test |
|--------|--------|-------|-------|-----------------------|
| | | From | То | (MPa) |
| | | | | |
| | | | | |
| 133 | | 7.50 | 9.00 | |
| 138 | | 9.00 | 10.50 | |
| 139 | | 10.50 | 12.00 | |
| 140 | | 12.00 | 13.50 | |
| 141 | | 13.50 | 15.00 | |
| 142 | | 15.00 | 16.50 | 15.89 |
| 143 | | 16.50 | 18.00 | |
| 144 | | 18.00 | 19.50 | |
| 145 | | 19.50 | 21.00 | |
| 146 | | 21.00 | 22.50 | 14.91 |
| 147 | | 22.50 | 24.00 | |
| 148 | | 25.50 | 27.00 | |
| 149 | | 27.00 | 28.50 | |
| 150 | | 28.50 | 30.00 | 15.97 |
| 151 | | 30.00 | 31.50 | |
| 152 | | 31.50 | 33.00 | |
| 153 | | 33.00 | 34.50 | |
| 154 | | 34.50 | 36.00 | 18.78 |
| 155 | | 36.00 | 37.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Dep | th | Tensile Strength Test |
|--------|--------|-------|-------|-----------------------|
| | | From | То | (MPa) |
| | | | | |
| 156 | | 37.50 | 39.00 | |
| 157 | | 39.00 | 40.50 | |
| 158 | | 40.50 | 42.00 | |
| 450 | | 42.00 | 42.50 | 17.21 |
| 159 | | 42.00 | 43.50 | |
| 160 | | 43.50 | 45.00 | |
| 161 | | 46.50 | 48.00 | |
| 162 | | 48.00 | 49.50 | |
| 163 | | 49.50 | 51.00 | 17.64 |
| | | Min. | | 14.91 |
| | | Max. | | 18.78 |
| | | Avg. | | 16.70 |
| 164 | | 0.00 | 1.50 | |
| 165 | | 1.50 | 3.00 | |
| 166 | | 3.00 | 4.50 | |
| 167 | | 4.50 | 6.00 | 15.72 |
| 168 | | 4.50 | 6.00 | |
| 169 | | 7.50 | 9.00 | |
| 170 | | 9.00 | 10.50 | 15.39 |
| 171 | | 10.50 | 12.00 | |
| 172 | | 12.00 | 13.50 | |
| 173 | BH-16 | 13.50 | 15.00 | |
| 174 | | 18.00 | 19.50 | 25.83 |
| 175 | | 19.50 | 21.00 | |
| 176 | | 21.00 | 22.50 | 26.24 |
| 177 | | 22.50 | 24.00 | |
| 178 | | 24.00 | 25.50 | |
| 179 | | 25.50 | 27.00 | |
| 180 | | 27.00 | 28.50 | |
| 181 | | 28.50 | 30.00 | 16.65 |
| 182 | | 30.00 | 31.50 | |
| 183 | | 31.50 | 33.00 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Tensile Strength Test |
|--------|--------|-------|-------|-----------------------|
| | | From | То | (MPa) |
| 184 | | 33.00 | 34.50 | 19.89 |
| 185 | | 33.00 | 34.50 | |
| 186 | | 36.00 | 37.50 | 23.96 |
| 187 | | 37.50 | 39.00 | |
| 188 | | 39.00 | 40.50 | |
| 189 | | 40.50 | 42.00 | 23.86 |
| 190 | | 42.00 | 43.50 | |
| 191 | | 45.00 | 46.50 | |
| 192 | | 46.50 | 48.00 | |
| 193 | | 48.00 | 49.50 | |
| 194 | | 49.50 | 51.00 | 27.77 |
| 195 | | 52.50 | 54.00 | 22.76 |
| 196 | | 54.00 | 55.50 | |
| 197 | | 55.50 | 57.00 | 20.25 |
| 198 | | 58.50 | 60.00 | |
| 199 | | 60.00 | 61.50 | |
| 200 | | 61.50 | 62.00 | |
| | | Min. | | 15.39 |
| | | Max. | | 27.77 |
| | | Avg. | | 21.67 |
| | | | | |

| BH 17 | | | |
|-------|----------------|-----------------------|--|
| Depth | Sample Number | Tensile Strength Test | |
| | | (Mpa) | |
| 19.50 | BH17/1221/R/01 | | |
| 20.50 | BH17/1221/R/03 | | |
| 22.00 | BH17/1221/R/05 | | |
| 23.00 | BH17/1221/R/06 | 26.58 | |
| 24.50 | BH17/1221/R/07 | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--------------------------------|
| S. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Development Corporation Ltd |

| BH 17 | | | | |
|-------|----------------|-----------------------|--|--|
| Depth | Sample Number | Tensile Strength Test | | |
| | BH17/1221/R/08 | | | |
| 25.00 | BH17/0122/R/09 | | | |
| 23.00 | BH17/0122/R/10 | | | |
| | BH17/0122/R/11 | 22.64 | | |
| 26.00 | BH17/0122/R/12 | | | |
| | BH17/0122/R/13 | | | |
| | BH17/0122/R/14 | | | |
| 27 50 | BH17/0122/R/15 | | | |
| 27.50 | BH17/0122/R/16 | | | |
| | BH17/0122/R/17 | 15.21 | | |
| | BH17/0122/R/18 | | | |
| 28.00 | BH17/0122/R/19 | | | |
| | BH17/0122/R/20 | | | |
| | BH17/0122/R/21 | 8.77 | | |
| 29.50 | BH17/0122/R/22 | | | |
| | BH17/0122/R/23 | | | |
| 30.00 | BH17/0122/R/24 | | | |
| 30.00 | BH17/0122/R/25 | | | |
| | BH17/0122/R/26 | | | |
| 31 50 | BH17/0122/R/27 | | | |
| 51.50 | BH17/0122/R/28 | | | |
| | BH17/0122/R/29 | 22.57 | | |
| 32 50 | BH17/0122/R/30 | | | |
| 52.50 | BH17/0122/R/31 | | | |
| 33 50 | BH17/0122/R/32 | | | |
| | BH17/0122/R/33 | | | |

| | Consultant: | Geotechnical | Investigation Report | Client: |
|----------------|------------------|--------------|----------------------|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \mathfrak{B} | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| BH 17 | | | | |
|-------|----------------|-----------------------|--|--|
| Depth | Sample Number | Tensile Strength Test | | |
| | BH17/0122/R/34 | | | |
| | BH17/0122/R/35 | | | |
| 35.00 | BH17/0122/R/37 | | | |
| | BH17/0122/R/38 | | | |
| 41.00 | BH17/0122/R/40 | | | |
| | BH17/0122/R/41 | | | |
| 42 50 | BH17/0122/R/42 | | | |
| | BH17/0122/R/43 | | | |
| | BH17/0122/R/44 | | | |
| 44.00 | BH17/0122/R/45 | | | |
| | BH17/0122/R/46 | | | |
| | BH17/0122/R/47 | | | |
| | BH17/1221/R/48 | | | |
| 45.50 | BH17/1221/R/49 | | | |
| | BH17/1221/R/50 | | | |
| | BH17/1221/R/51 | | | |
| 47.00 | BH17/1221/R/52 | | | |
| | BH17/1221/R/53 | | | |
| | BH17/1221/R/54 | | | |
| 48.50 | BH17/1221/R/55 | | | |
| | BH17/1221/R/56 | | | |
| | BH17/1221/R/57 | | | |
| | BH17/1221/R/58 | | | |
| 50.00 | BH17/1221/R/59 | | | |
| | BH17/1221/R/60 | | | |
| | BH17/1221/R/61 | | | |

| | Consultant: | Geotechnical | Investigation Report | Client: |
|--------------|------------------|--------------|----------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | BH 17 | |
|-------|----------------|-----------------------|
| Depth | Sample Number | Tensile Strength Test |
| | BH17/1221/R/65 | 15.46 |
| 53.00 | BH17/1221/R/69 | 18.01 |
| | BH17/1221/R/74 | |
| 54 50 | BH17/1221/R/75 | |
| | BH17/1221/R/76 | 19.83 |
| | BH17/1221/R/77 | |
| 56.00 | BH17/1221/R/78 | |
| | BH17/1221/R/79 | 19.09 |
| 58.00 | BH17/1221/R/80 | |
| | BH17/1221/R/81 | 15.07 |
| 59.50 | BH17/1221/R/82 | |
| | BH17/1221/R/87 | |
| | BH17/1221/R/88 | |
| 62.00 | BH17/1221/R/89 | 15.1 |
| | BH17/1221/R/90 | |
| | BH17/1221/R/91 | |
| | BH17/1221/R/92 | |
| Mi | n. | 8.77 |
| Ma | ax. | 26.58 |

Average.

18.03

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|----------|------------------|----------------|---------------------|--------------------------------|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| Ø | BHUBANESWAR | Report No.: | SMC/2050 | Development Corporation Ltd |

ANNEXURE –C Unconfined Compressive strength

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|-----|------------------|----------------|---------------------|--------------------------------|
| N.C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail Infrastructure |
| | BHUBANESWAR | Report No.: | SMC/2050 | Development Corporation Ltd |

Unconfined Compressive Strength

| Sr.No. | BH NO. | De | pth | UCS Test |
|--------|--------|-------|-------|----------|
| | | From | То | (MPa) |
| 1 | | 0.50 | 1.50 | |
| 2 | | 1.50 | 3.00 | 41.06 |
| 3 | | 3.00 | 4.50 | |
| 4 | | 4.50 | 6.00 | |
| 5 | BH-13 | 6.00 | 7.50 | |
| 6 | | 7.50 | 9.00 | |
| 7 | | 9.00 | 10.50 | |
| 8 | | 10.50 | 12.00 | 61.6 |
| 9 | | 15.00 | 16.50 | |
| 10 | | 16.50 | 18.00 | |
| 11 | | 18.00 | 19.50 | 67.07 |
| 12 | | 19.50 | 21.00 | |
| 13 | | 21.00 | 22.50 | |
| 14 | | 22.50 | 24.00 | |
| 15 | | 24.00 | 25.50 | |
| 16 | | 25.50 | 27.00 | 67.01 |
| 17 | | 27.00 | 28.50 | |
| 18 | | 28.50 | 30.00 | |
| 19 | | 30.00 | 31.50 | |
| 20 | | 31.50 | 33.00 | |
| 21 | | 33.00 | 34.50 | 64.01 |
| 22 | | 34.50 | 36.00 | |
| 23 | | 36.00 | 37.50 | |
| 24 | | 37.50 | 39.00 | |
| 25 | | 39.00 | 40.50 | 65.17 |
| 26 | | 40.50 | 42.00 | |
| 27 | | 42.00 | 43.50 | |
| 28 | | 43.50 | 45.00 | 64.79 |
| 29 | | 45.00 | 46.50 | |
| 30 | | 46.50 | 48.00 | 64.94 |
| 31 | | 48.00 | 49.50 | |
| 32 | | 49.50 | 51.00 | 63.23 |
| 33 | | 51.00 | 52.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | UCS Test |
|--------|--------|-------|-------|----------|
| | | From | То | (MPa) |
| 34 | | 52.50 | 54.00 | 64.29 |
| 35 | | 54.00 | 55.50 | |
| 36 | | 55.50 | 57.00 | 68.34 |
| 37 | | 57.00 | 58.50 | |
| 38 | | 58.50 | 60.00 | 70.33 |
| | | • | Min. | 41.06 |
| | | | Max. | 70.33 |
| | | | Avg. | 63.49 |
| 39 | | 1.50 | 3.00 | |
| 40 | | 3.00 | 4.50 | |
| 41 | | 4.50 | 6.00 | 49.1 |
| 42 | | 6.00 | 7.50 | |
| 43 | | 7.50 | 9.00 | |
| 44 | | 9.00 | 10.50 | |
| 45 | | 10.50 | 12.00 | 69.54 |
| 46 | | 12.00 | 13.50 | |
| 47 | | 15.00 | 16.50 | |
| 48 | | 16.50 | 18.00 | 68.69 |
| 49 | | 18.00 | 19.50 | |
| 50 | | 19.50 | 21.00 | |
| 51 | | 21.00 | 22.50 | |
| 52 | BH-14 | 22.50 | 24.00 | |
| 53 | | 24.00 | 25.50 | |
| 54 | | 25.50 | 27.00 | 66.51 |
| 55 | | 27.00 | 28.50 | |
| 56 | | 28.50 | 30.00 | |
| 57 | | 30.00 | 31.50 | 65.1 |
| 58 | | 31.50 | 33.00 | |
| 59 | | 33.00 | 34.50 | |
| 60 | | 34.50 | 36.00 | |
| 61 | | 36.00 | 37.50 | 53.54 |
| 62 | | 37.50 | 39.00 | |
| 63 | | 39.00 | 40.50 | |
| 64 | | 40.50 | 42.00 | |
| 65 | | 42.00 | 43.50 | 10.01 |
| 66 | | 43.50 | 45.00 | 49.01 |
| 67 | | 45.00 | 46.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | UCS Test |
|--------|--------|-------|-------|----------|
| | | From | То | (MPa) |
| 68 | | 46.50 | 48.00 | 55.52 |
| 69 | | 48.00 | 49.50 | |
| 70 | | 49.50 | 51.00 | |
| 71 | | 51.00 | 52.50 | 59.06 |
| 72 | | 52.50 | 54.00 | |
| 73 | | 54.00 | 55.50 | |
| 74 | | 57.00 | 58.50 | 45.15 |
| 75 | | 58.50 | 60.00 | |
| 76 | | 60.00 | 61.50 | 60.66 |
| 77 | | 63.00 | 64.50 | |
| 78 | | 64.50 | 66.00 | |
| 79 | | 66.00 | 67.50 | |
| 80 | | 67.50 | 69.00 | 45.15 |
| 81 | | 69.00 | 70.50 | |
| 82 | | 70.50 | 72.00 | 47.33 |
| 83 | | 72.00 | 73.50 | |
| | | Min. | | 45.15 |
| | | Max. | | 69.54 |
| | | Avg. | | 56.49 |
| 84 | | 0.00 | 1.50 | |
| 85 | | 1.50 | 3.00 | 69.58 |
| 86 | | 3.00 | 4.50 | |
| 87 | | 4.50 | 6.00 | |
| 88 | BH-15 | 6.00 | 7.50 | |
| 89 | | 7.50 | 9.00 | 67.04 |
| 90 | | 9.00 | 10.50 | |
| 91 | | 10.50 | 12.00 | |
| 92 | | 12.00 | 13.50 | |
| 93 | | 15.00 | 16.50 | |
| 94 | | 16.50 | 18.00 | 68.52 |
| 95 | | 18.00 | 19.50 | |
| 96 | | 19.50 | 21.00 | |
| 97 | | 21.00 | 22.50 | |
| 98 | | 22.50 | 24.00 | 66.01 |
| 99 | | 24.00 | 25.50 | |
| 100 | | 25.50 | 27.00 | |
| 101 | | 27.00 | 28.50 | 68.94 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | UCS Test |
|--------|--------|-------|-------|----------|
| | | From | То | (MPa) |
| 102 | | 28.50 | 30.00 | |
| 103 | | 30.00 | 31.50 | |
| 104 | | 31.50 | 33.00 | |
| 105 | | 33.00 | 34.50 | 68.84 |
| 106 | | 34.50 | 36.00 | |
| 107 | | 36.00 | 37.50 | |
| 108 | | 37.50 | 39.00 | |
| 109 | | 39.00 | 40.50 | |
| 110 | | 40.50 | 42.00 | |
| 111 | | 42.00 | 43.50 | |
| 112 | | 43.50 | 45.00 | 70.44 |
| 113 | | 45.00 | 46.50 | |
| 114 | | 46.50 | 48.00 | 69.4 |
| 115 | | 48.00 | 49.50 | |
| 116 | | 49.50 | 51.00 | 62.21 |
| 117 | | 51.00 | 52.50 | |
| 118 | | 52.50 | 54.00 | 61.45 |
| 119 | | 54.00 | 55.50 | |
| 120 | | 57.00 | 58.50 | 64.29 |
| 121 | | 58.50 | 60.00 | |
| 122 | | 60.00 | 61.50 | |
| 123 | | 61.50 | 63.00 | 68.63 |
| 124 | | 64.50 | 66.00 | |
| 125 | | 66.00 | 67.50 | 68.41 |
| 126 | | 67.50 | 69.00 | |
| 127 | | 69.00 | 70.00 | 64.97 |
| | | Min. | | 61.45 |
| | | Max. | | 70.44 |
| | | Avg. | | 67.05 |
| 128 | | 0.00 | 1.50 | |
| 129 | | 1.50 | 3.00 | 69.38 |
| 130 | BH-15A | 3.00 | 4.50 | |
| 131 | | 4.50 | 6.00 | |
| 132 | | 6.00 | 7.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | UCS Test |
|--------|--------|-------|-------|----------|
| | | From | То | (MPa) |
| | | | | 66 |
| | | | | |
| 133 | | 7.50 | 9.00 | |
| | | | | |
| 138 | | 9.00 | 10.50 | |
| 139 | | 10.50 | 12.00 | |
| | | | | |
| | | 40.00 | 40.55 | |
| 140 | | 12.00 | 13.50 | 62.28 |
| 141 | | 13.50 | 15.00 | |
| 142 | | 15.00 | 16.50 | |
| 143 | | 16.50 | 18.00 | |
| 144 | | 18.00 | 19.50 | |
| 145 | | 19.50 | 21.00 | |
| 146 | | 21.00 | 22.50 | 62.06 |
| | | | | 05.00 |
| 147 | | 22.50 | 24.00 | |
| 148 | | 25.50 | 27.00 | |
| | | | | |
| 149 | | 27.00 | 28.50 | |
| | | | | 64.78 |
| 150 | | 28.50 | 30.00 | |
| | | | | |
| 151 | | 30.00 | 31.50 | |
| | | | | |
| | | | | 65.17 |
| 152 | | 31.50 | 33.00 | |
| | | | | 67.2 |
| 153 | | 33.00 | 34.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | UCS Test |
|--------|--------|-------|-------|----------|
| | | From | То | (MPa) |
| 154 | | 34.50 | 36.00 | |
| | | | | 69.38 |
| 155 | | 36.00 | 37.50 | |
| | | | | |
| 156 | | 37.50 | 39.00 | |
| 157 | | 39.00 | 40.50 | 63.64 |
| 158 | | 40.50 | 42.00 | |
| | | | | |
| 159 | | 42.00 | 43.50 | 60.42 |
| 160 | | 43.50 | 45.00 | |
| 161 | | 46.50 | 48.00 | |
| 162 | | 48.00 | 49.50 | 65.05 |
| 163 | | 49.50 | 51.00 | |
| | | Min. | | 60.42 |
| | | Max. | | 69.38 |
| | | Avg. | | 65.12 |
| 164 | | 0.00 | 1.50 | 66 |
| 165 | | 1.50 | 3.00 | |
| 166 | | 3.00 | 4.50 | |
| 167 | | 4.50 | 6.00 | |
| 168 | | 4.50 | 6.00 | |
| 169 | | 7.50 | 9.00 | 52.79 |
| 170 | | 9.00 | 10.50 | |
| 171 | | 10.50 | 12.00 | |
| 172 | BH-16 | 12.00 | 13.50 | |
| 173 | | 13.50 | 15.00 | |
| 174 | | 18.00 | 19.50 | 70.8 |
| 175 | | 19.50 | 21.00 | |
| 176 | | 21.00 | 22.50 | |
| 177 | | 22.50 | 24.00 | 44.8 |
| 178 | | 24.00 | 25.50 | |
| 179 | | 25.50 | 27.00 | |
| 180 | | 27.00 | 28.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | UCS Test |
|--------|--------|-------|-------|----------|
| | | From | То | (MPa) |
| 181 | | 28.50 | 30.00 | |
| 182 | | 30.00 | 31.50 | 70.27 |
| 183 | | 31.50 | 33.00 | |
| 184 | | 33.00 | 34.50 | |
| 185 | | 33.00 | 34.50 | |
| 186 | | 36.00 | 37.50 | |
| 187 | | 37.50 | 39.00 | 70.23 |
| 188 | | 39.00 | 40.50 | |
| 189 | | 40.50 | 42.00 | |
| 190 | | 42.00 | 43.50 | 52.49 |
| 191 | | 45.00 | 46.50 | |
| 192 | | 46.50 | 48.00 | 70.08 |
| 193 | | 48.00 | 49.50 | |
| 194 | | 49.50 | 51.00 | 69.57 |
| 195 | | 52.50 | 54.00 | |
| 196 | | 54.00 | 55.50 | |
| 197 | | 55.50 | 57.00 | 70.16 |
| 198 | | 58.50 | 60.00 | |
| 199 | | 60.00 | 61.50 | 68.55 |
| 200 | | 61.50 | 62.00 | |
| | | Min. | | 44.8 |
| | | Max. | | 70.8 |
| | | Avg. | | 64.16 |
| | | | | |
| | | | | |
| | | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| BH 17 | | | | | | |
|-------|----------------|-----------|--|--|--|--|
| Depth | Sample Number | UCS (Mpa) | | | | |
| | | | | | | |
| 19.50 | BH17/1221/R/01 | | | | | |
| 20.50 | BH17/1221/R/03 | | | | | |
| 22.00 | BH17/1221/R/05 | 70.68 | | | | |
| 23.00 | BH17/1221/R/06 | | | | | |
| 24.50 | BH17/1221/R/07 | | | | | |
| 24.50 | BH17/1221/R/08 | | | | | |
| 25.00 | BH17/0122/R/09 | 69.63 | | | | |
| 25.00 | BH17/0122/R/10 | | | | | |
| | BH17/0122/R/11 | | | | | |
| 26.00 | BH17/0122/R/12 | | | | | |
| | BH17/0122/R/13 | | | | | |
| | BH17/0122/R/14 | | | | | |
| 27.50 | BH17/0122/R/15 | | | | | |
| 27.50 | BH17/0122/R/16 | | | | | |
| | BH17/0122/R/17 | | | | | |
| | BH17/0122/R/18 | 69.31 | | | | |
| 28.00 | BH17/0122/R/19 | | | | | |
| | BH17/0122/R/20 | | | | | |
| | BH17/0122/R/21 | | | | | |
| 29.50 | BH17/0122/R/22 | | | | | |
| | BH17/0122/R/23 | | | | | |
| 20.00 | BH17/0122/R/24 | | | | | |
| 30.00 | BH17/0122/R/25 | | | | | |
| | BH17/0122/R/26 | | | | | |
| 24.50 | BH17/0122/R/27 | 66.51 | | | | |
| 31.50 | BH17/0122/R/28 | | | | | |
| | BH17/0122/R/29 | | | | | |
| 22.50 | BH17/0122/R/30 | | | | | |
| 32.50 | BH17/0122/R/31 | | | | | |
| | BH17/0122/R/32 | | | | | |
| | BH17/0122/R/33 | | | | | |
| 33.50 | BH17/0122/R/34 | | | | | |
| | BH17/0122/R/35 | | | | | |
| | BH17/0122/R/36 | 67.94 | | | | |
| 25.00 | BH17/0122/R/37 | | | | | |
| 35.00 | BH17/0122/R/38 | | | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | BH 17 | |
|-------|----------------|-----------|
| Depth | Sample Number | UCS (Mpa) |
| 41.00 | BH17/0122/R/40 | |
| 41.00 | BH17/0122/R/41 | 68.41 |
| 42.50 | BH17/0122/R/42 | |
| 42.50 | BH17/0122/R/43 | |
| | BH17/0122/R/44 | |
| 44.00 | BH17/0122/R/45 | |
| 44.00 | BH17/0122/R/46 | |
| | BH17/0122/R/47 | |
| 45.50 | BH17/1221/R/49 | 67.23 |
| 47.00 | BH17/1221/R/52 | |
| 47.00 | BH17/1221/R/53 | |
| | BH17/1221/R/54 | |
| 49.50 | BH17/1221/R/55 | |
| 48.50 | BH17/1221/R/56 | |
| | BH17/1221/R/57 | 63.34 |
| 50.00 | BH17/1221/R/58 | |
| | BH17/1221/R/62 | |
| | BH17/1221/R/63 | |
| 51.50 | BH17/1221/R/64 | |
| 51.50 | BH17/1221/R/65 | |
| | BH17/1221/R/66 | 61.24 |
| | BH17/1221/R/67 | |
| | BH17/1221/R/69 | |
| | BH17/1221/R/70 | |
| 53.00 | BH17/1221/R/71 | |
| | BH17/1221/R/72 | |
| | BH17/1221/R/73 | |
| | BH17/1221/R/74 | |
| 54.50 | BH17/1221/R/75 | 70.85 |
| 54.50 | BH17/1221/R/76 | |
| | BH17/1221/R/77 | |
| FC 00 | BH17/1221/R/78 | |
| 56.00 | BH17/1221/R/79 | |
| FR 00 | BH17/1221/R/80 | 68.97 |
| 58.00 | BH17/1221/R/81 | |
| 59.50 | BH17/1221/R/82 | |
| (2.00 | BH17/1221/R/87 | 69.04 |
| 02.00 | BH17/1221/R/88 | |

| | Consultant: | Geotechnical | Investigation Report | Client: |
|--------------|------------------|--------------|----------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| BH 17 | | | | | |
|-------|----------------|-----------|--|--|--|
| Depth | Sample Number | UCS (Mpa) | | | |
| | BH17/1221/R/89 | | | | |
| | BH17/1221/R/90 | | | | |
| | BH17/1221/R/91 | | | | |
| | BH17/1221/R/92 | | | | |
| | 61.24 | | | | |
| | 70.85 | | | | |
| | Average. | | | | |

| Consultant: | Geotechnical I | nvestigation Report | Client: |
|---------------------------------|-------------------------|---------------------|--|
| S.M. CONSULTANTS BHUBANESWAR | Job No.: Report No.: | 830 SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

ANNEXURE –D Specific Gravity, Water absorption, Density

| | Consultant: | Geotechnical | nvestigation Report | Client: |
|--------------|------------------|--------------|---------------------|--|
| C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

Specific Gravity, Water absorption, Density

| Sr.No. | BH NO. | Depth | | Weight Density | Specific Gravity | Water Absorption |
|--------|--------|-------|-------|-------------------|---------------------|------------------|
| | | From | То | (kN/m³) | | (%) |
| 1 | BH-13 | 0.50 | 1.50 | 24.31 | 2.47 | 0.4 |
| 2 | DH-13 | 1.50 | 3.00 | | | |
| 3 | | 3.00 | 4.50 | | | |
| 4 | | 4.50 | 6.00 | | | |
| 5 | | 6.00 | 7.50 | 25.15 | 2.55 | 0.45 |
| 6 | | 7.50 | 9.00 | | | |
| 7 | | 9.00 | 10.50 | | | |
| 8 | | 10.50 | 12.00 | | | |
| 9 | | 15.00 | 16.50 | 25.26 | 2.57 | 0.32 |
| 10 | | 16.50 | 18.00 | | | |
| 11 | | 18.00 | 19.50 | | | |
| 12 | | 19.50 | 21.00 | | | |
| 13 | | 21.00 | 22.50 | 25.65 | 2.6 | 0.44 |
| 14 | | 22.50 | 24.00 | | | |
| 15 | | 24.00 | 25.50 | | | |
| 16 | | 25.50 | 27.00 | | | |
| 17 | | 27.00 | 28.50 | | | |
| 18 | | 28.50 | 30.00 | 25.08 | 2.55 | 0.4 |
| 19 | | 30.00 | 31.50 | | | |
| 20 | | 31.50 | 33.00 | | | |
| 21 | | 33.00 | 34.50 | | | |
| 22 | | 34.50 | 36.00 | 25.35 | 2.58 | 0.14 |
| 23 | | 36.00 | 37.50 | | | |
| 24 | | 37.50 | 39.00 | 25.47 | 2.58 | 0.47 |
| 25 | | 39.00 | 40.50 | | | |
| 26 | | 40.50 | 42.00 | 25.23 | 2.56 | 0.3 |
| 27 | | 42.00 | 43.50 | | | |
| 28 | | 43.50 | 45.00 | 25.47 | 2.58 | 0.47 |
| 29 | | 45.00 | 46.50 | | | |
| 30 | | 46.50 | 48.00 | 25.73 | 2.61 | 0.39 |
| 31 | | 48.00 | 49.50 | | | |
| 32 | | 49.50 | 51.00 | 25.43 | 2.58 | 0.38 |
| 33 | | 51.00 | 52.50 | | | |
| 34 | | 52.50 | 54.00 | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

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| Sr.No. | BH NO. | Depth | | Weight Density | Specific Gravity | Water Absorption |
|--------|--------|-------|-------|-------------------|---------------------|------------------|
| | | From | То | (kN/m³) | | (%) |
| 35 | | 54.00 | 55.50 | 25.64 | 2.6 | 0.51 |
| 36 | | 55.50 | 57.00 | | | |
| 37 | | 57.00 | 58.50 | | | |
| 38 | | 58.50 | 60.00 | | | |
| | | • | Min. | 24.31 | 2.47 | 0.14 |
| | | | Max. | 25.73 | 2.61 | 0.51 |
| | | | Avg. | 25.31 | 2.57 | 0.39 |
| 39 | | 1.50 | 3.00 | | | |
| 40 | | 3.00 | 4.50 | | | |
| 41 | | 4.50 | 6.00 | | | |
| 42 | | 6.00 | 7.50 | 25.67 | 2.61 | 0.41 |
| 43 | | 7.50 | 9.00 | | | |
| 44 | | 9.00 | 10.50 | | | |
| 45 | | 10.50 | 12.00 | | | |
| 46 | | 12.00 | 13.50 | 25.8 | 2.63 | 0.16 |
| 47 | | 15.00 | 16.50 | | | |
| 48 | BH-14 | 16.50 | 18.00 | | 0.00 | |
| 49 | | 18.00 | 19.50 | 25.83 | 2.62 | 0.35 |
| 50 | | 19.50 | 21.00 | | | |
| 51 | | 21.00 | 22.50 | 25 70 | 2.62 | 0.2 |
| 52 | | 22.50 | 24.00 | 25.78 | 2.62 | 0.3 |
| 53 | | 24.00 | 25.50 | | | |
| 54 | | 25.50 | 27.00 | | | |
| 55 | | 27.00 | 30.00 | | | |
| 57 | | 30.00 | 31.50 | | | |
| 58 | | 31.50 | 33.00 | | | |
| 59 | | 33.00 | 34.50 | 26.09 | 2.65 | 0.43 |
| 60 | | 34.50 | 36.00 | | | |
| 61 | | 36.00 | 37.50 | | | |
| 62 | | 37.50 | 39.00 | 25.99 | 2.65 | 0.15 |
| 63 | | 39.00 | 40.50 | | | |
| 64 | | 40.50 | 42.00 | | | |
| 65 | | 42.00 | 43.50 | 25.92 | 2.63 | 0.41 |
| 66 | | 43.50 | 45.00 | | | |
| 67 | | 45.00 | 46.50 | | | |
| 68 | | 46.50 | 48.00 | | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

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Т

| Sr.No. | BH NO. | De | pth | Weight Density | Specific Gravity | Water Absorption |
|--------|---------|-------|-------|-------------------|---------------------|------------------|
| | | From | То | (kN/m³) | | (%) |
| 69 | | 48.00 | 49.50 | | | |
| 70 | | 49.50 | 51.00 | 25.82 | 2.62 | 0.57 |
| 71 | | 51.00 | 52.50 | | | |
| 72 | | 52.50 | 54.00 | | | |
| 73 | | 54.00 | 55.50 | | | |
| 74 | | 57.00 | 58.50 | 25.96 | 2.64 | 0.23 |
| 75 | | 58.50 | 60.00 | | | |
| 76 | | 60.00 | 61.50 | | | |
| 77 | | 63.00 | 64.50 | | | |
| 78 | | 64.50 | 66.00 | 25.94 | 2.64 | 0.28 |
| 79 | | 66.00 | 67.50 | | | |
| 80 | | 67.50 | 69.00 | 25.82 | 2.63 | 0.23 |
| 81 | | 69.00 | 70.50 | 25.91 | 2.63 | 0.29 |
| 82 | | 70.50 | 72.00 | | | |
| 83 | | 72.00 | 73.50 | | | |
| | Min. | | 25.67 | 2.61 | 0.15 | |
| | Max. | | 26.09 | 2.65 | 0.57 | |
| | | Avg. | 1 | 25.88 | 2.63 | 0.32 |
| 84 | BH-15 | 0.00 | 1.50 | | | |
| 85 | 2.1. 20 | 1.50 | 3.00 | | | |
| 86 | | 3.00 | 4.50 | | | |
| 87 | | 4.50 | 6.00 | 25.66 | 2.6 | 0.51 |
| 88 | | 6.00 | 7.50 | | | |
| 89 | | 7.50 | 9.00 | | | |
| 90 | | 9.00 | 10.50 | | | |
| 91 | | 10.50 | 12.00 | | | |
| 92 | | 12.00 | 13.50 | 25.22 | 2 5 7 | 0.54 |
| 93 | | 15.00 | 16.50 | 25.33 | 2.57 | 0.51 |
| 94 | | 18.50 | 18.00 | | | |
| 95 | | 10.00 | 19.50 | 25.52 | 2 50 | 0.5 |
| 90 | | 21.00 | 21.00 | 25.55 | 2.59 | 0.5 |
| 97 | | 21.00 | 22.50 | | | |
| 50 | | 22.50 | 24.00 | | | |
| 100 | | 25.50 | 23.30 | 25 28 | 2 57 | 0.63 |
| 100 | | 23.30 | 27.00 | 23.30 | 2.37 | 0.05 |
| 101 | | 27.00 | 20.30 | | | |
| 102 | | 20.50 | 50.00 | | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | Weight Density | Specific Gravity | Water Absorption |
|--------|--------|-------|-------|-------------------|---------------------|------------------|
| | | From | То | (kN/m³) | | (%) |
| 103 | | 30.00 | 31.50 | | | |
| 104 | | 31.50 | 33.00 | 25.5 | 2.59 | 0.49 |
| 105 | | 33.00 | 34.50 | | | |
| 106 | | 34.50 | 36.00 | | | |
| 107 | | 36.00 | 37.50 | | | |
| 108 | | 37.50 | 39.00 | | | |
| 109 | | 39.00 | 40.50 | | | |
| 110 | | 40.50 | 42.00 | | • | |
| 111 | | 42.00 | 43.50 | 25.2 | 2.55 | 0.6 |
| 112 | | 43.50 | 45.00 | | | |
| 113 | | 45.00 | 46.50 | | | |
| 114 | | 46.50 | 48.00 | | | |
| 115 | | 48.00 | 49.50 | 25.36 | 2.57 | 0.47 |
| 116 | | 49.50 | 51.00 | | | |
| 117 | | 51.00 | 52.50 | | | |
| 118 | | 52.50 | 54.00 | | | |
| 119 | | 54.00 | 55.50 | 25.5 | 2.59 | 0.47 |
| 120 | | 57.00 | 58.50 | | | |
| 121 | | 58.50 | 60.00 | | | |
| 122 | | 60.00 | 61.50 | | | |
| 123 | | 61.50 | 63.00 | | | |
| 124 | | 64.50 | 66.00 | 25.74 | 2.61 | 0.53 |
| 125 | | 66.00 | 67.50 | | | |
| 126 | | 67.50 | 69.00 | | | |
| 127 | | 69.00 | 70.00 | 25.07 | 2.54 | 0.46 |
| | | Min. | | 25.07 | 2.54 | 0.46 |
| | | Max. | | 25.74 | 2.61 | 0.63 |
| | | Avg. | | 25.43 | 2.58 | 0.52 |
| 128 | | 0.00 | 1.50 | | | |
| 129 | | 1.50 | 3.00 | | | |
| | | | | 25.44 | 2.59 | 0.16 |
| 130 | | 3.00 | 4.50 | | | |
| | BH-15A | | | | | |
| 121 | | 4 50 | 6.00 | | | |
| 151 | | 4.50 | 0.00 | | | |
| 100 | | 6.00 | 7 50 | | | |
| 152 | | 0.00 | 7.50 | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | Weight Density | Specific Gravity | Water Absorption |
|--------|--------|-------|-------|-------------------|---------------------|------------------|
| | | From | То | (kN/m³) | | (%) |
| | | | | | | |
| 133 | | 7.50 | 9.00 | | | |
| | | | | 25.55 | 2.59 | 0.47 |
| 138 | | 9.00 | 10.50 | | | |
| | | | | | | |
| 139 | | 10.50 | 12.00 | | | |
| 140 | | 12.00 | 13.50 | | | |
| 141 | | 13.50 | 15.00 | | | |
| 142 | | 15.00 | 16.50 | | | |
| 143 | | 16.50 | 18.00 | | | |
| 144 | | 18.00 | 19.50 | 25.35 | 2.57 | 0.75 |
| 145 | | 19.50 | 21.00 | | | |
| 146 | | 21.00 | 22.50 | | | |
| | | | | 25.60 | 2.6 | 0.55 |
| 147 | | 22.50 | 24.00 | 25.69 | 2.6 | 0.55 |
| | | | | | | |
| 148 | | 25.50 | 27.00 | | | |
| 149 | | 27.00 | 28.50 | | | |
| 150 | | 28.50 | 30.00 | 25.17 | 2.56 | 0.2 |
| 151 | | 30.00 | 31.50 | | | |
| | | | | | | |
| 152 | | 31.50 | 33.00 | 25.45 | 2.58 | 0.72 |
| 453 | | 22.00 | 24 50 | | | |
| 153 | | 33.00 | 34.50 | | | |
| 134 | | 37.30 | 30.00 | | | |
| 155 | | 36.00 | 37.50 | 24.81 | 2.52 | 0.46 |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | Weight Density | Specific Gravity | Water Absorption |
|--------|--------|-------|-------|-------------------|---------------------|------------------|
| | | From | То | (kN/m³) | | (%) |
| | | | | | | |
| 156 | | 37.50 | 39.00 | | | |
| 157 | | 39.00 | 40.50 | 25.01 | 2.54 | 0.45 |
| 158 | | 40.50 | 42.00 | | | |
| 159 | | 42.00 | 43.50 | 25.58 | 2.6 | 0.38 |
| 160 | | 43.50 | 45.00 | 25.02 | 2.54 | 0.57 |
| 161 | | 46.50 | 48.00 | | | |
| 162 | | 48.00 | 49.50 | | | |
| 163 | | 49.50 | 51.00 | | | |
| | | Min. | | 24.81 | 2.52 | 0.16 |
| | | Max. | | 25.69 | 2.6 | 0.75 |
| | | Avg. | | 25.307 | 2.57 | 0.47 |
| 164 | | 0.00 | 1.50 | | | |
| 165 | | 1.50 | 3.00 | 25.43 | 2.59 | 0.25 |
| 166 | | 3.00 | 4.50 | | | |
| 167 | | 4.50 | 6.00 | | | |
| 168 | | 4.50 | 6.00 | | | |
| 169 | | 7.50 | 9.00 | | | |
| 170 | | 9.00 | 10.50 | | | |
| 171 | BH-16 | 10.50 | 12.00 | 25.3 | 2.56 | 0.62 |
| 172 | | 12.00 | 13.50 | | | |
| 173 | | 13.50 | 15.00 | 25.51 | 2.58 | 0.7 |
| 174 | | 18.00 | 19.50 | | | |
| 175 | | 19.50 | 21.00 | | | |
| 176 | | 21.00 | 22.50 | | | |
| 177 | | 22.50 | 24.00 | 26.39 | 2.68 | 0.57 |
| 178 | | 24.00 | 25.50 | | | |
| 179 | | 25.50 | 27.00 | | | |
| 180 | | 27.00 | 28.50 | | | |
| 181 | | 28.50 | 30.00 | | | |
| 182 | | 30.00 | 31.50 | 26.33 | 2.67 | 0.48 |
| 183 | | 31.50 | 33.00 | | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Weight Density | Specific Gravity | Water Absorption |
|--------|--------|-------|-------|-------------------|---------------------|------------------|
| | | From | То | (kN/m³) | | (%) |
| 184 | | 33.00 | 34.50 | | | |
| 185 | | 33.00 | 34.50 | | | |
| 186 | | 36.00 | 37.50 | | | |
| 187 | | 37.50 | 39.00 | 26.52 | 2.69 | 0.51 |
| 188 | | 39.00 | 40.50 | | | |
| 189 | | 40.50 | 42.00 | | | |
| 190 | | 42.00 | 43.50 | | | |
| 191 | | 45.00 | 46.50 | | | |
| 192 | | 46.50 | 48.00 | 25.54 | 2.63 | 0.63 |
| 193 | | 48.00 | 49.50 | 26.24 | 2.67 | 0.3 |
| 194 | | 49.50 | 51.00 | | | |
| 195 | | 52.50 | 54.00 | | | |
| 196 | | 54.00 | 55.50 | | | |
| 197 | | 55.50 | 57.00 | | | |
| 198 | | 58.50 | 60.00 | 26.36 | 2.67 | 0.46 |
| 199 | | 60.00 | 61.50 | 26.1 | 2.65 | 0.51 |
| 200 | | 61.50 | 62.00 | | | |
| | | Min. | | 25.3 | 2.56 | 0.25 |
| | | Max. | | 26.52 | 2.69 | 0.7 |
| | | Avg. | | 25.97 | 2.64 | 0.50 |

| BH 17 | | | | | | | |
|-------|----------------|-------------------|---------------------|------------------|--|--|--|
| Depth | Sample Number | Weight Density | Specific Gravity | Water Absorption | | | |
| | | (kN/m³) | | (%) | | | |
| 19.50 | BH17/1221/R/01 | 26.21 | 2.67 | 0 | | | |
| 20.50 | BH17/1221/R/03 | | | | | | |
| 22.00 | BH17/1221/R/05 | | | | | | |
| 23.00 | BH17/1221/R/06 | 25.73 | 2.61 | 0.36 | | | |
| 24.50 | BH17/1221/R/07 | | | | | | |
| 24.50 | BH17/1221/R/08 | | | | | | |
| 25.00 | BH17/0122/R/09 | | | | | | |
| | BH17/0122/R/10 | | | | | | |
| 26.00 | BH17/0122/R/11 | 25.7 | 2.61 | 0.38 | | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | BH 17 | | | | | | |
|-------|-------------------|-------------------|---------------------|------------------|--|--|--|
| Depth | Sample Number | Weight Density | Specific Gravity | Water Absorption | | | |
| | BH17/0122/R/12 | | | | | | |
| | BH17/0122/R/13 | | | | | | |
| | BH17/0122/R/14 | | | | | | |
| 27.50 | BH17/0122/R/15 | | | | | | |
| 27.50 | BH17/0122/R/16 | 24.79 | 2.5 | 0.95 | | | |
| | BH17/0122/R/17 | | | | | | |
| | BH17/0122/R/18 | | | | | | |
| 28.00 | BH17/0122/R/19 | | | | | | |
| | BH17/0122/R/20 | | | | | | |
| | BH17/0122/R/21 | 25.21 | 2.54 | 1.18 | | | |
| 29.50 | BH17/0122/R/22 | | | | | | |
| | BH17/0122/R/23 | | | | | | |
| 20.00 | BH17/0122/R/24 | | | | | | |
| 30.00 | BH17/0122/R/25 | 25.79 | 2.63 | 0.16 | | | |
| | BH17/0122/R/26 | | | | | | |
| 24.50 | BH17/0122/R/27 | | | | | | |
| 31.50 | BH17/0122/R/28 | | | | | | |
| | BH17/0122/R/29 | 25.82 | 2.62 | 0.36 | | | |
| | BH17/0122/R/30 | | | | | | |
| 32.50 | BH17/0122/R/31 | | | | | | |
| | BH17/0122/R/32 | | | | | | |
| | BH17/0122/R/33 | | | | | | |
| 33.50 | BH17/0122/R/34 | | | | | | |
| | BH17/0122/R/35 | 26.2 | 2.66 | 0.21 | | | |
| | BH17/0122/R/36 | | | | | | |
| | BH17/0122/R/37 | | | | | | |
| 35.00 | BH17/0122/R/38 | | | | | | |
| | BH17/0122/R/40 | 24.96 | 2.52 | 1.1 | | | |
| 41.00 | BH17/0122/R/41 | | | | | | |
| | BH17/0122/R/42 | | | | | | |
| 42.50 | BH17/0122/R/43 | | | | | | |
| | BH17/1221/R/48 | 25.48 | 2.59 | 0.39 | | | |
| | BH17/1221/R/49 | | | | | | |
| 45.50 | BH17/1221/R/50 | | | | | | |
| | BH17/1221/R/51 | | | | | | |
| | BH17/1221/R/52 | | | | | | |
| 47.00 | BH17/1221/R/53 | | | | | | |
| 48.50 | BH17/1221/R/54 | 24.23 | 2.45 | 0.9 | | | |
| 10.00 | 511277 2222/19/37 | 27.25 | 2.45 | 0.5 | | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|-------------|------------------|----------------|---------------------|--|
| | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| BH 17 | | | | | | | |
|-------|----------------|-------------------|---------------------|------------------|--|--|--|
| Depth | Sample Number | Weight Density | Specific Gravity | Water Absorption | | | |
| | BH17/1221/R/55 | | | | | | |
| | BH17/1221/R/56 | | | | | | |
| | BH17/1221/R/57 | | | | | | |
| 50.00 | BH17/1221/R/58 | | | | | | |
| 30.00 | BH17/1221/R/59 | | | | | | |
| | BH17/1221/R/62 | | | | | | |
| | BH17/1221/R/63 | 25.13 | 2.54 | 0.81 | | | |
| 51 50 | BH17/1221/R/64 | | | | | | |
| 51.50 | BH17/1221/R/65 | | | | | | |
| | BH17/1221/R/66 | | | | | | |
| | BH17/1221/R/67 | | | | | | |
| | BH17/1221/R/69 | | | | | | |
| | BH17/1221/R/70 | | | | | | |
| 53.00 | BH17/1221/R/71 | 25.73 | 2.62 | 0.2 | | | |
| | BH17/1221/R/72 | | | | | | |
| | BH17/1221/R/73 | | | | | | |
| | BH17/1221/R/74 | | | | | | |
| 54.50 | BH17/1221/R/75 | | | | | | |
| 54.50 | BH17/1221/R/76 | | | | | | |
| | BH17/1221/R/77 | 25.51 | 2.59 | 0.21 | | | |
| 56.00 | BH17/1221/R/78 | | | | | | |
| 56.00 | BH17/1221/R/79 | | | | | | |
| 50.00 | BH17/1221/R/80 | | | | | | |
| 58.00 | BH17/1221/R/81 | 25.54 | 2.58 | 0.72 | | | |
| 59.50 | BH17/1221/R/82 | 25.25 | 2.55 | 0.78 | | | |
| | BH17/1221/R/83 | | | | | | |
| | BH17/1221/R/84 | | | | | | |
| 61.00 | BH17/1221/R/85 | 25.31 | 2.57 | 0.45 | | | |
| | BH17/1221/R/86 | | | | | | |
| | BH17/1221/R/87 | | | | | | |
| | BH17/1221/R/88 | 25.68 | 2.61 | 0.42 | | | |
| | BH17/1221/R/89 | | | | | | |
| 62.00 | BH17/1221/R/90 | | | | | | |
| | BH17/1221/R/91 | | | | | | |
| | BH17/1221/R/92 | | | | | | |
| I | Min. | 24.23 | 2.45 | 0 | | | |
| | Max. | 26.21 | 2.67 | 1.18 | | | |
| | Average. | 25.42 | 2.58 | 0.56 | | | |

| Consultant: | | Geotechnical | nvestigation Report | Client: |
|-------------|------------------|--------------|---------------------|--------------------------------|
| S.M.C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail Infrastructure |
| | BHUBANESWAR | Report No.: | SMC/2050 | Development Corporation Ltd |

ANNEXURE –E Point load index

| Consultant: | | Geotechnical | Investigation Report | Client: |
|-------------|----------------|--------------|----------------------|--|
| S. M. C | SM CONSULTANTS | Job No.: | 830 | Haryana Rail |
| | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

Point load index Test

| Sr.No. | BH NO. | Depth | | Point load index |
|--------|--------|-------|-------|------------------|
| | | From | То | (MPa) |
| 1 | | 0.50 | 1.50 | |
| 2 | | 1.50 | 3.00 | |
| 3 | | 3.00 | 4.50 | |
| 4 | | 4.50 | 6.00 | 3.73 |
| 5 | | 6.00 | 7.50 | |
| 6 | | 7.50 | 9.00 | |
| 7 | | 9.00 | 10.50 | |
| 8 | | 10.50 | 12.00 | |
| 9 | | 15.00 | 16.50 | |
| 10 | | 16.50 | 18.00 | 2.61 |
| 11 | | 18.00 | 19.50 | |
| 12 | | 19.50 | 21.00 | |
| 13 | | 21.00 | 22.50 | |
| 14 | | 22.50 | 24.00 | 2.39 |
| 15 | | 24.00 | 25.50 | |
| 16 | | 25.50 | 27.00 | |
| 17 | DU 13 | 27.00 | 28.50 | |
| 18 | DU-12 | 28.50 | 30.00 | |
| 19 | | 30.00 | 31.50 | 1.01 |
| 20 | | 31.50 | 33.00 | |
| 21 | | 33.00 | 34.50 | |
| 22 | | 34.50 | 36.00 | |
| 23 | | 36.00 | 37.50 | |
| 24 | | 37.50 | 39.00 | 2.30 |
| 25 | | 39.00 | 40.50 | |
| 26 | | 40.50 | 42.00 | |
| 27 | | 42.00 | 43.50 | |
| 28 | | 43.50 | 45.00 | |
| 29 | | 45.00 | 46.50 | |
| 30 | | 46.50 | 48.00 | |
| 31 | | 48.00 | 49.50 | |
| 32 | | 49.50 | 51.00 | |
| 33 | | 51.00 | 52.50 | |
| 34 | | 52.50 | 54.00 | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| C N | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Point load index |
|--------|--------|-------|-------|------------------|
| | | From | То | (MPa) |
| 35 | | 54.00 | 55.50 | 1.6 |
| 36 | | 55.50 | 57.00 | |
| 37 | | 57.00 | 58.50 | |
| 38 | | 58.50 | 60.00 | |
| | | | Min. | 1.01 |
| | | | Max. | 3.20 |
| | | | Avg. | 2.18 |
| 39 | | 1.50 | 3.00 | 21.83 |
| 40 | | 3.00 | 4.50 | |
| 41 | | 4.50 | 6.00 | |
| 42 | | 6.00 | 7.50 | |
| 43 | | 7.50 | 9.00 | |
| 44 | | 9.00 | 10.50 | 3.2 |
| 45 | | 10.50 | 12.00 | |
| 46 | | 12.00 | 13.50 | |
| 47 | | 15.00 | 16.50 | 3.23 |
| 48 | | 16.50 | 18.00 | |
| 49 | | 18.00 | 19.50 | |
| 50 | | 19.50 | 21.00 | |
| 51 | | 21.00 | 22.50 | |
| 52 | | 22.50 | 24.00 | |
| 53 | BH-14 | 24.00 | 25.50 | 3.62 |
| 54 | | 25.50 | 27.00 | |
| 55 | | 27.00 | 28.50 | |
| 56 | | 28.50 | 30.00 | |
| 57 | | 30.00 | 31.50 | |
| 58 | | 31.50 | 33.00 | |
| 59 | | 33.00 | 34.50 | |
| 60 | | 34.50 | 36.00 | 3.08 |
| 61 | | 36.00 | 37.50 | |
| 62 | | 37.50 | 39.00 | |
| 63 | | 39.00 | 40.50 | |
| 64 | | 40.50 | 42.00 | |
| 65 | | 42.00 | 43.50 | |
| 66 | | 43.50 | 45.00 | |
| 67 | | 45.00 | 46.50 | |
| 68 | | 46.50 | 48.00 | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Point load index |
|--------|--------|-------|-------|------------------|
| | | From | То | (MPa) |
| 69 | | 48.00 | 49.50 | 3.16 |
| 70 | | 49.50 | 51.00 | |
| 71 | | 51.00 | 52.50 | |
| 72 | | 52.50 | 54.00 | |
| 73 | | 54.00 | 55.50 | 2.37 |
| 74 | | 57.00 | 58.50 | |
| 75 | | 58.50 | 60.00 | |
| 76 | | 60.00 | 61.50 | |
| 77 | | 63.00 | 64.50 | |
| 78 | | 64.50 | 66.00 | |
| 79 | | 66.00 | 67.50 | 2.26 |
| 80 | | 67.50 | 69.00 | |
| 81 | | 69.00 | 70.50 | |
| 82 | | 70.50 | 72.00 | |
| 83 | | 72.00 | 73.50 | |
| | | Min. | | 2.27 |
| | Max. | | | 3.62 |
| | | Avg. | | 2.99 |
| 84 | | 0.00 | 1.50 | 3.15 |
| 85 | | 1.50 | 3.00 | |
| 86 | | 3.00 | 4.50 | |
| 87 | | 4.50 | 6.00 | |
| 88 | | 6.00 | 7.50 | |
| 89 | | 7.50 | 9.00 | |
| 90 | DU-12 | 9.00 | 10.50 | |
| 91 | | 10.50 | 12.00 | 3.66 |
| 92 | | 12.00 | 13.50 | |
| 93 | | 15.00 | 16.50 | |
| 94 | | 16.50 | 18.00 | |
| 95 | | 18.00 | 19.50 | |
| 96 | | 19.50 | 21.00 | |
| 97 | | 21.00 | 22.50 | 2.53 |
| 98 | | 22.50 | 24.00 | |
| 99 | | 24.00 | 25.50 | |
| 100 | | 25.50 | 27.00 | |
| 101 | | 27.00 | 28.50 | |
| 102 | | 28.50 | 30.00 | |
| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | Point load index |
|--------|--------|-------|-------|------------------|
| | | From | То | (MPa) |
| 103 | | 30.00 | 31.50 | 3.21 |
| 104 | | 31.50 | 33.00 | |
| 105 | | 33.00 | 34.50 | |
| 106 | | 34.50 | 36.00 | |
| 107 | | 36.00 | 37.50 | |
| 108 | | 37.50 | 39.00 | |
| 109 | | 39.00 | 40.50 | 3.66 |
| 110 | | 40.50 | 42.00 | |
| 111 | | 42.00 | 43.50 | |
| 112 | | 43.50 | 45.00 | |
| 113 | | 45.00 | 46.50 | 3.35 |
| 114 | | 46.50 | 48.00 | |
| 115 | | 48.00 | 49.50 | |
| 116 | | 49.50 | 51.00 | 3.53 |
| 117 | | 51.00 | 52.50 | |
| 118 | | 52.50 | 54.00 | |
| 119 | | 54.00 | 55.50 | |
| 120 | | 57.00 | 58.50 | |
| 121 | | 58.50 | 60.00 | |
| 122 | | 60.00 | 61.50 | 3.85 |
| 123 | | 61.50 | 63.00 | |
| 124 | | 64.50 | 66.00 | |
| 125 | | 66.00 | 67.50 | |
| 126 | | 67.50 | 69.00 | |
| 127 | | 69.00 | 70.00 | |
| | | Min. | | 2.5 |
| | | Max. | | 3.8 |
| | | Avg. | | 3.37 |
| 128 | | 0.00 | 1.50 | 2.86 |
| 129 | | 1.50 | 3.00 | |
| 130 | BH-15A | 3.00 | 4.50 | |
| 131 | | 4.50 | 6.00 | |
| 132 | | 6.00 | 7.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | De | pth | Point load index |
|--------|--------|-------|-------|------------------|
| | | From | То | (MPa) |
| | | | | |
| 133 | | 7.50 | 9.00 | |
| | | | | |
| 138 | | 9.00 | 10.50 | |
| | | | | |
| 139 | | 10.50 | 12.00 | |
| | | | | 3.02 |
| 140 | | 12.00 | 13.50 | |
| 141 | | 13.50 | 15.00 | |
| 142 | | 15.00 | 16.50 | |
| 143 | | 16.50 | 18.00 | |
| 144 | | 18.00 | 19.50 | |
| 145 | | 19.50 | 21.00 | |
| 146 | | 21.00 | 22.50 | |
| 147 | | 22.50 | 24.00 | 3.15 |
| 148 | | 25.50 | 27.00 | |
| 149 | | 27.00 | 28.50 | |
| 150 | | 28.50 | 30.00 | |
| 151 | | 30.00 | 31.50 | |
| 152 | | 31.50 | 33.00 | |
| 153 | | 33.00 | 34.50 | 3.4 |
| 154 | | 34.50 | 36.00 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Dej | pth | Point load index |
|--------|--------|-------|-------|------------------|
| | | From | То | (MPa) |
| 155 | | 36.00 | 37.50 | |
| 156 | | 37.50 | 39.00 | |
| 157 | | 39.00 | 40.50 | |
| 158 | | 40.50 | 42.00 | 3.3 |
| 159 | | 42.00 | 43.50 | |
| 160 | | 43.50 | 45.00 | |
| 161 | | 46.50 | 48.00 | |
| 162 | | 48.00 | 49.50 | |
| 163 | | 49.50 | 51.00 | |
| | | Min. | | 2.86 |
| | | Max. | | 3.4 |
| | | Avg. | | 3.14 |
| 164 | | 0.00 | 1.50 | |
| 165 | | 1.50 | 3.00 | |
| 166 | | 3.00 | 4.50 | |
| 167 | | 4.50 | 6.00 | |
| 168 | | 4.50 | 6.00 | |
| 169 | | 7.50 | 9.00 | |
| 170 | | 9.00 | 10.50 | 2.16 |
| 171 | | 10.50 | 12.00 | |
| 172 | | 12.00 | 13.50 | |
| 173 | BH-16 | 13.50 | 15.00 | |
| 174 | | 18.00 | 19.50 | |
| 175 | | 19.50 | 21.00 | 2.06 |
| 176 | | 21.00 | 22.50 | |
| 177 | | 22.50 | 24.00 | |
| 178 | | 24.00 | 25.50 | |
| 179 | | 25.50 | 27.00 | |
| 180 | | 27.00 | 28.50 | |
| 181 | 1 | 28.50 | 30.00 | |
| 182 | 1 | 30.00 | 31.50 | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Point load index |
|--------|--------|-------|-------|------------------|
| | | From | То | (MPa) |
| 183 | | 31.50 | 33.00 | 3.47 |
| 184 | | 33.00 | 34.50 | |
| 185 | | 33.00 | 34.50 | |
| 186 | | 36.00 | 37.50 | |
| 187 | | 37.50 | 39.00 | |
| 188 | | 39.00 | 40.50 | |
| 189 | | 40.50 | 42.00 | |
| 190 | | 42.00 | 43.50 | |
| 191 | | 45.00 | 46.50 | 3.84 |
| 192 | | 46.50 | 48.00 | |
| 193 | | 48.00 | 49.50 | |
| 194 | | 49.50 | 51.00 | 3.32 |
| 195 | | 52.50 | 54.00 | |
| 196 | | 54.00 | 55.50 | |
| 197 | | 55.50 | 57.00 | |
| 198 | | 58.50 | 60.00 | |
| 199 | | 60.00 | 61.50 | 3.60 |
| 200 | | 61.50 | 62.00 | |
| | | Min. | | 2.06 |
| | | Max. | | 3.84 |
| | | Avg. | | 3.07 |

| BH 17 | | | | |
|-------|----------------|---------------------------|--|--|
| Depth | Sample Number | Point load index (Mpa) | | |
| | | | | |
| 19.50 | BH17/1221/R/01 | 3.02 | | |
| 20.50 | BH17/1221/R/03 | | | |
| 22.00 | BH17/1221/R/05 | | | |
| 23.00 | BH17/1221/R/06 | | | |
| 24 50 | BH17/1221/R/07 | | | |
| 24.50 | BH17/1221/R/08 | 2.97 | | |
| 25.00 | BH17/0122/R/09 | | | |
| | BH17/0122/R/10 | | | |
| 26.00 | BH17/0122/R/11 | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| $\begin{array}{ c c c c c c c c c c c c c c c c c c c$ | BH 17 | | | | |
|---|-------|----------------|------------------|--|--|
| BH17/0122/R/12 2.9 BH17/0122/R/13 2.9 BH17/0122/R/13 2.9 BH17/0122/R/13 2.95 BH17/0122/R/15 2.95 BH17/0122/R/16 3.9 BH17/0122/R/16 3.9 BH17/0122/R/18 3.9 28.00 BH17/0122/R/18 28.00 BH17/0122/R/20 BH17/0122/R/21 3.0 BH17/0122/R/22 3.0 BH17/0122/R/23 2.84 30.00 BH17/0122/R/24 BH17/0122/R/25 3.50 BH17/0122/R/26 31.50 BH17/0122/R/26 31.50 BH17/0122/R/26 31.50 BH17/0122/R/26 31.50 BH17/0122/R/32 33.50 BH17/0122/R/32 33.50 BH17/0122/R/33 33.50 BH17/0122/R/33 33.50 BH17/0122/R/33 33.50 BH17/0122/R/34 30.00 BH17/0122/R/35 30.00 BH17/0122/R/35 30.00 BH17/0122/R/34 30.00 | Depth | Sample Number | Point load index | | |
| BH17/0122/R/13 8H17/0122/R/14 27.50 BH17/0122/R/15 27.50 BH17/0122/R/15 28.00 BH17/0122/R/18 28.00 BH17/0122/R/18 28.00 BH17/0122/R/19 29.50 BH17/0122/R/20 BH17/0122/R/21 29.50 BH17/0122/R/23 28.00 BH17/0122/R/23 29.50 BH17/0122/R/23 29.50 BH17/0122/R/23 28.00 BH17/0122/R/23 28.00 BH17/0122/R/23 28.150 BH17/0122/R/26 31.50 BH17/0122/R/28 BH17/0122/R/28 BH17/0122/R/30 32.50 BH17/0122/R/31 BH3/0122/R/32 BH17/0122/R/32 BH17/0122/R/34 BH17/0122/R/35 BH17/0122/R/34 BH17/0122/R/34 BH17/0122/R/44 41.00 < | | BH17/0122/R/12 | 2.9 | | |
| BH17/0122/R/14 2.95 BH17/0122/R/15 2.95 BH17/0122/R/16 3 BH17/0122/R/16 3 BH17/0122/R/16 3 BH17/0122/R/18 3 BH17/0122/R/18 3 BH17/0122/R/19 3 BH17/0122/R/20 3 BH17/0122/R/20 3 BH17/0122/R/20 3 BH17/0122/R/20 3 BH17/0122/R/20 3 BH17/0122/R/21 3 BH17/0122/R/23 2.84 30.00 BH17/0122/R/24 BH17/0122/R/24 3 BH17/0122/R/24 3 BH17/0122/R/25 3 BH17/0122/R/26 3 BH17/0122/R/26 3 BH17/0122/R/28 3 BH17/0122/R/30 3 BH17/0122/R/31 3 BH17/0122/R/33 3 BH17/0122/R/34 3 BH17/0122/R/35 3 BH17/0122/R/36 3 BH17/0122/R/37 3 | | BH17/0122/R/13 | | | |
| 27.50 BH17/0122/R/15 2.95 BH17/0122/R/16 BH17/0122/R/16 0 BH17/0122/R/18 0 0 28.00 BH17/0122/R/18 0 BH17/0122/R/19 0 0 29.50 BH17/0122/R/20 0 BH17/0122/R/21 0 0 29.50 BH17/0122/R/23 2.84 30.00 BH17/0122/R/23 2.84 31.50 BH17/0122/R/25 0 BH17/0122/R/25 0 0 BH17/0122/R/26 0 0 31.50 BH17/0122/R/26 0 BH17/0122/R/26 0 0 BH17/0122/R/26 0 0 33.50 BH17/0122/R/30 0 BH17/0122/R/33 0 0 33.50 BH17/0122/R/33 0 BH17/0122/R/35 0 0 BH17/0122/R/36 0 0 35.00 BH17/0122/R/37 0 BH17/0122/R/44 0 0 41. | | BH17/0122/R/14 | | | |
| 27.50 BH17/0122/R/16 BH17/0122/R/17 BH17/0122/R/17 28.00 BH17/0122/R/19 28.00 BH17/0122/R/19 29.50 BH17/0122/R/20 BH17/0122/R/21 BH17/0122/R/22 29.50 BH17/0122/R/22 BH17/0122/R/22 Second BH17/0122/R/23 30.00 BH17/0122/R/23 BH17/0122/R/25 BH17/0122/R/26 31.50 BH17/0122/R/26 BH17/0122/R/26 BH17/0122/R/26 31.50 BH17/0122/R/26 BH17/0122/R/26 BH17/0122/R/26 33.50 BH17/0122/R/30 BH17/0122/R/30 BH17/0122/R/30 33.50 BH17/0122/R/33 BH17/0122/R/33 BH17/0122/R/34 BH17/0122/R/34 BH17/0122/R/34 BH17/0122/R/34 BH17/0122/R/34 BH17/0122/R/35 BH17/0122/R/34 BH17/0122/R/34 BH17/0122/R/34 BH17/0122/R/44 BH17/0122/R/44 41.00 BH17/0122/R/44 BH17/0122/R/44 BH17/0122/R/45 BH17/0122/R/45 BH17/012 | 27.50 | BH17/0122/R/15 | 2.95 | | |
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| 8H17/0122/R/18 28.00 BH17/0122/R/19 8H17/0122/R/19 BH17/0122/R/20 29.50 BH17/0122/R/21 29.50 BH17/0122/R/21 30.00 BH17/0122/R/23 2.84 31.50 BH17/0122/R/26 BH17/0122/R/26 31.50 BH17/0122/R/30 BH17/0122/R/30 32.50 BH17/0122/R/30 BH17/0122/R/30 33.50 BH17/0122/R/31 BH17/0122/R/32 BH17/0122/R/35 BH17/0122/R/35 BH17/0122/R/35 35.00 BH17/0122/R/35 BH17/0122/R/35 41.00 BH17/0122/R/40 BH17/0122/R/40 41.00 BH17/0122/R/41 BH17/0122/R/42 42.50 BH17/0122/R/42 BH17/0122/R/42 44.00 BH17/0122/R/43 BH17/0122/R/44 45.50 BH17/0122/R/45 BH17/0122/R/45 | | BH17/0122/R/17 | | | |
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| $\begin{array}{c c c c c c c c c c c c c c c c c c c $ | 35.00 | BH17/0122/R/38 | | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | | BH17/0122/R/40 | | | |
| 42.50 BH17/0122/R/42 44.00 BH17/0122/R/43 44.00 BH17/0122/R/45 BH17/0122/R/45 BH17/0122/R/45 44.00 BH17/0122/R/45 BH17/0122/R/45 BH17/0122/R/45 45.50 BH17/1221/R/48 BH17/1221/R/49 BH17/1221/R/50 BH17/1221/R/50 BH17/1221/R/51 47.00 BH17/1221/R/52 | 41.00 | BH17/0122/R/41 | | | |
| 42.50 BH17/0122/R/43 BH17/0122/R/44 BH17/0122/R/45 BH17/0122/R/46 BH17/0122/R/47 BH17/1221/R/48 BH17/1221/R/49 BH17/1221/R/49 BH17/1221/R/50 BH17/1221/R/51 A7.00 BH17/1221/R/53 | | BH17/0122/R/42 | | | |
| 44.00 BH17/0122/R/44 BH17/0122/R/45 BH17/0122/R/45 BH17/0122/R/46 BH17/0122/R/46 BH17/0122/R/47 BH17/1221/R/47 45.50 BH17/1221/R/48 BH17/1221/R/49 BH17/1221/R/49 47.00 BH17/1221/R/52 BH17/1221/R/52 BH17/1221/R/53 | 42.50 | BH17/0122/R/43 | | | |
| 44.00 BH17/0122/R/45 BH17/0122/R/46 BH17/0122/R/47 A5.50 BH17/1221/R/48 BH17/1221/R/49 BH17/1221/R/50 BH17/1221/R/51 A7.00 BH17/1221/R/52 BH17/1221/R/53 | | BH17/0122/R/44 | | | |
| 44.00 BH17/0122/R/46 BH17/0122/R/47 45.50 BH17/1221/R/48 BH17/1221/R/49 BH17/1221/R/50 BH17/1221/R/51 47.00 BH17/1221/R/52 BH17/1221/R/53 | | BH17/0122/R/45 | | | |
| BH17/0122/R/47 BH17/0122/R/47 45.50 BH17/1221/R/48 BH17/1221/R/49 BH17/1221/R/50 BH17/1221/R/50 BH17/1221/R/50 47.00 BH17/1221/R/52 BH17/1221/R/52 BH17/1221/R/53 | 44.00 | BH17/0122/R/46 | | | |
| 45.50 BH17/1221/R/48 BH17/1221/R/49 BH17/1221/R/50 BH17/1221/R/51 A7.00 BH17/1221/R/52 BH17/1221/R/53 BH17/1221/R/53 | | BH17/0122/R/47 | | | |
| 45.50 BH17/1221/R/49 BH17/1221/R/50 BH17/1221/R/51 47.00 BH17/1221/R/52 BH17/1221/R/53 BH17/1221/R/53 | | BH17/1221/R/48 | | | |
| 45.50 BH17/1221/R/50 BH17/1221/R/51 47.00 BH17/1221/R/52 BH17/1221/R/53 | | BH17/1221/R/49 | | | |
| 47.00 BH17/1221/R/53 | 45.50 | BH17/1221/R/50 | | | |
| 47.00 BH17/1221/R/53 | | BH17/1221/R/51 | | | |
| 47.00 BH17/1221/R/53 | | BH17/1221/R/52 | | | |
| | 47.00 | BH17/1221/R/53 | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M.C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | BH 17 | | | | | |
|--------|----------------|------------------|--|--|--|--|
| Depth | Sample Number | Point load index | | | | |
| | BH17/1221/R/54 | | | | | |
| 49.50 | BH17/1221/R/55 | | | | | |
| 48.50 | BH17/1221/R/56 | | | | | |
| | BH17/1221/R/57 | | | | | |
| | BH17/1221/R/58 | | | | | |
| F0.00 | BH17/1221/R/59 | | | | | |
| 50.00 | BH17/1221/R/60 | | | | | |
| | BH17/1221/R/61 | | | | | |
| | BH17/1221/R/62 | | | | | |
| | BH17/1221/R/63 | | | | | |
| F1 F0 | BH17/1221/R/64 | | | | | |
| 51.50 | BH17/1221/R/65 | | | | | |
| | BH17/1221/R/66 | | | | | |
| | BH17/1221/R/67 | | | | | |
| | BH17/1221/R/69 | | | | | |
| | BH17/1221/R/70 | | | | | |
| 53.00 | BH17/1221/R/71 | | | | | |
| | BH17/1221/R/72 | | | | | |
| | BH17/1221/R/73 | 2.82 | | | | |
| | BH17/1221/R/74 | | | | | |
| 54 50 | BH17/1221/R/75 | | | | | |
| 54.50 | BH17/1221/R/76 | | | | | |
| | BH17/1221/R/77 | 3.02 | | | | |
| 56.00 | BH17/1221/R/78 | | | | | |
| 50.00 | BH17/1221/R/79 | 2.94 | | | | |
| E 9 00 | BH17/1221/R/80 | | | | | |
| 58.00 | BH17/1221/R/81 | | | | | |
| 59.50 | BH17/1221/R/82 | | | | | |
| | BH17/1221/R/83 | | | | | |
| 61.00 | BH17/1221/R/84 | | | | | |
| 01.00 | BH17/1221/R/85 | | | | | |
| | BH17/1221/R/86 | | | | | |
| | Min. | 2.82 | | | | |
| | Max. | 3.02 | | | | |
| | Average. | 2.9325 | | | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--------------------------------|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Development Corporation Ltd |

ANNEXURE –F Modulus of elasticity and Poisson's ratio

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

Modulus of elasticity and Poisson's ratio

| Sr.No. | BH NO. | Depth | | Modulus of Elasticity | Poisson's Ratio |
|--------|--------|-------|-------|-----------------------------|-----------------|
| | | From | То | (GI a) | |
| 1 | | 0.50 | 1.50 | | |
| 2 | | 1.50 | 3.00 | 31.4 | 0.14 |
| 3 | | 3.00 | 4.50 | | |
| 4 | | 4.50 | 6.00 | | |
| 5 | | 6.00 | 7.50 | | |
| 6 | | 7.50 | 9.00 | | |
| 7 | | 9.00 | 10.50 | | |
| 8 | | 10.50 | 12.00 | 45.2 | 0.15 |
| 9 | | 15.00 | 16.50 | | |
| 10 | | 16.50 | 18.00 | | |
| 11 | | 18.00 | 19.50 | 48 | 0.13 |
| 12 | | 19.50 | 21.00 | | |
| 13 | | 21.00 | 22.50 | | |
| 14 | | 22.50 | 24.00 | | |
| 15 | | 24.00 | 25.50 | | |
| 16 | | 25.50 | 27.00 | 46.3 | 0.14 |
| 17 | BH-13 | 27.00 | 28.50 | | |
| 18 | DH-13 | 28.50 | 30.00 | | |
| 19 | | 30.00 | 31.50 | | |
| 20 | | 31.50 | 33.00 | | |
| 21 | | 33.00 | 34.50 | 42.4 | 0.16 |
| 22 | | 34.50 | 36.00 | | |
| 23 | | 36.00 | 37.50 | | |
| 24 | | 37.50 | 39.00 | | |
| 25 | | 39.00 | 40.50 | 42.7 | 0.15 |
| 26 | | 40.50 | 42.00 | | |
| 27 | | 42.00 | 43.50 | | |
| 28 | | 43.50 | 45.00 | 43.1 | 0.14 |
| 29 | | 45.00 | 46.50 | | |
| 30 | | 46.50 | 48.00 | 43.5 | 0.15 |
| 31 | | 48.00 | 49.50 | | |
| 32 | | 49.50 | 51.00 | 41.6 | 0.17 |
| 33 | | 51.00 | 52.50 | | |
| 34 | | 52.50 | 54.00 | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Modulus of Elasticity (CPa) | Poisson's Ratio |
|--------|--------|-------|-------|--------------------------------------|-----------------|
| | | From | То | (01 a) | |
| 35 | | 54.00 | 55.50 | | |
| 36 | | 55.50 | 57.00 | 45.7 | 0.16 |
| 37 | | 57.00 | 58.50 | | |
| 38 | | 58.50 | 60.00 | 53.6 | 0.1 |
| | | | Min. | 31.4 | 0.1 |
| | | | Max. | 53.6 | 0.17 |
| | | | Avg. | 43.95 | 0.14 |
| 39 | | 1.50 | 3.00 | | |
| 40 | | 3.00 | 4.50 | | |
| 41 | | 4.50 | 6.00 | 35.6 | 0.12 |
| 42 | | 6.00 | 7.50 | | |
| 43 | | 7.50 | 9.00 | | |
| 44 | | 9.00 | 10.50 | | |
| 45 | | 10.50 | 12.00 | 47.4 | 0.12 |
| 46 | | 12.00 | 13.50 | | |
| 47 | BH-14 | 15.00 | 16.50 | | |
| 48 | | 16.50 | 18.00 | 53 | 0.11 |
| 49 | | 18.00 | 19.50 | | |
| 50 | | 19.50 | 21.00 | | |
| 51 | | 21.00 | 22.50 | | |
| 52 | | 22.50 | 24.00 | | |
| 53 | | 24.00 | 25.50 | 47.1 | 0.12 |
| 54 | | 25.50 | 27.00 | 47.1 | 0.13 |
| 55 | | 27.00 | 28.50 | | |
| 50 | | 20.50 | 21 50 | 15 1 | 0.14 |
| 57 | | 21 50 | 31.50 | 45.4 | 0.14 |
| 50 | | 33.00 | 34 50 | | |
| 60 | | 34.50 | 36.00 | | |
| 61 | | 36.00 | 37.50 | 35.1 | 0.16 |
| 62 | | 37.50 | 39.00 | | 0.10 |
| 63 | | 39.00 | 40.50 | | |
| 64 | | 40.50 | 42.00 | | |
| 65 | | 42.00 | 43.50 | | |
| 66 | | 43.50 | 45.00 | 33.7 | 0.16 |
| 67 | | 45.00 | 46.50 | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Modulus of Elasticity | Poisson's Ratio |
|--------|--------|-------|-------|-----------------------------|-----------------|
| | | From | То | (01 a) | |
| 68 | | 46.50 | 48.00 | 52.2 | 0.13 |
| 69 | | 48.00 | 49.50 | | |
| 70 | | 49.50 | 51.00 | | |
| 71 | | 51.00 | 52.50 | 43.6 | 0.14 |
| 72 | | 52.50 | 54.00 | | |
| 73 | | 54.00 | 55.50 | | |
| 74 | | 57.00 | 58.50 | 38.7 | 0.15 |
| 75 | | 58.50 | 60.00 | | |
| 76 | | 60.00 | 61.50 | 45.3 | 0.13 |
| 77 | | 63.00 | 64.50 | | |
| 78 | | 64.50 | 66.00 | | |
| 79 | | 66.00 | 67.50 | | |
| 80 | | 67.50 | 69.00 | 39.5 | 0.13 |
| 81 | | 69.00 | 70.50 | | |
| 82 | | 70.50 | 72.00 | 39.7 | 0.14 |
| 83 | | 72.00 | 73.50 | | |
| | | Min. | | 33.7 | 0.11 |
| | | Max. | | 53 | 0.16 |
| | | Avg. | 1 | 42.79 | 0.14 |
| 84 | | 0.00 | 1.50 | | |
| 85 | | 1.50 | 3.00 | 47.6 | 0.14 |
| 86 | | 3.00 | 4.50 | | |
| 87 | | 4.50 | 6.00 | | |
| 88 | | 6.00 | 7.50 | | |
| 89 | | 7.50 | 9.00 | 49.1 | 0.12 |
| 90 | | 9.00 | 10.50 | | |
| 91 | | 10.50 | 12.00 | | |
| 92 | BH-15 | 12.00 | 13.50 | | |
| 93 | | 15.00 | 16.50 | | |
| 94 | | 16.50 | 18.00 | 48 | 0.15 |
| 95 | | 18.00 | 19.50 | | |
| 96 | | 19.50 | 21.00 | | |
| 97 | | 21.00 | 22.50 | | • · · - |
| 98 | | 22.50 | 24.00 | 46.9 | 0.15 |
| 99 | | 24.00 | 25.50 | | |
| 100 | | 25.50 | 27.00 | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Modulus of Elasticity | Poisson's Ratio |
|--------|--------|-------|-------|-----------------------------|-----------------|
| | | From | То | (GI a) | |
| 101 | | 27.00 | 28.50 | 47.6 | 0.15 |
| 102 | | 28.50 | 30.00 | | |
| 103 | | 30.00 | 31.50 | | |
| 104 | | 31.50 | 33.00 | | |
| 105 | | 33.00 | 34.50 | 46.6 | 0.14 |
| 106 | | 34.50 | 36.00 | | |
| 107 | | 36.00 | 37.50 | | |
| 108 | | 37.50 | 39.00 | | |
| 109 | | 39.00 | 40.50 | | |
| 110 | | 40.50 | 42.00 | | |
| 111 | | 42.00 | 43.50 | | |
| 112 | | 43.50 | 45.00 | 52.4 | 0.12 |
| 113 | | 45.00 | 46.50 | | |
| 114 | | 46.50 | 48.00 | 51.6 | 0.13 |
| 115 | | 48.00 | 49.50 | | |
| 116 | | 49.50 | 51.00 | 41.2 | 0.14 |
| 117 | | 51.00 | 52.50 | | |
| 118 | | 52.50 | 54.00 | 43.4 | 0.14 |
| 119 | | 54.00 | 55.50 | | |
| 120 | | 57.00 | 58.50 | 47.7 | 0.13 |
| 121 | | 58.50 | 60.00 | | |
| 122 | | 60.00 | 61.50 | | |
| 123 | | 61.50 | 63.00 | 48.9 | 0.13 |
| 124 | | 64.50 | 66.00 | | |
| 125 | | 66.00 | 67.50 | 45.8 | 0.14 |
| 126 | | 67.50 | 69.00 | | |
| 127 | | 69.00 | 70.00 | 48.9 | 0.12 |
| | | Min. | | 41.2 | 0.12 |
| | | Max. | | 52.4 | 0.15 |
| | | Avg. | | 47.55 | 0.14 |
| 128 | | 0.00 | 1.50 | | |
| 129 | | 1.50 | 3.00 | 46.1 | 0.12 |
| 130 | BH-15A | 3.00 | 4.50 | | |
| 131 | | 4.50 | 6.00 | | |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Modulus of Elasticity | Poisson's Ratio |
|--------|--------|-------|-------|-----------------------------|-----------------|
| | | From | То | (GPa) | |
| | | | | | |
| 132 | | 6.00 | 7.50 | 45.8 | 0.11 |
| 133 | | 7.50 | 9.00 | | |
| 138 | | 9.00 | 10.50 | | |
| 139 | | 10.50 | 12.00 | | |
| 140 | | 12.00 | 13.50 | 42.9 | 0.13 |
| 141 | | 13.50 | 15.00 | | |
| 142 | | 15.00 | 16.50 | | |
| 143 | | 16.50 | 18.00 | | |
| 144 | | 18.00 | 19.50 | | |
| 145 | | 19.50 | 21.00 | | |
| 146 | | 21.00 | 22.50 | 44.5 | 0.12 |
| 147 | | 22.50 | 24.00 | | |
| 148 | | 25.50 | 27.00 | | |
| 149 | | 27.00 | 28.50 | 46.3 | 0.11 |
| 150 | | 28.50 | 30.00 | | |
| 151 | | 30.00 | 31.50 | | |
| | | | | 47.4 | 0.11 |
| 152 | | 31.50 | 33.00 | 49.8 | 0.1 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Modulus of Elasticity | Poisson's Ratio | |
|--------|--------|-------|-------|-----------------------------|-----------------|--|
| | | From | То | (Gra) | | |
| 153 | | 33.00 | 34.50 | | | |
| 154 | | 34.50 | 36.00 | | | |
| | | | | 47.6 | 0.09 | |
| 155 | | 36.00 | 37.50 | | | |
| | | | | | | |
| 156 | | 37.50 | 39.00 | | | |
| 157 | | 39.00 | 40.50 | 45.8 | 0.13 | |
| | | | | | | |
| 158 | | 40.50 | 42.00 | | | |
| | | | | | | |
| 159 | | 42.00 | 43.50 | | | |
| | | | | 47.9 | 0.12 | |
| 160 | | 43.50 | 45.00 | | | |
| 161 | | 46.50 | 48.00 | | | |
| 162 | | 48.00 | 49.50 | 50.1 | 0.12 | |
| 163 | | 49.50 | 51.00 | | | |
| | | Min. | | 42.9 | 0.09 | |
| | | Max. | | 50.1 | 0.13 | |
| | | Avg. | 4 50 | 46.75 | 0.11 | |
| 164 | | 0.00 | 1.50 | 54.2 | 0.14 | |
| 165 | | 1.50 | 3.00 | | | |
| 166 | | 3.00 | 4.50 | | | |
| 167 | BH-10 | 4.50 | 6.00 | | | |
| 168 | | 4.5U | 0.00 | 20.0 | 0.14 | |
| 170 | | 9.00 | 9.00 | 53.3 | 0.14 | |
| 170 | | 10 50 | 12.00 | | | |
| 171 | | 12.00 | 12.00 | | | |
| 172 | | 13.50 | 15.00 | | | |
| 173 | | 18.00 | 19.50 | 51 3 | 0.11 | |
| 175 | | 19,50 | 21,00 | 51.5 | 0.11 | |
| 176 | | 21.00 | 22,50 | | | |
| 177 | | 22,50 | 24.00 | 39.7 | 0.13 | |
| 178 | | 24.00 | 25.50 | | | |
| 179 | | 25.50 | 27.00 | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|-----------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \otimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr.No. | BH NO. | Depth | | Modulus of Elasticity | Poisson's Ratio |
|--------|--------|-------|-------|-----------------------------|-----------------|
| | | From | То | (GI a) | |
| 180 | | 27.00 | 28.50 | | |
| 181 | | 28.50 | 30.00 | | |
| 182 | | 30.00 | 31.50 | 51.3 | 0.12 |
| 183 | | 31.50 | 33.00 | | |
| 184 | | 33.00 | 34.50 | | |
| 185 | | 33.00 | 34.50 | | |
| 186 | | 36.00 | 37.50 | | |
| 187 | | 37.50 | 39.00 | 55.5 | 0.11 |
| 188 | | 39.00 | 40.50 | | |
| 189 | | 40.50 | 42.00 | | |
| 190 | | 42.00 | 43.50 | 40.3 | 0.13 |
| 191 | | 45.00 | 46.50 | | |
| 192 | | 46.50 | 48.00 | 52.6 | 0.11 |
| 193 | | 48.00 | 49.50 | | |
| 194 | | 49.50 | 51.00 | 45.9 | 0.12 |
| 195 | | 52.50 | 54.00 | | |
| 196 | | 54.00 | 55.50 | | |
| 197 | | 55.50 | 57.00 | 51.4 | 0.1 |
| 198 | | 58.50 | 60.00 | | |
| 199 | | 60.00 | 61.50 | 50.8 | 0.12 |
| 200 | | 61.50 | 62.00 | | |
| | | Min. | | 39.7 | 0.1 |
| | | Max. | | 55.5 | 0.14 |
| | | Avg. | | 48.45 | 0.12 |

| | BH 17 | | | | | |
|-------|----------------|--------------------------------|-----------------|--|--|--|
| Depth | Sample Number | Modulus of Elasticity (GPa) | Poisson's Ratio | | | |
| | | | | | | |
| 19.50 | BH17/1221/R/01 | | | | | |
| 20.50 | BH17/1221/R/03 | | | | | |
| 22.00 | BH17/1221/R/05 | 44.3 | 0.12 | | | |
| 23.00 | BH17/1221/R/06 | | | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| M.C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Intrastructure Development Corporation Ltd |

| | BH 17 | | | | | |
|-------|----------------|------------|-----------------|--|--|--|
| Depth | Sample Number | Modulus of | Poisson's Ratio | | | |
| 24.50 | BH17/1221/R/07 | | | | | |
| 24.50 | BH17/1221/R/08 | | | | | |
| 25.00 | BH17/0122/R/09 | 42.1 | 0.1 | | | |
| 25.00 | BH17/0122/R/10 | | | | | |
| | BH17/0122/R/11 | | | | | |
| 26.00 | BH17/0122/R/12 | | | | | |
| | BH17/0122/R/13 | | | | | |
| | BH17/0122/R/14 | | | | | |
| 27.50 | BH17/0122/R/15 | | | | | |
| 27.50 | BH17/0122/R/16 | | | | | |
| | BH17/0122/R/17 | | | | | |
| | BH17/0122/R/18 | 48.4 | 0.12 | | | |
| 28.00 | BH17/0122/R/19 | | | | | |
| | BH17/0122/R/20 | | | | | |
| | BH17/0122/R/21 | | | | | |
| 29.50 | BH17/0122/R/22 | | | | | |
| 20100 | BH17/0122/R/23 | | | | | |
| 30.00 | BH17/0122/R/24 | | | | | |
| | BH17/0122/R/25 | | | | | |
| | BH17/0122/R/26 | | | | | |
| 24.50 | BH17/0122/R/27 | 43.3 | 0.11 | | | |
| 31.50 | BH17/0122/R/28 | | | | | |
| | BH17/0122/R/29 | | | | | |
| 22.50 | BH17/0122/R/30 | | | | | |
| 32.50 | BH17/0122/R/31 | | | | | |
| | BH17/0122/R/32 | | | | | |
| | BH17/0122/R/33 | | | | | |
| 33.50 | BH17/0122/R/34 | | | | | |
| | BH17/0122/R/35 | | | | | |
| | BH17/0122/R/36 | 44.3 | 0.08 | | | |
| 25.00 | BH17/0122/R/37 | | | | | |
| 35.00 | BH17/0122/R/38 | | | | | |
| 44.00 | BH17/0122/R/40 | | | | | |
| 41.00 | BH17/0122/R/41 | 45.1 | 0.13 | | | |
| 42.50 | BH17/0122/R/42 | | | | | |
| 42.50 | BH17/0122/R/43 | | | | | |
| | BH17/0122/R/44 | | | | | |
| 44.00 | BH17/0122/R/45 | | | | | |
| 44.00 | BH17/0122/R/46 | | | | | |
| | BH17/0122/R/47 | | | | | |
| | BH17/1221/R/48 | | | | | |
| 45 50 | BH17/1221/R/49 | 42.8 | 0.11 | | | |
| 45.50 | BH17/1221/R/50 | | | | | |
| | BH17/1221/R/51 | | | | | |
| 1 | | | 1 | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| | BH 17 | | | | |
|-------|----------------|------------|-----------------|--|--|
| Depth | Sample Number | Modulus of | Poisson's Ratio | | |
| | | | | | |
| 47.00 | BH17/1221/R/52 | | | | |
| 47.00 | BH17/1221/R/53 | | | | |
| | BH17/1221/R/54 | | | | |
| 18 50 | BH17/1221/R/55 | | | | |
| 40.50 | BH17/1221/R/56 | | | | |
| | BH17/1221/R/57 | 41.6 | 0.13 | | |
| | BH17/1221/R/58 | | | | |
| 50.00 | BH17/1221/R/59 | | | | |
| 50.00 | BH17/1221/R/60 | | | | |
| | BH17/1221/R/61 | | | | |
| | BH17/1221/R/62 | | | | |
| | BH17/1221/R/63 | | | | |
| F1 F0 | BH17/1221/R/64 | | | | |
| 51.50 | BH17/1221/R/65 | | | | |
| | BH17/1221/R/66 | 45.5 | 0.1 | | |
| | BH17/1221/R/67 | | | | |
| | BH17/1221/R/74 | | | | |
| 54.50 | BH17/1221/R/75 | 48.5 | 0.09 | | |
| 54.50 | BH17/1221/R/76 | | | | |
| | BH17/1221/R/77 | | | | |
| 56.00 | BH17/1221/R/78 | | | | |
| 56.00 | BH17/1221/R/79 | | | | |
| 50.00 | BH17/1221/R/80 | 49.3 | 0.11 | | |
| 58.00 | BH17/1221/R/81 | | | | |
| 59.50 | BH17/1221/R/82 | | | | |
| | BH17/1221/R/83 | | | | |
| C1 00 | BH17/1221/R/84 | | | | |
| 61.00 | BH17/1221/R/85 | | | | |
| | BH17/1221/R/86 | | | | |
| 63.00 | BH17/1221/R/87 | 43.7 | 0.1 | | |
| 62.00 | BH17/1221/R/88 | | | | |
| | Min. | 41.6 | 0.08 | | |
| | Max. | 49.3 | 0.13 | | |
| | Average. | 44.91 | 0.11 | | |

| | Consultant: | Geotechnical | nvestigation Report | Client: |
|---------|---------------------------------|--------------|---------------------|--------------------------------|
| S. M. C | S.M. CONSULTANTS BHUBANESWAR | Job No.: | 830 SMC /2050 | Haryana Rail Infrastructure |
| | | Report No | 51010/2030 | Ltd |

ANNEXURE –G Triaxial Test

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr No. | BH No. | Depth | | Tr | iaxial Test |
|--------|--------|-------|-------|----------|-------------------------------|
| | | From | То | Cohesion | Angle of Internal Friction |
| 1 | | 27.00 | 30.00 | 17.9 | 63 |
| 2 | BH-13 | 40.50 | 43.50 | 20.88 | 60.02 |
| 3 | | 48.00 | 49.50 | 15.13 | 65.23 |
| | | Min. | | 15.13 | 60.02 |
| | | Max. | | 20.88 | 65.23 |
| | Avg. | | | 17.97 | 62.75 |
| 4 | | 10.50 | 13.50 | 17.66 | 62.8 |
| 5 | BH-14 | 28.50 | 31.50 | 18.53 | 62.06 |
| 6 | | 63.00 | 66.00 | 24.39 | 56.48 |
| | | Min. | | 17.66 | 56.48 |
| | | Max. | | 24.39 | 62.8 |
| | | Avg. | | 20.19 | 60.45 |
| 7 | BH-15 | 40.50 | 43.50 | 13.78 | 66.39 |
| | Min. | | | 13.78 | 66.39 |
| | Max. | | | 13.78 | 66.39 |
| | | Avg. | | 13.78 | 66.39 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr No. | BH No. | Depth | | Tr | iaxial Test |
|--------|--------------|-------|-------|----------|-------------------------------|
| | | From | То | Cohesion | Angle of Internal Friction |
| 8 | | 13.50 | 15.00 | 16.54 | 64.08 |
| 9 | DH-ISA | 30.00 | 31.50 | 15.71 | 64.67 |
| | | Min. | | 15.71 | 64.08 |
| | | Max. | | 16.54 | 64.67 |
| | Avg. | | | 16.13 | 64.38 |
| 10 | BU 16 | 27.00 | 30.00 | 14.50 | 65.63 |
| 11 | <u>ВЦ-10</u> | 52.50 | 54.00 | 14.75 | 65.63 |
| | | Min. | | 14.50 | 65.63 |
| | | Max. | | 14.75 | 65.63 |
| | | Avg. | | 14.63 | 65.63 |
| 12 | | 25.0 | 27.5 | 13.58 | 69.96 |
| 13 | BH-17 | 42.5 | 44.0 | 19.44 | 66.36 |
| 14 | | 59.5 | 61.0 | 18.89 | 66.76 |
| | Min. | | | 13.58 | 66.36 |
| | Max. | | | 19.44 | 69.96 |
| | Avg. | | | 17.30 | 67.69 |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|----------|------------------|----------------------|---------------------|--------------------------------|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail Infrastructure |
| S | BHUBANESWAR | Report No.: SMC/2050 | SMC/2050 | Development Corporation Ltd |

ANNEXURE –H Hardness

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S M | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr No. | BH No. | Depth | | Hardness Number |
|--------|--------|-------|-------|-----------------|
| | | From | То | |
| 1 | | 3.00 | 4.50 | 66.5 |
| 2 | | 6.00 | 7.50 | 64.6 |
| 3 | | 19.50 | 21.00 | 61.4 |
| 4 | | 24.00 | 25.50 | 60 |
| 5 | BH-13 | 31.50 | 33.00 | 53.1 |
| 6 | | 36.00 | 37.50 | 58.2 |
| 7 | | 43.50 | 45.00 | 59.9 |
| 8 | | 46.50 | 48.00 | 64.8 |
| 9 | | 57.00 | 58.50 | 59.9 |
| | Min. | | | 53.1 |
| | | Max. | 66.5 | |
| | | Avg. | | 60.93 |
| 10 | | 6.00 | 7.50 | 59.8 |
| 11 | | 18.00 | 19.50 | 63.2 |
| 12 | | 22.50 | 24.00 | 61.8 |
| 13 | | 31.50 | 33.00 | 63.6 |
| 14 | BH-14 | 40.50 | 42.00 | 58.8 |
| 15 | | 46.50 | 48.00 | 56.2 |
| 16 | | 57.00 | 58.50 | 59.00 |
| 17 | | 70.50 | 72.00 | 57.2 |
| 18 | | 72.00 | 73.50 | 57.8 |
| | | Min. | | 56.2 |
| | | Max. | | 63.6 |
| | Avg. | | | 59.71 |

| | Consultant: | Geotechnical | Investigation Report | Client: |
|--------------|------------------|--------------|----------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr No. | BH No. | Depth | | Hardness Number |
|--------|--------|-------|-------|-----------------|
| | | From | То | |
| 19 | | 4.50 | 6.00 | 58.6 |
| 20 | - | 9.00 | 10.50 | 53.4 |
| 21 | | 12.00 | 13.50 | 59 |
| 22 | | 18.00 | 19.50 | 61.7 |
| 23 | | 25.50 | 27.00 | 60 |
| 24 | BH-12 | 34.50 | 36.00 | 54.4 |
| 25 | | 51.00 | 52.50 | 59.6 |
| 26 | | 54.00 | 55.50 | 60.6 |
| 27 | | 60.00 | 61.50 | 61.5 |
| 28 | | 67.50 | 69.00 | 60.1 |
| | | Min. | | 53.4 |
| | | Max. | | 61.7 |
| | | Avg. | | 58.89 |
| 29 | | 3.00 | 4.50 | 61 |
| 30 | | 9.00 | 10.50 | 61.2 |
| 31 | | 15.00 | 16.50 | 61.5 |
| 32 | | 21.00 | 22.50 | 60.2 |
| 33 | DU-124 | 25.50 | 27.00 | 56.2 |
| 34 | | 33.00 | 34.50 | 56.1 |
| 35 | | 39.00 | 40.50 | 61.1 |
| 36 | | 46.50 | 48.00 | 62.2 |
| | | Min. | | 56.1 |
| | | Max. | | 62.2 |
| | Avg. | | | 59.94 |

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr No. | BH No. | Depth | | Hardness Number |
|--------|--------|-------|-------|-----------------|
| | | From | То | |
| 37 | | 3.00 | 4.50 | 60.2 |
| 38 | | 13.50 | 15.00 | 61.7 |
| 39 | | 21.00 | 22.50 | 61.7 |
| 40 | BH-16 | 27.00 | 28.50 | 61.6 |
| 41 | | 36.00 | 37.50 | 54.8 |
| 42 | | 46.50 | 48.00 | 58.6 |
| 43 | | 55.50 | 57.00 | 60.2 |
| | | М | in. | 54.8 |
| | | M | ax. | 61.7 |
| | | Αν | /g. | 59.83 |
| 44 | | 20.5 | 22.0 | 27.4 |
| 45 | | 26.0 | 27.5 | 25.5 |
| 46 | | 27.5 | 28.0 | 30.2 |
| 47 | | 29.5 | 30.0 | 31.8 |
| 48 | | 31.5 | 32.5 | 22.1 |
| 49 | | 32.5 | 33.5 | 50.6 |
| 50 | BH-17 | 33.5 | 35.0 | 34.5 |
| 51 | | 41.0 | 42.5 | 34.1 |
| 52 | | 44.0 | 45.5 | 40.0 |
| 53 | | 47 | 48.5 | 24.5 |
| 54 | | 51.5 | 53.0 | 28.6 |
| 55 | | 54.5 | 56 | 33.9 |
| 56 | | 61.0 | 62.0 | 36.3 |
| | | Min. | | 22.1 |
| | | Max. | | 50.6 |
| | | Avg. | | 32.65 |

| Consultant: | Geotechnical I | nvestigation Report | Client: |
|---------------------------------|-------------------------|---------------------|--|
| S.M. CONSULTANTS BHUBANESWAR | Job No.: Report No.: | 830 SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

ANNEXURE –I Abrasiveness Test

| Consultant: | | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr No. | BH No. | Depth | | Abrasiveness | Classification |
|--------|--------|-------|-------|--------------|-------------------|
| | | From | То | | (HRC=55) |
| 1 | | 3.00 | 4.50 | 2.66 | High Abrasiveness |
| 2 | | 6.00 | 7.50 | 2.7 | High Abrasiveness |
| 3 | | 19.50 | 21.00 | 2.62 | High Abrasiveness |
| 4 | | 24.00 | 25.50 | 2.68 | High Abrasiveness |
| 5 | BH-13 | 31.50 | 33.00 | 2.96 | High Abrasiveness |
| 6 | | 36.00 | 37.50 | 2.99 | High Abrasiveness |
| 7 | | 43.50 | 45.00 | 2.96 | High Abrasiveness |
| 8 | | 46.50 | 48.00 | 3.01 | High Abrasiveness |
| 9 | | 57.00 | 58.50 | 3.37 | High Abrasiveness |
| | | Min. | | 2.62 | High Abrasiveness |
| | Max. | | | 3.37 | High Abrasiveness |
| | | Avg. | | 2.88 | High Abrasiveness |
| 10 | | 6.00 | 7.50 | 2.54 | High Abrasiveness |
| | | 10.50 | 12.00 | 2.38 | High Abrasiveness |
| 11 | | 18.00 | 19.50 | 2.5 | High Abrasiveness |
| 12 | | 22.50 | 24.00 | 2.44 | High Abrasiveness |
| 13 | | 31.50 | 33.00 | 2.33 | High Abrasiveness |
| 14 | DU-14 | 40.50 | 42.00 | 2.74 | High Abrasiveness |
| 15 | | 46.50 | 48.00 | 2.5 | High Abrasiveness |
| 16 | | 57.00 | 58.50 | 2.76 | High Abrasiveness |
| 17 | | 70.50 | 72.00 | 2.64 | High Abrasiveness |
| 18 | | 72.00 | 73.50 | 2.64 | High Abrasiveness |
| | | Min. | | 2.33 | High Abrasiveness |
| | | Max. | | 2.76 | High Abrasiveness |
| | Avg. | | | 2.55 | High Abrasiveness |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr No. | BH No. | De | pth | Abrasiveness | Classification | | | | |
|--------|----------------|-------|-------|--------------------|-------------------|--|--|--|--|
| | | From | То | | (HRC=55) | | | | |
| 19 | | 4.50 | 6.00 | 2.99 | High Abrasiveness | | | | |
| 20 | | 9.00 | 10.50 | 2.96 | High Abrasiveness | | | | |
| 21 | | 12.00 | 13.50 | 3.19 | High Abrasiveness | | | | |
| 22 | | 18.00 | 19.50 | 2.88 | High Abrasiveness | | | | |
| 23 | | 25.50 | 27.00 | 3.25 | High Abrasiveness | | | | |
| 24 | BH-15 | 34.50 | 36.00 | 3.23 | High Abrasiveness | | | | |
| | | 43.50 | 45.00 | 3.43 | High Abrasiveness | | | | |
| 25 | | 51.00 | 52.50 | 3.07 | High Abrasiveness | | | | |
| 26 | | 54.00 | 55.50 | 3.19 | High Abrasiveness | | | | |
| 27 | | 60.00 | 61.50 | 3.15 | High Abrasiveness | | | | |
| 28 | - | 67.50 | 3.29 | High Abrasiveness | | | | | |
| | | Min. | | 2.88 | High Abrasiveness | | | | |
| | | Max. | | 3.43 | High Abrasiveness | | | | |
| | | Avg. | 3.15 | High Abrasiveness | | | | | |
| 29 | | 3.00 | 4.50 | 3.17 | High Abrasiveness | | | | |
| 30 | | 9.00 | 10.50 | 3.23 | High Abrasiveness | | | | |
| 31 | | 15.00 | 16.50 | 3.21 | High Abrasiveness | | | | |
| 32 | | 21.00 | 22.50 | 3.39 | High Abrasiveness | | | | |
| 33 | ВП-15 А | 25.50 | 27.00 | 2.92 | High Abrasiveness | | | | |
| 34 | | 33.00 | 34.50 | 3.13 | High Abrasiveness | | | | |
| 35 | | 39.00 | 40.50 | 3.15 | High Abrasiveness | | | | |
| 36 | | 46.50 | 48.00 | 3.01 | High Abrasiveness | | | | |
| | | Min. | | 2.92 | High Abrasiveness | | | | |
| | | Max. | | 3.39 | High Abrasiveness | | | | |
| | | Avg. | | 3.15 High Abrasive | | | | | |

| | Consultant: | Geotechnical I | nvestigation Report | Client: |
|--------------|------------------|----------------|---------------------|--|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | Haryana Rail |
| \bigotimes | BHUBANESWAR | Report No.: | SMC/2050 | Infrastructure Development Corporation Ltd |

| Sr No. | BH No. | De | pth | Abrasiveness | Classification |
|--------|--------|-------|-------|--------------|---------------------|
| | | From | То | | (HRC=55) |
| 37 | | 3.00 | 4.50 | 3.15 | High Abrasiveness |
| 38 | | 13.50 | 15.00 | 3.23 | High Abrasiveness |
| 39 | | 21.00 | 22.50 | 2.94 | High Abrasiveness |
| 40 | BH-16 | 27.00 | 28.50 | 3.15 | High Abrasiveness |
| 41 | | 36.00 | 37.50 | 3.15 | High Abrasiveness |
| 42 | | 46.50 | 48.00 | 3.27 | High Abrasiveness |
| 43 | | 55.50 | 57.00 | 3.31 | High Abrasiveness |
| | | Min. | | 2.94 | |
| | | Max. | | 3.31 | |
| | | Avg. | | 3.17 | |
| 44 | | 20.5 | 22.0 | 1.95 | Medium Abrasiveness |
| 45 | | 26.0 | 27.5 | 1.91 | Medium Abrasiveness |
| 46 | | 27.5 | 28.0 | 2.38 | High Abrasiveness |
| 47 | | 29.5 | 30.0 | 2.58 | High Abrasiveness |
| 48 | | 31.5 | 32.5 | 2.18 | High Abrasiveness |
| 49 | | 32.5 | 33.5 | 2.36 | High Abrasiveness |
| 50 | BH-17 | 33.5 | 35.0 | 2.46 | High Abrasiveness |
| 51 | | 41.0 | 42.5 | 2.12 | High Abrasiveness |
| 52 | | 44.0 | 45.5 | 2.28 | High Abrasiveness |
| 53 | | 47 | 48.5 | 2.16 | High Abrasiveness |
| 54 | | 51.5 | 53.0 | 2.08 | High Abrasiveness |
| 55 |] | 54.5 | 56 | 2.24 | High Abrasiveness |
| 56 |] | 61.0 | 62.0 | 1.97 | Medium Abrasiveness |
| | | Min. | | 1.91 | |
| | | Max. | | 2.58 | |
| | | Avg. | | 2.21 | |

| | Consultant: | Geotechnical Ir | nvestigation Report | Client: |
|--------------|------------------|-----------------|---------------------|---|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | |
| \bigotimes | BHUBANESWAR | REPORT. No.: | SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |
| | | TEST | RESULTSHE | ET |

ANNEXURE –G SOIL TEST Results

* The SPT N values illustrated in the tables below are raw values (without correction factor) collected directly from field. * The phi values represented in the tables are measured in laboratory, they do not illustrate the phi values in the insitu condition.

| | Consultant: | Geotechnica | Client: | |
|--------------|------------------|--------------|--------------|---|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | |
| \bigotimes | BHUBANESWAR | REPORT. No.: | SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |
| | | TES | ST RESULTSHE | ΕΤ |

BH-17, (CH-25785 M)

| | | | | (| Grain size | e analys | is | Hydro Ana | meter lysis | At | tterbe Limit | rg's t | | | | | | | | | | |
|---------|--------------------------------|------------------------|---------------|---------------------------------------|--|--------------------|--|--------------|----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|----------------------------------|--------------------|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | עספר איז | (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | φ) in degree | Triaxial test (UU) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | From 0.0 m to 1.50 m depth | UDS | | 6.23 | 1.87 | 4.63 | 37.26 | 37.56 | 12.45 | 25 | 19 | 6 | 10.56 | 1.754 | 1.586 | 0.09 | 27 | DS | 2.66 | 0.68 | 0.136 | ML-CL |
| 2 | From 1.50 m to 3.0 m depth | SPT | 12 | 11.53 | 2.21 | 5.3 | 29.63 | 38.70 | 12.63 | 25 | 20 | 5 | | | | | | | 2.66 | | | ML-CL |
| 3 | From 3.0 m to 4.50 m depth | UDS | | 5.23 | 3.14 | 4.87 | 6.85 | 65.06 | 14.85 | 26 | 20 | 6 | 12.45 | 1.816 | 1.615 | 0.15 | 14 | UU | 2.67 | 0.65 | 0.129 | ML-CL |
| 4 | From 4.50 m to 6.0 m depth | SPT | 16 | 4.21 | 1.35 | 4.58 | 7.59 | 65.88 | 16.39 | 27 | 20 | 7 | | | | | | | 2.67 | | | ML-CL |
| 5 | From 6.0 m to 9.0 m depth | UDS | | 3.15 | 2.84 | 6.47 | 9.66 | 63.26 | 14.62 | 25 | 20 | 5 | 13.82 | 1.853 | 1.628 | 0.15 | 12 | UU | 2.66 | 0.63 | 0.139 | ML-CL |
| 6 | From 9.0 m to 12.0 m depth | SPT | 26 | 7.14 | 0.73 | 1.12 | 5.69 | 68.56 | 16.76 | 26 | 19 | 7 | | | | | | | 2.68 | | | ML-CL |
| 7 | From 12.0 m to 15.0 m depth | SPT | 21 | 6.02 | 1.06 | 2.48 | 7.03 | 67.55 | 15.86 | 25 | 19 | 6 | | | | | | | 2.67 | | | ML-CL |

| | Consultant: | Geotechnica | Investigation Report | Client: |
|--------------|------------------|--------------|----------------------|---|
| S. M. C. | S.M. CONSULTANTS | Job No.: | 830 | |
| \bigotimes | BHUBANESWAR | REPORT. No.: | SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |
| | | TES | T RESULTSHE | ET |

| | | | | | Grains | size analys | is | Hydro Anal | meter lysis | Atte | erberg's | s Limit | nt in | /cc. | | n² | | | | | Cc) | |
|---------|----------------------------------|------------------------|---------------|---------------------------------------|--|---------------------------------------|---|---------------|----------------|-------------------|--------------------|--------------------------|----------------------------|-----------------------|----------------------|-----------------------|---------------------------------|--|------------------|------------|---|---------------|
| sl. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm | Medium Sand in % (2.0mm To 0.425mm | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Contei % | Natural density in gm | Dry density in gm/cc | Cohesion (C) Kgf/cr | Angle of shearing resistance | Triaxial test (UU) Direct shear test (DV) | Specific gravity | Void ratio | Consolidation test (Compression Index, (| Group of soil |
| 8 | From 15.0 m to 16.50 m depth | SPT | 37 | 6.97 | 3.25 | 2.28 | 3.29 | 68.2 9 | 15. 92 | 25 | 20 | 5 | | | | | | | 2.67 | | | ML-CL |
| 9 | From 16.50 m to 18.00 m depth | SPT | >50 | 26 | 0.87 | 0.9 | 3.67 | 56.1 0 | 12. 46 | 24 | 18 | 6 | | | | | | | 2.66 | | | ML-CL |
| 10 | From 18.0 m to 19.50 m depth | ROCK | | | | | • | • | • | R | OCK (| CORE R | ECOVER | Y=17%, | R.Q.D=1 | NIL) | • | | | • | • | |
| 11 | From 19.50 m to 20.50 m depth | ROCK | | | | | | | | R | OCK (| CORE R | ECOVER | Y=22%, | R.Q.D=1 | NIL) | | | | | | |
| 12 | From 20.50m to 22.00 m depth | ROCK | | | | | | | | RC | ОСК (СС | ORE REG | COVERY | =25%, R | .Q.D=11 | 6%) | | | | | | |
| 13 | From 22.0 m to 23.0 m depth | ROCK | | | | | | | | R | OCK (| CORE R | ECOVER | Y=32%, | R.Q.D=1 | NIL) | | | | | | |
| 14 | From 23.0 m to 24.50 m depth | ROCK | | | ROCK (CORE RECOVERY=33%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | |
| 15 | From 24.50 m to 25.0 m depth | ROCK | | | ROCK (CORE RECOVERY=48%, R.Q.D=25%) | | | | | | | | | | | | | | | | | |

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| | | | | | Grain siz | e analy | sis | Hyd Ar | rometer nalysis | Att | erberg | s Limit | | | | | | | | | | | | |
|---------|---------------------------------|------------------------|---------------|---------------------------------------|---------------------|--------------------|--|-----------|--------------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|------------------------------|---------------|--------------------|---------------------------------------|------------|--------------------|-------------------------|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) Loarse sand in % | (4.75mm To 2.00 mm) | (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in% | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance | (φ) in degree | Triaxial test (UU) | Direct cheet (DS) Specific gravity | Void ratio | consolidation test | (Compression Index, Cc) | Group of soil |
| 16 | From 25.00 m to 26.00 m depth | ROCK | | | | | | | | RO | CK (COI | RE RECC | OVERY=5 | 59%, R.Q | .D=32.6 | %) | | | | | | | | |
| 17 | From 26.00 m to 27.50 m depth | ROCK | | | | | | | | ROC | CK (COR | E RECO | VERY=44 | 4%, R.Q. | D=12.66 | 5%) | | | | | | | | |
| 18 | From 27.50 m to 28.0 m depth | ROCK | | | | | | | | RO | CK (COI | RE RECC | OVERY=6 | 58%, R.Q | .D=25.8 | %) | | | | | | | | |
| 19 | From 28.0 m to 29.50 m depth | ROCK | | | | | | | | RO | CK (CO | RE REC | OVERY=! | 58%, R.C | Q.D=7.69 | 6) | | | | | | | | |
| 20 | From 29.50 m to 30.0 m depth | ROCK | | | | | | | | R | OCK (C | ORE REC | COVERY= | =70%, R. | Q.D=NIL |) | | | | | | | | |
| 21 | From 30.00m to 31.00 m depth | ROCK | | | | | | | | ROC | CK (COR | E RECO | VERY=4 | 7%, R.Q. | D=17.13 | 8%) | | | | | | | | |
| 22 | From 31.0 m to 32.50 m depth | ROCK | | | | | | | | R | OCK (C | ORE REC | COVERY= | =64%, R. | Q.D=NIL | .) | | | | | | | | |

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| | | | | | Grains | size analysis | 5 | Hydro Ana | ometer alysis | A | tterber Limit | gʻs | | | | | | | | | | | | |
|---------|----------------------------------|------------------------|---------------|-------------------|--|---|--|--------------|------------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|------------------------------|---------------|--------------------|------------------|------------|--------------------|-------------------------|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance | (φ) in degree | Triaxial test (UU) | Specific gravity | Void ratio | Consolidation test | (Compression Index, Cc) | Group of soil |
| 23 | From 32.50 m to 33.50 m depth | ROCK | | | | | | | F | ROCK | (CORE | RECO | VERY | =54%, R.(| Q.D=15.5 | 53%) | | | | | | - | | |
| 24 | From 33.50 m to 35.0 m depth | ROCK | | | ROCK (CORE RECOVERY=34.66%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | | | |
| 25 | From 35.00 m to 36.50 m depth | SPT | >50 | 2.16 | 1.51 | 3.55 | 67.09 | 25.69 | 0.00 | 21 | | NP | | | | | | | | 2.65 | | | - | SM |
| 26 | From 36.50 m to 38.00 m depth | SPT | >50 | 3.41 | 1.61 | 9.75 | 71.60 | 13.63 | 0.00 | 20 | | NP | | | | | | | | 2.64 | | | | SM |
| 27 | From 38.00 m to 39.50 m depth | SPT | >50 | 4.10 | 1.0 1.37 2.57 5.31 71.41 15.24 25 NP 2.66 NL | | | | | | | | | | | | | | | | | | | |
| 28 | From 39.50 m to 41.00 m depth | ROCK | | | ROCK (CORE RECOVERY=32%, R.Q.D=11%) | | | | | | | | | | | | | | | | | | | |
| 29 | From 41.00 m to 42.50 m depth | ROCK | | | | ROCK (CORE RECOVERY=41.33%, R.Q.D=19.33%) | | | | | | | | | | | | | | | | | | |

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| | | | | | Grain | size a | inalysi | S | | Hydro Ana | ometer Ilysis | Α | tterbe Limit | ʻgʻs | | | | | | | | | | | | |
|---------|----------------------------------|------------------------|---------------|-------------------|---|--|--------------------|----------------|----------------------|--------------|------------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|------------------------------|---------------|--------------------|------------------|------------|--------------------|-------------------------|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | coarse sand in % (4.75mm To 2.00 mm) | Medium Sand in % | (2.0mm To 0.425mm) | Fine Sand in % | (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance | (φ) in degree | Triaxial test (UU) | Specific gravity | Void ratio | Consolidation test | (Compression Index, Cc) | Group of soil |
| 30 | From 42.50m to 44.00 m depth | ROCK | | | | ROCK (CORE RECOVERY=54%, R.Q.D=41.53%) | | | | | | | | | | | | | | | | | | | | |
| 31 | From 44.0 m to 45.50 m depth | ROCK | | | ROCK (CORE RECOVERY=30%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | | | | | |
| 32 | From 45.50 m to 47.00 m depth | ROCK | | | | | | | | | | ROCK | (COR | E RECO | OVER | Y=37.33% | %, R.Q.D= | NIL) | | | | | | | | |
| 33 | From 47.00 m to 48.50 m depth | ROCK | | | | | | | | | R | ЭСК ((| CORE I | RECOV | /ERY= | 41.33%, | R.Q.D=21 | 1.06%) | | | | | | | | |
| 34 | From 48.50 m to 50.00 m depth | ROCK | | | ROCK (CORE RECOVERY=30%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | | | | | |
| 35 | From 50.00 m to 51.50 m depth | ROCK | | | ROCK (CORE RECOVERY=36.66%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | | | | | |
| 36 | From 51.50 m to 53.00 m depth | ROCK | | | | ROCK (CORE RECOVERY=34.66%, R.Q.D=12%) | | | | | | | | | | | | | | | | | | | | |

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TEST CONDUCTED AS PER IS: 2720 (Pt. II, Pt. III, Pt. IV, Pt. V, Pt. X, Pt. XI / Pt. XIII & Pt. XV) AND IS: 1498 – 1970

| | | | | | Grain | size a | analysi | S | | Hydro Anal | meter ysis | Att | erberg': | s Limit | | | | | | | | | | | | | |
|---------|----------------------------------|------------------------|---------------|-------------------|--|---|--------------------|----------------|----------------------|---------------|---------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|------------------------------|---------------|--------------------|--|---|------------|----------|-------------------------|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % | (2.0mm To 0.425mm) | Fine Sand in % | (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance | (φ) in degree | Triaxial test (UU) | Diract charr tact (DS) Snerific pravity | 6 | Void ratio | <u> </u> | (Compression Index, Cc) | Group of soil |
| 37 | From 53.00 m to 54.50 m depth | ROCK | | | | ROCK (CORE RECOVERY=33.33%, R.Q.D=6.8%) | | | | | | | | | | | | | | | | | | | | | |
| 38 | From 54.50 m to 56.00m depth | ROCK | | | | | | | | | | ROC | CK (COF | RE RECO | OVERY=2 | 28%, R.Q | .D=6.73 | %) | | | | | | | | | |
| 39 | From 56.00m to 58.00 m depth | ROCK | | | | | | | | | | RC | DCK (CO | ORE REC | COVERY | =38% <i>,</i> R. | Q.D=8% |) | | | | | | | | | |
| 40 | From 58.00 m to 59.50m depth | ROCK | | | | ROCK (CORE RECOVERY=38.33%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | | | | | |
| 41 | From 59.50 m to 61.00 m depth | ROCK | | | ROCK (CORE RECOVERY=40.6%, R.Q.D=27.66%) | | | | | | | | | | | | | | | | | | | | | | |
| 42 | From 61.00 m to 62.00 m depth | ROCK | | | | ROCK (CORE RECOVERY=70%, R.Q.D=12.66%) | | | | | | | | | | | | | | | | | | | | | |

*Note: From 35.0 m to 39.5m depth, highly weathered soft rock stratum exists from which core sample couldn't be collected only washed out sample has been collected.

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| | | | | | | Grains | size analys | iis | | Atte | rberg's | s Limit | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|-------------------|---|--------------------|---------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|------------------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (φ) in degree | Type of shear test Triaxial test (UU) Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 2.77 | 21.85 | 66.69 | 8.69 | 26 | | NP | | | | | | | 2.67 | | | ML |
| 2 | At 1.5 m depth | UDS | | 0 | 0.09 | 0.54 | 34.22 | 58.61 | 6.54 | 24 | | NP | 11.42 | 1.765 | 1.584 | 0.13 | 17 | UU | 2.66 | 0.68 | 0.132 | ML |
| 3 | At 3.0 m depth | SPT | 11 | 1.21 | 0.16 | 1.49 | 7.87 | 80.01 | 9.26 | 25 | | NP | | | | | | | 2.68 | | | ML |
| 4 | At 4.5 m depth | UDS | | 0 | 0.13 | 0.53 | 35.77 | 55.94 | 7.63 | 25 | | NP | 12.63 | 1.803 | 1.601 | 0.12 | 19 | UU | 2.66 | 0.66 | 0.128 | ML |
| 5 | At 6.0 m depth | SPT | 20 | 0.75 | 1.12 | 1.02 | 11.01 | 76.63 | 9.47 | 26 | | NP | | | | | | | 2.68 | | | ML |
| 6 | At 9.0 m depth | UDS | | 0 | 0 | 0.64 | 22.85 | 67.82 | 8.69 | 26 | | NP | 14.63 | 1.853 | 1.617 | 0.16 | 14 | UU | 2.67 | 0.65 | 0.125 | ML |
| 7 | At 12.0 m depth | SPT | 24 | 0 | 0 | 0.41 | 17.66 | 71.47 | 10.46 | 27 | | NP | | | | | | | 2.68 | | | ML |
| 8 | At 15.0 m depth | SPT | 31 | 0 | 0 | 0.65 | 13.25 | 70.87 | 15.23 | 27 | 21 | 6 | | | | | | | 2.70 | | | ML-CL |
| 9 | At 18.0 m depth | SPT | 35 | 1.12 | 3.05 | 3.21 | 12.74 | 65.99 | 13.89 | 25 | 20 | 5 | | | | | | | 2.69 | | | ML-CL |

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| | | | | | | Grain size | analysis | | | Att | erber Limit | g's | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|---------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|---------------------------------|--|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion(C) Kgf/cm ² | Angle of shearing resistance (φ) in degree | Type of shear test Triaxial test (UU) Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | SPT | 40 | 0 | 4.27 | 4.28 | 12.73 | 66.51 | 12.21 | 26 | 20 | 6 | | | | | | | 2.69 | | | ML-CL |
| 11 | At 24.0 m depth | SPT | 47 | 2.08 | 5.39 | 4.35 | 10.17 | 70.32 | 7.69 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 12 | At 27.00 m depth | SPT | 49 | 2.77 | 5.59 | 4.54 | 7.57 | 71.08 | 8.45 | 24 | | NP | | | | | | | 2.67 | | | ML |
| 13 | At 30.00 m depth | SPT | 57 | 6.59 | 2.30 | 2.13 | 11.62 | 70.87 | 6.49 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 14 | At 33.00 m depth | SPT | 64 | 2.29 | 3.32 | 2.72 | 20.65 | 64.68 | 6.34 | 24 | | NP | | | | | | | 2.65 | | | ML |
| 15 | At 36.00 m depth | SPT | 69 | 1.21 | 3.92 | 2.72 | 20.65 | 64.94 | 6.56 | 25 | | NP | | | | | | | 2.67 | | | ML |
| 16 | At 39.00 m depth | SPT | 77 | 1.21 | 3.92 | 5.48 | 13.20 | 68.82 | 7.37 | 26 | | NP | | | | | | | 2.66 | | | ML |
| 17 | At 42.00 m depth | SPT | 84 | 0 | 0.29 | 4.69 | 14.85 | 70.53 | 9.64 | 27 | | NP | | | | | | | 2.67 | | | ML |
| 18 | At 45.00 m depth | SPT | >50 | 0.86 | 1.29 | 2.47 | 21.77 | 66.35 | 7.26 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 19 | At 47.00 m depth | SPT | >50 | 1.01 | 0.95 | 1.68 | 21.22 | 67.29 | 7.85 | 25 | | NP | | | | | | | 2.65 | | | ML |
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| | | | | | | Grain size | analysis | | | Att | erber Limit | gʻs | _ | | | | | | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|---------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|------------------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (φ) in degree | Type of shear test Triaxial test (UU) Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 20 | At 50.0 m depth | SPT | >50 | 0 | 0 | 0.38 | 36.92 | 56.16 | 6.54 | 24 | | NP | | | | | | | 2.68 | | | ML |
| 21 | At 53.0 m depth | SPT | >50 | 5.50 | 1.11 | 0.98 | 17.76 | 66.76 | 7.89 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 22 | At 55.00 m depth | SPT | >50 | 4.29 | 1.92 | 1.75 | 16.29 | 67.63 | 8.12 | 26 | | NP | | | | | | | 2.66 | | | ML |

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BH-19, (CH-26210 M)

| | | | | | Grain size | e analysi | S | Hydro Anal | meter lysis | Atter | berg's | s Limit | | | | | .9 | / (Nſ | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|---------------|----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|--|---|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | меснин эанс н 20 (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance(φ) degree | Type of shear test (Triaxial test (U Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0.52 | 31.8 | 46.32 | 21.36 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 2 | At 1.5 m depth | SPT | 17 | 0 | 0 | 0.35 | 29.33 | 47.89 | 22.43 | 26 | | NP | | | | | | | 2.67 | | | ML |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0.78 | 33.46 | 45.28 | 20.48 | 24 | | NP | 10.59 | 1.761 | 1.592 | 0.14 | 20 | DS | 2.66 | 0.67 | 0.123 | ML |
| 4 | At 4.5 m depth | SPT | 23 | 13.54 | 1.59 | 3.96 | 10.02 | 49.93 | 20.96 | 24 | | NP | | | | | | | 2.65 | | | ML |
| 5 | At 6.0 m depth | UDS | | 6.24 | 2.85 | 4.39 | 13.62 | 49.46 | 23.44 | 27 | | NP | 11.36 | 1.792 | 1.609 | 0.13 | 24 | DS | 2.67 | 0.66 | 0.118 | ML |
| 6 | At 9.0 m depth | SPT | 30 | 5.8 | 0.24 | 3.24 | 9.08 | 54.79 | 26.85 | 26 | | NP | | | | | | | 2.68 | | | ML |
| 7 | At 12.0 m depth | UDS | | 3.15 | 0.46 | 1.79 | 13.63 | 56.03 | 24.94 | 26 | | NP | 11.85 | 1.813 | 1.621 | 0.10 | 26 | DS | 2.68 | 0.65 | 0.114 | ML |
| 8 | At 15.0 m depth | SPT | 35 | 1.01 | 0.3 | 0.8 | 17.77 | 55.86 | 24.26 | 25 | | NP | | | | | | | 2.67 | | | ML |

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| | | | | | Grain siz | ze analysis | | Hydro Ana | ometer lysis | Att | terberg Limit | g's | _ | | | | (φ) | test)) | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|---|---|------------------|------------|---|---------------|
| Sl. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance in degree | Type of shear test (Triaxial (UU) / Direct shear test (DS | Specific gravity | Void ratio | Composition test (Compression Index, Cc) | Group of soil |
| 9 | At 18.0 m depth | UDS | | 5.26 | 0.96 | 1.45 | 14.96 | 54.50 | 22.87 | 26 | | NP | 12.64 | 1.826 | 1.621 | 0.11 | 25 | DS | 2.66 | 0.64 | 0.111 | ML |
| 10 | At 21.0 m depth | SPT | 35 | 8.28 | 0.81 | 2.77 | 12.82 | 55.69 | 19.63 | 24 | | NP | | | | | | | 2.65 | | | ML |
| 11 | At 24.0 m depth | UDS | | 3.45 | 0.69 | 1.75 | 21.82 | 51.85 | 20.44 | 25 | | NP | 13.76 | 1.849 | 1.625 | 0.12 | 23 | DS | 2.66 | 0.64 | 0.115 | ML |
| 12 | At 27.00 m depth | SPT | 39 | 0.55 | 0.29 | 1.08 | 27.15 | 51.39 | 19.54 | 24 | | NP | | | | | | | 2.65 | | | ML |
| 13 | At 30.00 m depth | UDS | | 0.63 | 0.45 | 1.69 | 24.85 | 50.75 | 21.63 | 25 | | NP | 14.24 | 1.863 | 1.631 | 0.08 | 27 | DS | 2.66 | 0.63 | 0.116 | ML |
| 14 | At 33.00 m depth | SPT | 43 | 2.3 | 3.3 | 12.85 | 60.05 | 21.50 | 0.00 | 19 | | NP | | | | | | | 2.65 | | | SM |
| 15 | At 36.00 m depth | DS | | 0.53 | 3.24 | 13.83 | 62.42 | 19.98 | 0.00 | 18 | | NP | | | | | | | 2.63 | | | SM |
| 16 | At 39.00 m depth | SPT | 52 | 0 | 0 | 11.29 | 43.73 | 44.98 | 0.00 | 21 | | NP | | | | | | | 2.65 | | | SM |
| 17 | At 42.00 m depth | DS | | 0.14 | 1.64 | 12.89 | 50.37 | 34.96 | 0.00 | 20 | | NP | | | | | | | 2.64 | | | SM |
| 18 | At 45.00 m depth | SPT | 65 | 0.62 | 0.82 | 10.3 | 43.26 | 45.00 | 0.00 | 21 | | NP | | | | | | | 2.65 | | | SM |

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Contd... BH-19, (CH-26210 M)

| | | | | | Grain siz | ze analysis | | Hydro Ana | ometer lysis | Att | terberg Limit | g's | | | | | (φ) | test)) | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|---|--|------------------|------------|---|---------------|
| Sl. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance in degree | Type of shear test (Triaxial (UU) / Direct shear test (DS | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 19 | At 48.00 m depth | DS | | 1.01 | 2.08 | 12.23 | 52.69 | 31.99 | 0.00 | 20 | | NP | | | | | | | 2.64 | | | SM |
| 20 | At 50.00 m depth | SPT | 80 | 0.22 | 0.92 | 11.98 | 51.54 | 35.34 | 0.00 | 21 | | NP | | | | | | | 2.63 | | | SM |

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BH-20, (CH-26387M)

| | | | | | Grain size | analysi | 5 | Hydro Anal | meter ysis | Atter | rberg's | s Limit | | | | | (φ) in | est)) | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|---|--|---------------|---------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|--|---|------------------|------------|---|---------------|
| Sl. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | יא זון אוואס אוון איז | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance degree | Type of shear test (Triaxial t (UU) / Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 1.04 | 38.61 | 54.08 | 6.27 | 27 | | NP | | | | | | | 2.67 | | | ML |
| 2 | At 1.5 m depth | SPT | 18 | 0 | 0 | 2.56 | 45.72 | 46.58 | 5.14 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 3 | At 3.0 m depth | UDS | | 1.8 | 0.78 | 1.42 | 39.52 | 50.44 | 6.04 | 26 | | NP | 11.58 | 1.761 | 1.578 | 0.12 | 24 | DS | 2.66 | 0.69 | 0.118 | ML |
| 4 | At 4.5 m depth | SPT | 32 | 0 | 0 | 1.13 | 39.71 | 53.23 | 5.93 | 26 | | NP | | | | | | | 2.67 | | | ML |
| 5 | At 6.0 m depth | UDS | | 0 | 0 | 0.67 | 40.58 | 52.93 | 5.82 | 25 | | NP | 12.43 | 1.795 | 1.597 | 0.14 | 27 | DS | 2.66 | 0.67 | 0.112 | ML |
| 6 | At 9.0 m depth | SPT | 48 | 8.24 | 0.8 | 1.32 | 4.08 | 77.09 | 8.47 | 27 | | NP | | | | | | | 2.68 | | | ML |
| 7 | At 12.0 m depth | DS | | 14.74 | 5.96 | 3.44 | 37.78 | 38.08 | 0.00 | 21 | | NP | | | | | | | 2.64 | | | SM |
| 8 | At 15.0 m depth | SPT | 60 | 13.83 | 3.05 | 4.49 | 14.01 | 57.77 | 6.85 | 26 | | NP | | | | | | | 2.67 | | | ML |
| 9 | At 18.0 m depth | DS | | 15.72 | 10.44 | 3.33 | 15.53 | 49.18 | 5.80 | 22 | | NP | | | | | | | 2.65 | | | ML |

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| | | | | | Grain si | ze analysis | | Hydro Ana | ometer lysis | Att | terberg Limit | ç's | _ | | | | (φ) | test)) | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|---|---|------------------|------------|---|---------------|
| Sl. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance in degree | Type of shear test (Triaxial t (UU) / Direct shear test (DS) | Specific gravity | Void ratio | Composition test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | SPT | 67 | 4.2 | 2.21 | 2.11 | 28.52 | 56.46 | 6.50 | 25 | | NP | | | | | | | 2.67 | | | ML |
| 11 | At 24.0 m depth | SPT | 76 | 0 | 0 | 1.81 | 13.06 | 76.83 | 8.30 | 27 | | NP | | | | | | | 2.68 | | | ML |
| 12 | At 27.00 m depth | UDS | | 3.38 | 2.51 | 7.06 | 7.7 | 64.85 | 14.50 | 31 | 20 | 11 | 14.21 | 1.902 | 1.665 | 0.27 | 12 | UU | 2.70 | 0.62 | 0.134 | CL |
| 13 | At 30.00 m depth | SPT | 58 | 0 | 0 | 0.21 | 11.23 | 71.36 | 17.20 | 33 | 21 | 12 | | | | | | | 2.71 | | | CL |
| 14 | At 33.00 m depth | UDS | | 0.76 | 1.71 | 3.61 | 6.07 | 71.05 | 16.80 | 33 | 20 | 13 | 14.85 | 1.935 | 1.685 | 0.30 | 11 | UU | 2.71 | 0.61 | 0.136 | CL |
| 15 | At 36.00 m depth | SPT | 67 | 1.2 | 0.77 | 4.01 | 17.67 | 62.15 | 14.20 | 31 | 21 | 10 | | | | | | | 2.70 | | | CL |
| 16 | At 39.00 m depth | UDS | | 0 | 0.63 | 1.08 | 7.44 | 72.35 | 18.50 | 34 | 22 | 12 | 15.38 | 1.958 | 1.697 | 0.36 | 14 | UU | 2.72 | 0.60 | 0.138 | CL |
| 17 | At 42.00 m depth | SPT | 75 | 3.12 | 1.63 | 3.72 | 9.71 | 64.92 | 16.90 | 32 | 21 | 11 | | | | | | | 2.71 | | | CL |
| 18 | At 45.00 m depth | UDS | | 0 | 0 | 1.11 | 24.18 | 60.71 | 14.00 | 30 | 18 | 12 | 16.47 | 1.988 | 1.707 | 0.31 | 10 | UU | 2.70 | 0.58 | 0.133 | CL |
| 19 | At 48.00 m depth | SPT | 79 | 0 | 0.69 | 0.18 | 8.39 | 72.34 | 18.40 | 34 | 23 | 11 | | | | | | | 2.72 | | | CL |

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BH-21, (CH-26587 M)

| | | | | | Grain siz | e analysis | | Hydro Anal | meter ysis | A | tterber Limi | rg's t | | | | | u | /(nr | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|---------------|---------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|---------------------------|---|--|------------------|------------|---|---------------|
| Sl. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm^2 | Angle of shearing resistance(ϕ) degree | Type of shear test (Triaxial test (Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0.98 | 29.34 | 63.28 | 6.40 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 2 | At 1.5 m depth | SPT | 14 | 0 | 0 | 0.8 | 27.92 | 64.38 | 6.90 | 26 | | NP | | | | | | | 2.67 | | | ML |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0.78 | 23.87 | 67.85 | 7.50 | 27 | | NP | 10.28 | 1.768 | 1.603 | 0.11 | 24 | DS | 2.67 | 0.67 | 0.112 | ML |
| 4 | At 4.5 m depth | SPT | 20 | 0 | 0 | 1.02 | 26.12 | 65.76 | 7.10 | 26 | | NP | | | | | | | 2.66 | | | ML |
| 5 | At 6.0 m depth | UDS | | 10.23 | 0.57 | 2.52 | 8.02 | 70.86 | 7.80 | 27 | | NP | 11.47 | 1.819 | 1.632 | 0.10 | 25 | DS | 2.68 | 0.64 | 0.116 | ML |
| 6 | At 9.0 m depth | SPT | 31 | 8.31 | 1.47 | 2.56 | 10.42 | 69.94 | 7.30 | 27 | | NP | | | | | | | 2.68 | | | ML |
| 7 | At 12.0 m depth | UDS | | 22.85 | 4.06 | 2.15 | 19.18 | 45.06 | 6.70 | 25 | | NP | 12.16 | 1.824 | 1.626 | 0.07 | 27 | DS | 2.64 | 0.62 | 0.109 | ML |
| 8 | At 15.0 m depth | SPT | 38 | 0 | 1.06 | 3.7 | 6.73 | 80.11 | 8.40 | 27 | | NP | | | | | | | 2.68 | | | ML |
| 9 | At 18.0 m depth | ROCK | | | 1 | 1 | 1 | | FRA | GMEN | ITED | ROCK | (CORE F | RECOVE | RY = 6.0 | %, R.Q.I | D=4.5% | Ď) | 1 | | 1 | |

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Contd... BH-21, (CH-26587 M)

| | | | | | Grain | size analy | sis | Hydro Ana | ometer lysis | Att | erberg's | Limit | | | | |) in | (NU) | | | | |
|---------|---------------------|------------------------|---------------|-------------------|--|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|---|--|------------------|------------|--|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance(ϕ degree | Type of shear test (Triaxial test / Direct shear test (DS)) | Specific gravity | Void ratio | Comsonaation test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | ROCK | | | FRAGMENTED ROCK (CORE RECOVERY=3.5%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | |
| 11 | At 24.0 m depth | ROCK | | | FRAGMENTED ROCK (CORE RECOVERY=3.5%, R.Q.D=NIL) FRAGMENTED ROCK (CORE RECOVERY=4.0%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | |
| 12 | At 27.00 m depth | ROCK | | | | | | | FRAG | MENT | FED RC | OCK (CC | RE REC | COVERY | =6.0%, R | .Q.D=N | NIL) | | | | | |
| 13 | At 30.00 m depth | ROCK | | | | | | | FRAG | MENT | FED RC | OCK (CC | RE REC | COVERY | =9.0%, R | .Q.D=N | NIL) | | | | | |
| 14 | At 33.00 m depth | ROCK | | | | | | | FRAG | MENT | FED RC | CK (CC | RE REC | COVERY | =6.0%, R | Q.D=N | NIL) | | | | | |
| 15 | At 36.00 m depth | ROCK | | | | | | | FRAG | MENT | TED RC | CK (CC | RE REC | COVERY | =4.6%, R | Q.D=N | NIL) | | | | | |
| 16 | At 39.00 m depth | DS | | 1.59 | 1.05 | 1.79 | 9.41 | 77.76 | 8.40 | 28 | | NP | | | | | | | 2.68 | | | ML |
| 17 | At 42.00 m depth | SPT | 77 | 0 | 0.12 | 2.98 | 19.55 | 69.85 | 7.50 | 27 | | NP | | | | | | | 2.67 | | | ML |
| 18 | At 45.00 m depth | 26600 | | 0 | 0 | 3.56 | 22.62 | 66.62 | 7.20 | 25 | | NP | | | | | | | 2.66 | | | ML |

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BH-22, (CH-26787 M)

| | | | | | Grain siz | e analysis | | Hydro Ana | ometer Ilysis | A | tterbe Limi | rg's t | | | | | .u | /(nn | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|--|--|--|--------------|------------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|--|--|------------------|------------|---|---------------|
| Sl. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance(φ) degree | Type of shear test (Triaxial test (Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 0.2 20.81 60.79 18.20 31 20 11 2.70 CL | | | | | | | | | | | | | CL | | | | |
| 2 | At 1.5 m depth | SPT | 15 | 0 | 0 0.2 20.81 60.79 18.20 51 20 11 2.70 CL 0 0.29 29.32 62.89 7.50 27 NP 2.67 ML | | | | | | | | | | | | | | | | | |
| 3 | At 3.0 m depth | UDS | | 0.39 | 0.16 | 0.32 | 29.83 | 63.00 | 6.30 | 26 | | NP | 11.58 | 1.752 | 1.570 | 0.11 | 22 | DS | 2.66 | 0.69 | 0.116 | ML |
| 4 | At 4.5 m depth | SPT | 21 | 19.14 | 0.52 | 3.9 | 11.46 | 58.38 | 6.60 | 25 | | NP | | | | | | | 2.65 | | | ML |
| 5 | At 6.0 m depth | UDS | | 0 | 0.2 | 0.14 | 24.82 | 67.64 | 7.20 | 27 | | NP | 13.57 | 1.826 | 1.608 | 0.13 | 28 | DS | 2.67 | 0.66 | 0.112 | ML |
| 6 | At 9.0 m depth | SPT | 28 | 16.76 | 2.29 | 7.05 | 8.02 | 59.08 | 6.80 | 26 | | NP | | | | | | | 2.66 | | | ML |
| 7 | At 12.0 m depth | PEBBLE | | | 1 | 1 | 1 | 1 | 1 | 1 | PEBI | BLE PIE | CES WEI | RE COLL | ECTED | | <u>ı</u> | 1 | 1 | | 1 | <u> </u> |
| 8 | At 15.0 m depth | PEBBLE | | | | | | | | | PEBE | BLE PIE | ECES WE | RE COLL | ECTED | | | | | | | |
| 9 | At 18.0 m depth | ROCK | | | | | | | FRAG | MEN | TED F | ROCK (| CORE RE | COVERY | /=3.0%, R | .Q.D=1 | NIL) | | | | | |

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| | | | | | Grain s | ize analys | is | Hydro Ana | ometer lysis | Atte | erberg's | Limit | | | | | ni (o | | | | | |
|---------|---------------------|------------------------|---------------|-------------------|---|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|---|--|------------------|------------|------------------------|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance(q degree | Type of shear test (Triaxial tes (UU) / Direct shear test (DS)) | Specific gravity | Void ratio | Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | ROCK | | | FRAGMENTED ROCK (CORE RECOVERY=2.3%, R.Q.D=NIL) | | | | | | | | | | | | | | | | | |
| 11 | At 24.0 m depth | ROCK | | | | | | | FRAG | MENT | FED RC | CK (CO | ORE REC | COVERY | =3.0%, R | R.Q.D=1 | NIL) | | | | | |
| 12 | At 27.00 m depth | ROCK | | | | | | | FRAG | MENT | FED RC | CK (CO | ORE REC | COVERY | =2.0%, R | R.Q.D=1 | NIL) | | | | | |
| 13 | At 30.00 m depth | ROCK | | | | | | | FRAG | MENT | FED RC | CK (CO | ORE REC | COVERY | =3.0%, R | R.Q.D=1 | NIL) | | | | | |
| 14 | At 33.00 m depth | ROCK | | | | | | | FRAG | MENT | TED RC | CK (CO | ORE REC | COVERY | =2.3%, R | R.Q.D=1 | NIL) | | | | | |
| 15 | At 36.00 m depth | ROCK | | | | | | | FRAG | MENT | TED RC | CK (CO | RE REC | COVERY | =4.0%, R | R.Q.D=1 | NIL) | | | | | |
| 16 | At 39.00 m depth | ROCK | | | | | | | FRAG | MENT | TED RC | CK (CO | RE REC | COVERY | =4.0%, R | R.Q.D=1 | NIL) | | | | | |
| 17 | At 42.00 m depth | DS | | 0 | 0.3 | 1.58 | 33.52 | 44.10 | 20.50 | 30 | 20 | 10 | | | | | | | 2.71 | | | CL |
| 18 | At 45.00 m depth | SPT | 91 | 6.44 | 0.88 | 1.4 | 32.90 | 38.78 | 19.60 | 28 | 19 | 9 | | | | | | | 2.70 | | | CL |

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BH-23, (CH-26980 M)

| | | | | | Grain s | ize analys | sis | Hydro Ana | ometer llysis | A | tterber Limit | rg's t | | | | | II | /(กก) | | | | |
|---------|---------------------|------------------------|---------------|--------------------------------------|--|--|--|--------------|------------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|--|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | тис Опауст и 70 (20mm To 4.75mm) | coarse same m الله (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance(ϕ) degree | Type of shear test (Triaxial test (Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0 | 32.85 | 53.65 | 13.50 | 30 | 18 | 12 | | | | | | | 2.70 | | | CL |
| 2 | At 1.5 m depth | SPT | 16 | 0 | 0 | 0.2 | 20.45 | 64.55 | 14.80 | 32 | 19 | 13 | | | | | | | 2.71 | | | CL |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0.2 | 20.32 | 64.58 | 14.90 | 32 | 20 | 12 | 10.62 | 1.752 | 1.584 | 0.31 | 9 | UU | 2.71 | 0.71 | 0.130 | CL |
| 4 | At 4.5 m depth | SPT | 23 | 12.8 | 0.7 | 1.67 | 9.92 | 60.71 | 14.20 | 31 | 18 | 13 | | | | | | | 2.70 | | | CL |
| 5 | At 6.0 m depth | UDS | | 0 | 0 | 1.37 | 15.52 | 67.91 | 15.20 | 33 | 20 | 13 | 11.35 | 1.785 | 1.603 | 0.26 | 12 | UU | 2.72 | 0.70 | 0.132 | CL |
| 6 | At 9.0 m depth | SPT | 34 | 0 | 0 | 0 | 23.15 | 70.65 | 6.20 | 27 | | NP | | | | | | | 2.67 | | | ML |
| 7 | At 12.0 m depth | DS | | 6.27 | 1.67 | 7.71 | 9.26 | 60.89 | 14.20 | 32 | 19 | 13 | | | | | | | 2.70 | | | CL |
| 8 | At 15.0 m depth | SPT | 38 | 2.31 | 2.23 | 15.61 | 8.32 | 57.63 | 13.90 | 30 | 17 | 13 | | | | | | | 2.69 | | | CL |
| 9 | At 18.0 m depth | DS | | 0 | 0 | 0.2 | 19.19 | 65.81 | 14.80 | 33 | 19 | 14 | | | | | | | 2.71 | | | CL |

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Contd... BH-23, (CH-26980 M)

| | | | | | Grain s | ize analys | is | Hydro Ana | ometer lysis | Atter | berg's | Limit | | | | |) in | (NU) | | | | |
|---------|---------------------|------------------------|---------------|--------------------------------------|---------------------|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|--|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | тше отауст и 70 (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance(φ degree | Type of shear test (Triaxial test / Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | SPT | 50 | 5.71 | 0.9 | 0.99 | 49.32 | 43.08 | 0.00 | 20 | | NP | | | | | | | 2.65 | | | SM |
| 11 | At 24.0 m depth | UDS | | 3.47 | 1.7 | 1.54 | 31.5 | 48.59 | 13.20 | 30 | 17 | 13 | 13.45 | 1.851 | 1.632 | 0.29 | 11 | UU | 2.69 | 0.65 | 0.126 | CL |
| 12 | At 27.00 m depth | SPT | 63 | 1.03 | 0.51 | 0.23 | 61.61 | 36.62 | 0.00 | 19 | | NP | | | | | | | 2.64 | | | SM |
| 13 | At 30.00 m depth | UDS | | 4.84 | 1.61 | 1.35 | 18.75 | 67.65 | 5.80 | 26 | | NP | 14.62 | 1.883 | 1.643 | 0.11 | 26 | DS | 2.67 | 0.63 | 0.117 | ML |
| 14 | At 33.00 m depth | SPT | 73 | 2.64 | 1.21 | 1.95 | 10.36 | 68.54 | 15.30 | 33 | 19 | 14 | | | | | | | 2.72 | | | CL |
| 15 | At 36.00 m depth | UDS | | 7.71 | 0.7 | 1.56 | 42.4 | 47.63 | 0.00 | 21 | | NP | 15.48 | 1.906 | 1.651 | 0.04 | 27 | DS | 2.66 | 0.61 | | SM |
| 16 | At 39.00 m depth | SPT | 77 | 0 | 0 | 0.2 | 1.39 | 79.11 | 19.30 | 34 | 21 | 13 | | | | | | | 2.72 | | | CL |
| 17 | At 42.00 m depth | UDS | | 0 | 2.74 | 7.74 | 11.98 | 62.64 | 14.90 | 31 | 20 | 11 | 16.21 | 1.961 | 1.687 | 0.30 | 14 | UU | 2.70 | 0.60 | 0.132 | CL |
| 18 | At 45.00 m depth | SPT | 85 | 0 | 0 | 0.49 | 1.74 | 78.57 | 19.20 | 34 | 22 | 12 | | | | | | | 2.72 | | | CL |

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| | | TES | ST RESULTSHE | ET |

BH-24, (CH-27187 M)

| | | | | | Grain s | ize analys | sis | Hydro Ana | ometer lysis | Atter | berg's | Limit | | | | | ui (| /(NU)/ | | | | |
|---------|---------------------|------------------------|---------------|-------------------|---------------------|--|---------------------------------------|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|---------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm^2 | Angle of shearing resistance(ϕ_{i} degree | Type of shear test (Triaxial test Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0.36 | 23.48 | 68.86 | 7.30 | 26 | | NP | | | | | | | 2.67 | | | ML |
| 2 | At 1.5 m depth | SPT | 14 | 0 | 0 | 0.42 | 18.62 | 73.16 | 7.80 | 26 | | NP | | | | | | | 2.68 | | | ML |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0.82 | 13.57 | 77.41 | 8.20 | 27 | | NP | 10.82 | 1.761 | 1.589 | 0.14 | 25 | DS | 2.68 | 0.69 | 0.113 | ML |
| 4 | At 4.5 m depth | SPT | 21 | 0 | 0 | 0.72 | 16.82 | 74.46 | 8.00 | 27 | | NP | | | | | | | 2.68 | | | ML |
| 5 | At 6.0 m depth | UDS | | 0.82 | 0.36 | 1.42 | 23.27 | 67.63 | 6.50 | 26 | | NP | 11.48 | 1.784 | 1.600 | 0.11 | 26 | DS | 2.66 | 0.66 | 0.108 | ML |
| 6 | At 9.0 m depth | SPT | 27 | 0.34 | 0.68 | 0.95 | 17.43 | 72.9 | 7.70 | 26 | | NP | | | | | | | 2.68 | | | ML |
| 7 | At 12.0 m depth | UDS | | 0 | 0 | 0.17 | 25.49 | 67.74 | 6.60 | 25 | | NP | 12.44 | 1.824 | 1.622 | 0.10 | 26 | DS | 2.67 | 0.65 | 0.109 | ML |
| 8 | At 15.0 m depth | SPT | 33 | 0 | 0 | 0.48 | 21.46 | 70.46 | 7.60 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 9 | At 18.0 m depth | UDS | | 0.12 | 1.26 | 5.87 | 10.44 | 74.31 | 8.00 | 26 | | NP | 13.28 | 1.839 | 1.623 | 0.12 | 27 | DS | 2.67 | 0.64 | 0.117 | ML |

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| | | TES | ST RESULTSHE | ΕΤ |

Contd... BH-24, (CH-27187 M)

| | | | | | Grain siz | ze analysis | 5 | Hydro Ana | ometer lysis | Atte | rberg's | Limit | | | | |) in | | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|-------------------------|--|---|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm^2 | Angle of shearing resistance ($\boldsymbol{\phi}$ degree | Type of shear test (Triaxial test (UU) / Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | SPT | 43 | 0 | 0 | 12.62 | 15.87 | 65.21 | 6.30 | 25 | | NP | | | | | | | 2.66 | | | ML |
| 11 | At 24.0 m depth | UDS | | 0 | 0 | 8.47 | 11.49 | 64.44 | 15.60 | 32 | 20 | 12 | 15.47 | 1.935 | 1.676 | 0.25 | 15 | UU | 2.71 | 0.62 | 0.137 | CL |
| 12 | At 27.00 m depth | SPT | 58 | 0.43 | 0.82 | 5.44 | 8.79 | 68.32 | 16.20 | 34 | 21 | 13 | | | | | | | 2.72 | | | CL |
| 13 | At 30.00 m depth | UDS | | 0.29 | 0.45 | 3.28 | 16.74 | 64.14 | 15.10 | 30 | 20 | 10 | 15.89 | 1.958 | 1.690 | 0.30 | 11 | UU | 2.70 | 0.60 | 0.132 | CL |
| 14 | At 33.00 m depth | SPT | 72 | 0 | 0.17 | 2.62 | 21.53 | 60.88 | 14.80 | 30 | 19 | 11 | | | | | | | 2.70 | | | CL |
| 15 | At 36.00 m depth | UDS | | 0 | 0 | 4.51 | 11.43 | 67.46 | 16.60 | 33 | 21 | 12 | 16.52 | 1.992 | 1.710 | 0.25 | 10 | UU | 2.72 | 0.59 | 0.136 | CL |
| 16 | At 39.00 m depth | SPT | 89 | 0 | 0 | 0.32 | 18.84 | 65.04 | 15.80 | 31 | 20 | 11 | | | | | | | 2.71 | | | CL |
| 17 | At 40.00 m depth | UDS | | 1.23 | 4.62 | 7.38 | 12.56 | 59.61 | 14.60 | 30 | 21 | 9 | 17.24 | 2.018 | 1.721 | 0.30 | 12 | UU | 2.70 | 0.57 | 0.128 | CL |

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| | | TES | ST RESULTSHE | ΕΤ |

BH-25, (CH-27410 M)

| | | | | | Grain si | ze analysi | S | Hydro Ana | ometer Ilysis | A | tterbe Limi | rg's t | | | | | ii (| / (nn) | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---------------------|--|--|--------------|------------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance(<i>p</i> degree | Type of shear test (Triaxial test Direct shear test (DS)) | Specific gravity | Void ratio | Comsolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0.42 | 19.2 | 64.18 | 16.20 | 31 | 19 | 12 | | | | | | | 2.71 | | | CL |
| 2 | At 1.5 m depth | SPT | 13 | 0 | 0 | 0.28 | 5.96 | 74.26 | 19.50 | 34 | 21 | 13 | | | | | | | 2.72 | | | CL |
| 3 | At 3.0 m depth | UDS | | 9.16 | 1.88 | 10.4 | 7.00 | 56.36 | 15.20 | 29 | 17 | 12 | 12.14 | 1.758 | 1.568 | 0.31 | 10 | UU | 2.70 | 0.72 | 0.138 | CL |
| 4 | At 4.5 m depth | SPT | 20 | 0 | 0 | 0.56 | 20.8 | 62.64 | 16.00 | 30 | 17 | 13 | | | | | | | 2.70 | | | CL |
| 5 | At 6.0 m depth | UDS | | 24.64 | 0.24 | 0.18 | 11.95 | 48.39 | 14.60 | 28 | 18 | 10 | 12.58 | 1.779 | 1.580 | 0.29 | 13 | UU | 2.69 | 0.70 | 0.134 | CL |
| 6 | At 9.0 m depth | SPT | 30 | 0 | 0 | 0.82 | 20.36 | 62.72 | 16.10 | 30 | 18 | 12 | | | | | | | 2.70 | | | CL |
| 7 | At 12.0 m depth | UDS | | 0 | 0 | 0.08 | 21.46 | 62.66 | 15.80 | 30 | 17 | 13 | 13.42 | 1.816 | 1.601 | 0.26 | 10 | UU | 2.70 | 0.69 | 0.136 | CL |
| 8 | At 15.0 m depth | SPT | 31 | 18.06 | 0 | 0.42 | 18.4 | 48.42 | 14.70 | 29 | 18 | 11 | | | | | | | 2.69 | | | CL |
| 9 | At 18.0 m depth | UDS | | 0 | 4.3 | 7.84 | 9.5 | 62.66 | 15.70 | 31 | 19 | 12 | 14.34 | 1.846 | 1.614 | 0.30 | 9 | UU | 2.70 | 0.67 | 0.134 | CL |

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| | | TES | ST RESULTSHE | ΕΤ |

Contd... BH-25, (CH-27410 M)

| | | | | | Grain s | ize analys | is | Hydro Ana | ometer lysis | Atte | rberg's | Limit | | | | |) in | (NU) | | | | |
|---------|---------------------|------------------------|---------------|--|--|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | 1100 Otavet 11 70 (20mm To 4.75mm) | COARSE STAIRE IN 70 (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance(ϕ degree | Type of shear test (Triaxial test / Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | SPT | 33 | 1.16 | 1.15 | 23.2 | 8.81 | 50.88 | 14.80 | 28 | 16 | 12 | | | | | | | 2.69 | | | CL |
| 11 | At 24.0 m depth | UDS | | 0 | 0 | 26.28 | 5.92 | 52.9 | 14.90 | 29 | 17 | 12 | 15.32 | 1.878 | 1.629 | 0.30 | 10 | UU | 2.69 | 0.65 | 0.129 | CL |
| 12 | At 27.00 m depth | SPT | 48 | 9.1 | 1.82 | 18.91 | 7.42 | 48.25 | 14.50 | 28 | 17 | 11 | | | | | | | 2.69 | | | CL |
| 13 | At 30.00 m depth | UDS | | 0 | 0 | 8.74 | 12.18 | 63.28 | 15.80 | 30 | 17 | 13 | 15.86 | 1.906 | 1.645 | 0.25 | 14 | UU | 2.70 | 0.64 | 0.131 | CL |
| 14 | At 33.00 m depth | SPT | 68 | 0 | 0 | 0.32 | 16.1 | 66.78 | 16.80 | 31 | 19 | 12 | | | | | | | 2.71 | | | CL |
| 15 | At 36.00 m depth | UDS | | 4.24 | 5.46 | 10 | 5.02 | 59.98 | 15.30 | 30 | 17 | 13 | 16.38 | 1.936 | 1.664 | 0.31 | 11 | UU | 2.70 | 0.62 | 0.128 | CL |
| 16 | At 39.00 m depth | SPT | 81 | 0 | 0 | 0.54 | 14.4 | 68.36 | 16.70 | 32 | 20 | 12 | | | | | | | 2.71 | | | CL |
| 17 | At 40.00 m depth | UDS | | 7 | 3.42 | 20.7 | 7.68 | 47.3 | 13.90 | 28 | 17 | 11 | 16.69 | 1.952 | 1.673 | 0.29 | 16 | UU | 2.69 | 0.61 | 0.125 | CL |

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| | | TES | ST RESULTSHE | ET |

BH-26, (CH-27550)

| | | | | | Grain s | ize analys | is | Hydro Ana | ometer Ilysis | A | tterber Limit | g's | | | | | ii (| /(ЛЛ)/ | | | | |
|---------|---------------------|------------------------|---------------|------------------|---------------------|--|--|--------------|------------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|---------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in% | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm^2 | Angle of shearing resistance(ϕ) degree | Type of shear test (Triaxial test Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0 | 1.17 | 79.33 | 19.50 | 34 | 21 | 13 | | | | | | | 2.72 | | | CL |
| 2 | At 1.5 m depth | SPT | 11 | 0 | 0 | 0.10 | 1.20 | 79.50 | 19.20 | 34 | 22 | 12 | | | | | | | 2.72 | | | CL |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0 | 1.07 | 79.33 | 19.60 | 34 | 21 | 13 | 10.89 | 1.763 | 1.590 | 0.36 | 8 | UU | 2.72 | 0.71 | 0.140 | CL |
| 4 | At 4.5 m depth | SPT | 19 | 0 | 0 | 0.36 | 20.4 | 62.74 | 16.50 | 32 | 21 | 12 | | | | | | | 2.70 | | | CL |
| 5 | At 6.0 m depth | UDS | | 0 | 0 | 0.46 | 16.4 | 65.94 | 17.20 | 33 | 22 | 11 | 11.62 | 1.801 | 1.614 | 0.34 | 10 | UU | 2.71 | 0.68 | 0.132 | CL |
| 6 | At 9.0 m depth | SPT | 28 | 0 | 0 | 0.42 | 14.4 | 67.58 | 17.60 | 33 | 23 | 10 | | | | | | | 2.71 | | | CL |
| 7 | At 12.0 m depth | UDS | | 0 | 0.24 | 0.36 | 17.92 | 64.38 | 17.10 | 32 | 20 | 12 | 12.62 | 1.829 | 1.624 | 0.25 | 16 | UU | 2.70 | 0.66 | 0.130 | CL |
| 8 | At 15.0 m depth | SPT | 34 | 0 | 2.3 | 21.32 | 8.68 | 52.50 | 15.20 | 30 | 20 | 10 | | | | | | | 2.69 | | | CL |
| 9 | At 18.0 m depth | UDS | | 1.6 | 1.13 | 8.97 | 7.83 | 63.67 | 16.80 | 31 | 21 | 10 | 13.54 | 1.859 | 1.637 | 0.30 | 11 | UU | 2.70 | 0.65 | 0.128 | CL |

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| | | TES | ST RESULTSHE | ET |

Contd... BH-26, (CH-27550)

| | | | | | Grain si | ze analysi | S | Hydro Ana | ometer lysis | Atte | rberg's | Limit | | | | | ni (o | (nn) | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|----------------------------------|--|---|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | دمعتد عمده ۱۱ ۵۵ (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (q degree | Type of shear test (Triaxial test / Direct shear test (DS)) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | SPT | 41 | 2.2 | 5.4 | 9.62 | 3.64 | 62.64 | 16.50 | 31 | 21 | 10 | | | | | | | 2.71 | | | CL |
| 11 | At 24.0 m depth | UDS | | 30.22 | 3.28 | 1.12 | 11.78 | 39.40 | 14.20 | 28 | 19 | 9 | 14.86 | 1.892 | 1.647 | 0.29 | 14 | UU | 2.69 | 0.63 | 0.125 | CL |
| 12 | At 27.00 m depth | SPT | 53 | 16.38 | 0 | 0.56 | 10.63 | 56.73 | 15.70 | 30 | 19 | 11 | | | | | | | 2.71 | | | CL |
| 13 | At 30.00 m depth | UDS | | 11.84 | 0 | 0.24 | 9.2 | 62.42 | 16.30 | 31 | 20 | 11 | 15.42 | 1.936 | 1.677 | 0.30 | 12 | UU | 2.71 | 0.62 | 0.128 | CL |
| 14 | At 33.00 m depth | SPT | 65 | 28.78 | 0 | 0.22 | 13.00 | 43.60 | 14.40 | 29 | 19 | 10 | | | | | | | 2.69 | | | CL |
| 15 | At 35.00 m depth | UDS | | 0 | 0 | 0.38 | 21.96 | 61.56 | 16.10 | 31 | 20 | 11 | 16.38 | 1.958 | 1.682 | 0.25 | 16 | UU | 2.70 | 0.60 | 0.127 | CL |

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| | | TES | ST RESULTSHE | ET |

BH-27, (CH-28050m)

| | | | | 0 | Grain siz | e analys | is | Hydro Ana | ometer Iysis | At | tterber Limit | g's | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---------------------|--------------------|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|-----------------------------------|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | (4.75mm To 2.00 mm) | (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (| Type of shear testTriaxial test (UU) Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0.7 | 21.45 | 57.65 | 20.20 | 31 | 20 | 11 | | | | | | | 2.70 | | | CL |
| 2 | At 1.5 m depth | SPT | 14 | 0 | 0 | 0.4 | 16.2 | 66.60 | 16.80 | 32 | 21 | 11 | | | | | | | 2.72 | | | CL |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0.4 | 36.03 | 49.97 | 13.60 | 30 | 18 | 12 | 11.45 | 1.758 | 1.577 | 0.26 | 10 | UU | 2.69 | 0.71 | 0.126 | CL |
| 4 | At 4.5 m depth | SPT | 24 | 0 | 0 | 1.52 | 18.64 | 64.24 | 15.60 | 31 | 19 | 12 | | | | | | | 2.70 | | | CL |
| 5 | At 6.0 m depth | UDS | | 0 | 0 | 0.2 | 48.27 | 45.93 | 5.60 | 24 | | NP | 12.63 | 1.779 | 1.580 | 0.16 | 14 | UU | 2.67 | 0.69 | 0.109 | ML |
| 6 | At 9.0 m depth | SPT | 27 | 6.66 | 0.51 | 1.88 | 6.69 | 66.96 | 17.30 | 31 | 19 | 12 | | | | | | | 2.72 | | | CL |
| 7 | At 12.0 m depth | UDS | | 12.22 | 0.58 | 1.43 | 7.42 | 62.95 | 15.40 | 30 | 19 | 11 | 13.21 | 1.825 | 1.612 | 0.24 | 12 | UU | 2.70 | 0.67 | 0.132 | CL |
| 8 | At 15.0 m depth | SPT | 36 | 0 | 0 | 0.81 | 16.98 | 65.91 | 16.30 | 31 | 18 | 13 | | | | | | | 2.71 | | | CL |

| | Consultant: | Geotechnica | al Investigation Report | Client: |
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| | | TES | ST RESULTSHE | ET |

Contd... BH-27, (CH-28050m)

| | | | | | Grain siz | e analysis | | Hydro Ana | ometer Ilysis | А | tterber Limit | gʻs | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|-------------------|---|--|----------------------|--------------|------------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (φ) in degree | Type of shear testTriaxial test (UU) Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 9 | At 18.0 m depth | UDS | | 0 | 0 | 0.23 | 32.2 | 58.07 | 9.50 | 26 | | NP | 14.45 | 1.854 | 1.620 | 0.18 | 13 | UU | 2.69 | 0.66 | 0.118 | ML |
| 10 | At 21.0 m depth | SPT | 45 | 0 | 0 | 4.68 | 4.92 | 71.80 | 18.60 | 33 | 20 | 13 | | | | | | | 2.72 | | | CL |
| 11 | At 24.0 m depth | UDS | | 0 | 0.37 | 1.08 | 7.36 | 71.79 | 19.40 | 34 | 20 | 14 | 15.63 | 1.916 | 1.657 | 0.29 | 9 | UU | 2.72 | 0.64 | 0.136 | CL |
| 12 | At 27.00 m depth | SPT | 54 | 1.36 | 0.25 | 0.75 | 3.35 | 73.69 | 20.60 | 34 | 21 | 13 | | | | | | | 2.72 | | | CL |
| 13 | At 30.00 m depth | UDS | | 0 | 0 | 0.48 | 6.68 | 73.04 | 19.80 | 33 | 21 | 12 | 16.48 | 1.942 | 1.667 | 0.30 | 9 | UU | 2.72 | 0.63 | 0.138 | CL |

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BH-28, (CH-28350)

| | | | | | Grain si | ze analysi | 5 | Hydro Ana | ometer lysis | A | tterbe Limi | erg's t | | | | | | (nr | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---------------------|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|---------------------------------|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | A in degree | Type of shear testTriaxial test (U Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0.35 | 36.45 | 57.00 | 6.20 | 24 | | NP | | | | | | | 2.66 | | | ML |
| 2 | At 1.5 m depth | SPT | 12 | 0 | 0.44 | 34.2 | 4.36 | 47.6 | 13.40 | 28 | 18 | 10 | | | | | | | 2.69 | | | CL |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0.66 | 27.56 | 65.18 | 6.60 | 25 | | NP | 11.82 | 1.763 | 1.577 | 0.12 | 18 | UU | 2.67 | 0.69 | 0.108 | ML |
| 4 | At 4.5 m depth | SPT | 21 | 7.06 | 0.67 | 0.91 | 11.1 | 73.16 | 7.10 | 25 | | NP | | | | | | | 2.68 | | | ML |
| 5 | At 6.0 m depth | UDS | | 0 | 1.29 | 2.21 | 55.64 | 40.86 | 0.00 | 20 | | NP | 12.47 | 1.782 | 1.584 | 0.03 | 26 | DS | 2.64 | 0.67 | | SM |
| 6 | At 9.0 m depth | SPT | 28 | 0 | 0 | 1.6 | 8.52 | 82.08 | 7.80 | 25 | | NP | | | | | | | 2.68 | | | ML |
| 7 | At 12.0 m depth | UDS | | 16.98 | 0.76 | 1.3 | 6.54 | 67.62 | 6.80 | 25 | | NP | 12.86 | 1.806 | 1.600 | 0.14 | 18 | UU | 2.66 | 0.66 | 0.110 | ML |
| 8 | At 15.0 m depth | SPT | 38 | 4.65 | 7.39 | 16.02 | 5.62 | 60.02 | 6.30 | 27 | | NP | | | | | | | 2.67 | | | ML |
| 9 | At 18.0 m depth | UDS | | 2.89 | 1.51 | 2.82 | 15.3 | 62.18 | 15.30 | 32 | 19 | 13 | 13.27 | 1.866 | 1.647 | 0.28 | 10 | UU | 2.70 | 0.64 | 0.136 | CL |

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Contd... BH-28, (CH-28350)

| | | | | | Grain s | ize analysis | | Hydrc Ana | ometer lysis | Å | Atterber Limit | g's | | | | | | (nn) | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|--------------|-----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|-----------------|---|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | (ф) in degree | Type of shear testTriaxial test Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | SPT | 47 | 1.53 | 3.64 | 20.64 | 7.17 | 52.52 | 14.50 | 29 | 17 | 12 | | | | | | | 2.69 | | | CL |
| 11 | At 24.0 m depth | UDS | | 1.52 | 0.39 | 1.78 | 2.39 | 74.32 | 19.60 | 34 | 20 | 14 | 14.43 | 1.901 | 1.661 | 0.25 | 10 | UU | 2.72 | 0.64 | 0.138 | CL |
| 12 | At 27.00 m depth | SPT | 53 | 0 | 0 | 2.72 | 3.54 | 74.44 | 19.30 | 34 | 21 | 13 | | | | | | | 2.72 | | | CL |
| 13 | At 30.00 m depth | UDS | | 0 | 0 | 0.68 | 22.58 | 68.94 | 7.80 | 25 | | NP | 15.62 | 1.923 | 1.663 | 0.17 | 14 | UU | 2.66 | 0.60 | 0.109 | ML |
| 14 | At 33.00 m depth | SPT | 70 | 0 | 0.68 | 1.27 | 2.97 | 74.58 | 20.50 | 35 | 22 | 13 | | | | | | | 2.72 | | | CL |
| 15 | At 36.00 m depth | UDS | | 0 | 0 | 3.74 | 3.44 | 73.42 | 19.40 | 33 | 21 | 12 | 16.45 | 1.987 | 1.706 | 0.26 | 9 | UU | 2.72 | 0.59 | 0.136 | CL |
| 16 | At 39.00 m depth | SPT | 81 | 33.16 | 1.42 | 2.18 | 10.64 | 48.00 | 4.60 | 24 | | NP | | | | | | | 2.66 | | | ML |
| 17 | At 42.00 m depth | UDS | | 0 | 0 | 2.2 | 16.4 | 73.20 | 8.20 | 25 | | NP | 17.61 | 2.009 | 1.708 | 0.19 | 13 | UU | 2.66 | 0.56 | 0.112 | ML |
| 18 | At 45.00 m depth | SPT | 92 | 0 | 0 | 2.7 | 15.36 | 73.64 | 8.30 | 25 | | NP | | | | | | | 2.67 | | | ML |

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BH-29, (CH-28550m)

| | | | | | Grain siz | e analysis | i | Hydro Ana | meter lysis | A | tterbe. Limi | erg's t | | | | | | (ກາ | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|--------------|----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|-----------------|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel In % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | (φ) in degree | Type of shear testTriaxial test (L Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0.48 | 20.15 | 67.97 | 9.40 | 27 | | NP | | | | | | | 2.66 | | | ML |
| 2 | At 1.5 m depth | SPT | 12 | 0 | 0 | 0.56 | 37.26 | 54.88 | 7.30 | 27 | | NP | | | | | | | 2.67 | | | ML |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 1.07 | 36.44 | 48.09 | 14.40 | 26 | | NP | 11.45 | 1.761 | 1.580 | 0.20 | 11 | UU | 2.70 | 0.71 | 0.126 | ML-CL |
| 4 | At 4.5 m depth | SPT | 24 | 0 | 0 | 0.27 | 41.98 | 43.85 | 13.90 | 26 | | NP | | | | | | | 2.69 | | | ML-CL |
| 5 | At 6.0 m depth | UDS | | 8.04 | 17.4 | 7.97 | 3.10 | 48.89 | 14.60 | 27 | 20 | 7 | 11.89 | 1.795 | 1.604 | 0.18 | 14 | UU | 2.70 | 0.68 | 0.131 | ML-CL |
| 6 | At 9.0 m depth | SPT | 27 | 0 | 0 | 0.62 | 33.02 | 51.46 | 14.90 | 27 | 21 | 6 | | | | | | | 2.70 | | | ML-CL |
| 7 | At 12.0 m depth | UDS | | 0 | 0.18 | 0.17 | 57.05 | 42.60 | 0.00 | 21 | | NP | 12.63 | 1.802 | 1.600 | 0.02 | 25 | DS | 2.66 | 0.66 | | SM |
| 8 | At 15.0 m depth | SPT | 38 | 3.91 | 14.98 | 8.17 | 3.37 | 60.77 | 8.80 | 26 | | NP | | | | | | | 2.69 | | | ML |

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Contd... BH-29, (CH-28550m)

| | | | | | Grain size | analysis | | Hydro Ana | meter lysis | A | tterbe Limi | rg's t | | | | | | s(UU) | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--------------------|--|--------------|----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|-----------------------------------|---|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (| Type of shear testTriaxial te Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 9 | At 18.0 m depth | UDS | | 5.72 | 15.44 | 9.61 | 5.28 | 49.45 | 8.50 | 26 | | NP | 13.48 | 1.857 | 1.636 | 0.14 | 19 | UU | 2.69 | 0.64 | 0.128 | ML |
| 10 | At 21.0 m depth | SPT | 47 | 0 | 0 | 0.34 | 23.87 | 65.69 | 10.10 | 27 | | NP | | | | | | | 2.70 | | | ML |
| 11 | At 24.0 m depth | UDS | | 0 | 0 | 0.98 | 56.73 | 42.29 | 0.00 | 19 | | NP | 14.69 | 1.874 | 1.634 | 0.03 | 25 | DS | 2.66 | 0.63 | | SM |
| 12 | At 27.00 m depth | SPT | 61 | 26.98 | 0.17 | 6.66 | 14.33 | 41.06 | 10.80 | 26 | 19 | 7 | | | | | | | 2.67 | | | ML-CL |
| 13 | At 30.00 m depth | UDS | | 0 | 0 | 0.76 | 43.32 | 42.12 | 13.80 | 26 | 20 | 6 | 15.27 | 1.923 | 1.668 | 0.18 | 16 | UU | 2.69 | 0.61 | 0.127 | ML-CL |

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BH-30, (CH-28750)

| | | | | | | Grain | size analys | sis | | Atter | rberg's | s Limit | | | | | | (n | | | | |
|---------|---------------------|------------------------|---------------|-------------------|---------------------|--|---------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|------------------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (φ) in degree | Type of shear testTriaxial test (U Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 0 | 0.88 | 47.65 | 42.67 | 8.80 | 24 | | NP | | | | | | | 2.66 | | | ML |
| 2 | At 1.5 m depth | SPT | 17 | 0 | 0 | 0.41 | 42.88 | 47.51 | 9.20 | 26 | | NP | | | | | | | 2.67 | | | ML |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0.94 | 43.45 | 47.51 | 8.10 | 26 | | NP | 12.62 | 1.768 | 1.570 | 0.17 | 19 | UU | 2.67 | 0.71 | 0.123 | ML |
| 4 | At 4.5 m depth | SPT | 22 | 0 | 1.05 | 2.58 | 8.25 | 68.52 | 19.60 | 27 | 22 | 5 | | | | | | | 2.69 | | | ML-CL |
| 5 | At 6.0 m depth | UDS | | 0 | 0 | 0.27 | 11.1 | 69.73 | 18.90 | 28 | 22 | 6 | 13.47 | 1.816 | 1.600 | 0.19 | 14 | UU | 2.69 | 0.69 | 0.132 | ML-CL |
| 6 | At 9.0 m depth | SPT | 30 | 0 | 0 | 0.31 | 16.49 | 66.80 | 16.40 | 26 | 20 | 6 | | | | | | | 2.68 | | | ML-CL |
| 7 | At 12.0 m depth | UDS | | 0 | 0.5 | 0.98 | 2.4 | 72.52 | 23.60 | 34 | 23 | 11 | 13.86 | 1.847 | 1.622 | 0.25 | 10 | UU | 2.72 | 0.68 | 0.146 | CL |
| 8 | At 15.0 m depth | SPT | 38 | 0 | 0 | 0.66 | 10.22 | 66.22 | 22.90 | 33 | 22 | 11 | | | | | | | 2.72 | | | CL |
| 9 | At 18.0 m depth | UDS | | 0 | 0 | 1.69 | 24.57 | 64.54 | 10.20 | 25 | | NP | 14.43 | 1.864 | 1.629 | 0.19 | 14 | UU | 2.68 | 0.66 | 0.125 | ML |

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| | | | | | | Grain size | e analysis | | | Atte | rberg's | Limit | | | | | | (n | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|---------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|------------------------------------|---|--|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (φ) in degree | Type of shear testTriaxial test (U Direct shear test (DS) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 10 | At 21.0 m depth | SPT | 44 | 0 | 0 | 0.47 | 8.56 | 66.57 | 24.40 | 34 | 22 | 12 | | | | | | | 2.72 | | | CL |
| 11 | At 24.0 m depth | UDS | | 2.75 | 10.44 | 31.23 | 7.20 | 48.38 | 0.00 | 22 | | NP | 15.17 | 1.879 | 1.632 | 0.03 | 25 | DS | 2.67 | 0.64 | | SM |
| 12 | At 27.00 m depth | SPT | 56 | 18.53 | 0.57 | 1.46 | 5.54 | 63.20 | 10.70 | 24 | | NP | | | | | | | 2.70 | | | ML |
| 13 | At 30.00 m depth | UDS | | 0 | 0 | 2.11 | 15.18 | 71.41 | 11.30 | 26 | | NP | 16.21 | 1.936 | 1.666 | 0.18 | 15 | UU | 2.71 | 0.63 | 0.126 | ML |
| 14 | At 33.00 m depth | SPT | 64 | 0 | 0 | 0.47 | 35.50 | 54.83 | 9.20 | 25 | | NP | | | | | | | 2.68 | | | ML |
| 15 | At 36.00 m depth | UDS | | 0 | 0 | 1.72 | 36.52 | 52.16 | 9.60 | 24 | | NP | 16.72 | 1.947 | 1.668 | 0.14 | 17 | UU | 2.69 | 0.61 | 0.128 | ML |
| 16 | At 39.00 m depth | SPT | 73 | 0 | 9.34 | 6.6 | 23.74 | 52.12 | 8.20 | 24 | | NP | | | | | | | 2.67 | | | ML |
| 17 | At 42.00 m depth | UDS | | 0 | 1.88 | 6.24 | 13.57 | 68.11 | 10.20 | 26 | | NP | 17.62 | 1.995 | 1.696 | 0.16 | 13 | UU | 2.71 | 0.60 | 0.122 | ML |
| 18 | At 45.00 m depth | SPT | 84 | 10.2 | 14.44 | 7.44 | 13.61 | 38.31 | 16.00 | 27 | 20 | 7 | | | | | | | 2.69 | | | ML-CL |

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BH-31, (CH-29050)

| | | | | | Grain siz | e analysis | 5 | Hydro Ana | meter lysis | A | tterberg Limit | ç's | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|--|--------------|----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|---------------|--------------------|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel In % (20mm To 4.75mm) | Coarse Sand in % (4.75mm To 2.00 mm) | Wealum Sana In % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | (φ) in degree | Triaxial test (UU) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 4.09 | 1.33 | 3.53 | 31.98 | 45.07 | 14.00 | 29 | 18 | 11 | | | | | | | 2.69 | | | CL |
| 2 | At 1.5 m depth | SPT | 16 | 5.72 | 2.18 | 4.08 | 21.64 | 51.18 | 15.20 | 30 | 18 | 12 | | | | | | | 2.69 | | | CL |
| 3 | At 3.0 m depth | UDS | | 27.54 | 2.16 | 2.2 | 37.7 | 30.40 | 0.00 | 21 | | NP | 12.24 | 1.765 | 1.573 | 0.02 | 27 | DS | 2.65 | 0.69 | | SM |
| 4 | At 4.5 m depth | SPT | 23 | 5.46 | 1.94 | 3.82 | 24.96 | 53.02 | 10.80 | 27 | | NP | | | | | | | 2.67 | | | ML |
| 5 | At 6.0 m depth | UDS | | 0 | 0 | 0.2 | 42.13 | 47.27 | 10.40 | 25 | | NP | 13.47 | 1.808 | 1.593 | 0.04 | 29 | DS | 2.66 | 0.67 | 0.123 | ML |
| 6 | At 9.0 m depth | SPT | 32 | 0 | 0 | 0.86 | 45.22 | 40.02 | 13.90 | 26 | | NP | | | | | | | 2.69 | | | ML |
| 7 | At 12.0 m depth | UDS | | 0.92 | 1.86 | 11.96 | 5.42 | 63.64 | 16.20 | 26 | 20 | 6 | 14.61 | 1.882 | 1.642 | 0.17 | 12 | UU | 2.71 | 0.65 | 0.132 | ML-CL |
| 8 | At 15.0 m depth | SPT | 40 | 0 | 0 | 0.44 | 18.47 | 64.19 | 16.90 | 27 | 21 | 6 | | | | | | | 2.72 | | | ML-CL |

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Contd... BH-31, (CH-29050)

| | | | | | Grain si | ze analy | sis | Hydro Ana | meter lysis | At | terbeı Limit | rg's | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|---|---------------------|--|--|--------------|----------------|-------------------|--------------------|-----------------------|-----------------------------|---------------------------|----------------------|------------------------------------|---|--------------------|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | נוויט טומיטיווי <i>זיי</i> (20mm To 4.75mm) | (4.75mm To 2.00 mm) | איכטוטוו ספוט איז אי (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To 0.075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Natural density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (φ) in degree | Triaxial test (UU) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 9 | At 18.0 m depth | UDS | | 8.32 | 6.4 | 5.86 | 13.56 | 50.76 | 15.10 | 25 | 20 | 5 | 15.37 | 1.926 | 1.669 | 0.14 | 15 | UU | 2.70 | 0.62 | 0.130 | ML-CL |
| 10 | At 20.0 m depth | SPT | 51 | 1.65 | 2.91 | 6.1 | 11.29 | 61.95 | 16.10 | 27 | 20 | 7 | | | | | | | 2.69 | | | ML-CL |

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| | | | | | | Grain si | ze analysis | 5 | | A | tterbe Limit | rg's t | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---------------------|--|---------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|------------------------------------|-----------------|--------------------|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | (φ) in degree | Triaxial test (UU) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 2.18 | 0.46 | 3.88 | 17.28 | 61.30 | 14.90 | 26 | 20 | 6 | | | | | | | 2.69 | | | ML-CL |
| 2 | At 1.5 m depth | SPT | 17 | 1.56 | 2.2 | 1.92 | 17.08 | 61.94 | 15.30 | 27 | 21 | 6 | | | | | | | 2.68 | | | ML-CL |
| 3 | At 3.0 m depth | UDS | | 0 | 0.24 | 0.32 | 29 | 56.14 | 14.30 | 25 | 20 | 5 | 10.69 | 1.754 | 1.585 | 0.16 | 15 | UU | 2.69 | 0.70 | 0.141 | ML-CL |
| 4 | At 4.5 m depth | SPT | 27 | 0 | 3.54 | 3.6 | 16.4 | 61.36 | 15.10 | 27 | 20 | 7 | | | | | | | 2.67 | | | ML-CL |
| 5 | At 6.0 m depth | UDS | | 0 | 0 | 2.36 | 27.14 | 55.90 | 14.60 | 26 | 21 | 5 | 11.58 | 1.784 | 1.599 | 0.15 | 14 | UU | 2.69 | 0.68 | 0.136 | ML-CL |
| 6 | At 9.0 m depth | SPT | 35 | 0 | 0 | 0.26 | 18.4 | 72.54 | 8.80 | 25 | | NP | | | | | | | 2.68 | | | ML |
| 7 | At 12.0 m depth | UDS | | 25.98 | 8.4 | 6.38 | 8.46 | 43.28 | 7.50 | 24 | | NP | 12.18 | 1.824 | 1.626 | 0.02 | 30 | DS | 2.68 | 0.65 | 0.118 | ML |
| 8 | At 15.0 m depth | SPT | 44 | 0 | 0 | 0.64 | 18.06 | 72.60 | 8.70 | 25 | | NP | | | | | | | 2.67 | | | ML |

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| | | | | | | Grain si | ize analysi | s | | Att | erberg's | Limit | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|---------------------------------------|---|--|---------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|------------------------------------|---|--------------------|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | Fine Gravel in % (20mm To 4.75mm) | Loarse sand in % (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angre of snearing resistance (φ) in degree | Triaxial test (UU) | Specific gravity | Void ratio | consonation test (Compression Index, Cc) | Group of soil |
| 9 | At 18.0 m depth | UDS | | 0 | 0 | 1.36 | 33.9 | 57.24 | 7.50 | 25 | | NP | 12.87 | 1.847 | 1.636 | 0.03 | 27 | DS | 2.68 | 0.64 | 0.12 2 | ML |
| 10 | At 21.0 m depth | SPT | 54 | 0 | 0 | 0.42 | 30.4 | 60.38 | 8.80 | 26 | | NP | | | | | | | 2.67 | | | ML |
| 11 | At 24.0 m depth | UDS | | 0 | 0 | 0.54 | 33.06 | 57.80 | 8.60 | 26 | | NP | 13.68 | 1.882 | 1.656 | 0.04 | 26 | DS | 2.67 | 0.61 | 0.12 4 | ML |
| 12 | At 27.00 m depth | SPT | 63 | 0 | 0 | 1.22 | 16.54 | 72.84 | 9.40 | 27 | | NP | | | | | | | 2.68 | | | ML |
| 13 | At 30.00 m depth | UDS | | 0 | 0 | 0.82 | 17.96 | 72.02 | 9.20 | 27 | | NP | 14.57 | 1.937 | 1.691 | 0.16 | 17 | UU | 2.68 | 0.59 | 0.13 2 | ML |

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BH-33, (CH-30125)

| | | | | | | Grains | size analys | is | | Atte | rberg's | Limit | | | | | | | | | | |
|---------|---------------------|------------------------|---------------|-------------------|---------------------|--|---------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|------------------------------------|---|--------------------|------------------|------------|---|---------------|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | (4.75mm To 2.00 mm) | Medium Sand in % (2.0mm To 0.425mm) | Fine Sand in % (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of ancaring reastance (φ) in degree | Triaxial test (UU) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil |
| 1 | At 0.5 m depth | DS | | 0 | 1.94 | 0.77 | 36.88 | 52.61 | 7.80 | 25 | | NP | | | | | | | 2.67 | | | ML |
| 2 | At 1.5 m depth | SPT | 11 | 0 | 0 | 1.94 | 33.44 | 50.42 | 14.20 | 26 | 20 | 6 | | | | | | | 2.68 | | | ML-CL |
| 3 | At 3.0 m depth | UDS | | 0 | 0 | 0.79 | 9.79 | 73.02 | 16.40 | 28 | 22 | 6 | 11.62 | 1.772 | 1.588 | 0.16 | 14 | UU | 2.68 | 0.69 | 0.137 | ML-CL |
| 4 | At 4.5 m depth | SPT | 28 | 0 | 0 | 0.42 | 33.62 | 51.36 | 14.60 | 26 | 21 | 5 | | | | | | | 2.67 | | | ML-CL |
| 5 | At 6.0 m depth | UDS | | 0 | 0 | 3.19 | 20.06 | 61.45 | 15.30 | 27 | 22 | 5 | 12.47 | 1.814 | 1.613 | 0.14 | 13 | UU | 2.68 | 0.66 | 0.131 | ML-CL |
| 6 | At 9.0 m depth | SPT | 39 | 0 | 0 | 0.25 | 24.59 | 60.06 | 15.10 | 27 | 21 | 6 | | | | | | | 2.67 | | | ML-CL |
| 7 | At 12.0 m depth | UDS | | 0 | 0 | 0.42 | 25.78 | 59.00 | 14.80 | 26 | 20 | 6 | 13.27 | 1.843 | 1.627 | 0.09 | 27 | DS | 2.68 | 0.65 | 0.128 | ML-CL |
| 8 | At 15.0 m depth | SPT | 50 | 0 | 0 | 0.32 | 40.18 | 45.90 | 13.60 | 25 | 20 | 5 | | | | | | | 2.67 | | | ML-CL |

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|---------|---------------------|------------------------|---------------|-------------------|---------------------|--------------------|-------------------------------------|-----------|-----------|-------------------|--------------------|-----------------------|-----------------------------|------------------------|----------------------|------------------------------------|---|--------------------|------------------|------------|---|---------------|--|--|--|--|--|--|--|--|
| SI. No. | Sample Collected at | Type of soil collected | S.P.T N Value | (20mm To 4.75mm) | (4.75mm To 2.00 mm) | (2.0mm To 0.425mm) | சாம >வாம ா ≫ (0.425mm To .075mm) | Silt in % | Clay in % | Liquid Limit In % | Plastic Limit In % | Plasticity Index in % | Field Moisture Content in % | Bulk density in gm/cc. | Dry density in gm/cc | Cohesion (C) Kgf/cm ² | Angle of shearing resistance (ф) in degree | Triaxial test (UU) | Specific gravity | Void ratio | Consolidation test (Compression Index, Cc) | Group of soil | | | | | | | | |
| 9 | At 18.0 m depth | UDS | | 0 | 0 | 1.56 | 28.53 | 55.11 | 14.80 | 25 | 20 | 5 | 14.65 | 1.901 | 1.658 | 0.08 | 26 | DS | 2.68 | 0.62 | 0.126 | ML-CL | | | | | | | | |
| 10 | At 20.0 m depth | SPT | 63 | 0 | 0 | 3.23 | 20.48 | 61.29 | 15.00 | 26 | 21 | 5 | | | | | | | 2.67 | | | ML-CL | | | | | | | | |

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ANNEXURE –H GRAIN SIZE DISTRIBUTION CURVE

| Geotechnical Investigation Report | | | | | | | | | | | | |
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GRAIN SIZE DISTRIBUTION CURVE OF BH NO-19
| Geotechnical Investigation Report | | | | |
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| Geotechnical Investigation Report | | | | |
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GRAIN SIZE DISTRIBUTION CURVE OF BH NO-22

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| Geotechnical Investigation Report | | | | |
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| Geotechnical Investigation Report | | | | |
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| Consultant: | | | Client : | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | |



| Geotechnical Investigation Report | | | | |
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| Consultant: | | | Client : | |
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| Geotechnical Investigation Report | | | | |
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| Consultant: | | | Client : | |
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| Geotechnical Investigation Report | | | | |
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| Consultant: | | | Client : | |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | |



| Geotechnical Investigation Report | | | | |
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| Consultant: | | | Client : | |
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| Geotechnical Investigation Report | | | | |
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| Consultant: | | | Client : | |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | |



| Geotechnical Investigation Report | | | | |
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| Geotechnical Investigation Report | | | | | | | | | |
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| Geotechnical Investigation Report | | | | | | | | | |
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| | Geotechnical Investigation Report | | | | | | | | | |
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| Consul | tant: | | | Client : | | | | | | |
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ANNEXURE –I DESIGN PARAMETER & SPT N VALUE GRAPH

| Geotechnical Investigation Report | | | | | | | | | |
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| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------|-------------|-------------------------------|---|------------------------------------|---|--|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field S val | SPT N ue | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | |
| 1 | | 3.0 | | ML-CL | 12 | | 1.785 | 0.536 | 1.00 | 12.0 | 12.0 | |
| 2 | | 6.0 | | ML-CL | 16 | | 1.834 | 1.100 | 0.97 | 15.5 | 15.5 | |
| 3 | | 12.0 | | ML-CL | 26 | | 1.853 | 2.224 | 0.73 | 19.1 | 19.1 | |
| 4 | | 15.0 | | ML-CL | 21 | | 1.853 | 2.780 | 0.66 | 13.9 | 13.9 | |
| 5 | BH-17(CH- 25785 M) | 16.5 | 38.6 M | ML-CL | 37 | | 1.853 | 3.057 | 0.63 | 18.8 | 18.8 | |
| 6 |] , | 18.0 | | ML-CL | >50 | 30 | 1.853 | 3.335 | 0.60 | 18.0 | 18.0 | |
| 7 | | 36.5 | | SM | >50 | 50 | 1.853 | 6.763 | 0.36 | 18.1 | 18.1 | |
| 8 | | 38.0 | | SM | >50 | 50 | 1.853 | 7.041 | 0.35 | 17.5 | 17.5 | |
| 9 | | 39.5 | | ML | >50 | 50 | 1.000 | 3.950 | 0.54 | 27.1 | 21.1 | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.





| Geotechnical Investigation Report | | | | | | | | | |
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| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|--------------|-------------|-------------------------------|---|------------------------------------|---|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field val | SPT N ue | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy |
| 1 | | 3.0 | | ML | 11 | | 1.784 | 0.535 | 1.00 | 11.0 | 11.0 |
| 2 | | 6.0 | | ML | 20 | | 1.828 | 1.097 | 0.97 | 19.4 | 19.4 |
| 3 | | 12.0 | | ML | 24 | | 1.853 | 2.224 | 0.73 | 17.6 | 17.6 |
| 4 | | 15.0 | | ML-CL | 31 | 30 | 1.853 | 2.780 | 0.66 | 19.8 | 19.8 |
| 5 | | 18.0 | | ML-CL | 35 | 30 | 1.853 | 3.335 | 0.60 | 18.0 | 18.0 |
| 6 | | 21.0 | | ML-CL | 40 | 30 | 1.853 | 3.891 | 0.55 | 16.4 | 16.4 |
| 7 | | 24.0 | | ML | 47 | | 1.853 | 4.447 | 0.50 | 23.6 | 23.6 |
| 8 | | 27.0 | | ML | 49 | | 1.000 | 2.700 | 0.67 | 32.8 | 23.9 |
| 9 | BH-18(CH- | 30.0 | 26.2 M | ML | 57 | 50 | 1.000 | 3.000 | 0.63 | 31.7 | 23.4 |
| 10 | 25990 M) | 33.0 | 20.2 1 | ML | 64 | 50 | 1.000 | 3.300 | 0.60 | 30.1 | 22.6 |
| 11 | | 36.0 | | ML | 69 | 50 | 1.000 | 3.600 | 0.57 | 28.7 | 21.8 |
| 12 | | 39.0 | | ML | 77 | 50 | 1.000 | 3.900 | 0.55 | 27.3 | 21.2 |
| 13 | | 42.0 | | ML | 84 | 50 | 1.000 | 4.200 | 0.52 | 26.1 | 20.5 |
| 14 | | 45.0 | | ML | >50 | 50 | 1.000 | 4.500 | 0.50 | 24.9 | 20.0 |
| 15 | | 47.0 | | ML | >50 | 50 | 1.000 | 4.700 | 0.48 | 24.2 | 19.6 |
| 16 | | 50.0 | | ML | >50 | 50 | 1.000 | 5.000 | 0.46 | 23.2 | 19.1 |
| 17 | | 53.0 | | ML | >50 | 50 | 1.000 | 5.300 | 0.44 | 22.2 | 18.6 |
| 18 | | 55.0 | | ML | >50 | 50 | 1.000 | 5.500 | 0.43 | 21.6 | 18.3 |

Note: Above Strength parameters (C& φ) are calculated theoritically from N value.
As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

3 In case of clay soil, if N>30 then it may be considered limited to 30.

Overburden correction factor is considered as1 whereever its value is greater than 1. 4



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| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy |
| 1 | | 1.5 | | ML | 17 | | 1.761 | 0.264 | 1.00 | 17.0 | 17.0 |
| 2 | | 4.5 | | ML | 23 | | 1.776 | 0.799 | 1.00 | 23.0 | 23.0 |
| 3 | | 9.0 | | ML | 30 | | 1.802 | 1.622 | 0.84 | 25.2 | 25.2 |
| 4 | | 15.0 | | ML | 35 | | 1.819 | 2.729 | 0.67 | 23.3 | 23.3 |
| 5 | BH-19(CH- | 21.0 | NOT | ML | 35 | | 1.837 | 3.858 | 0.55 | 19.3 | 19.3 |
| 6 | 26210 M) | 27.0 | FOUND | ML | 39 | | 1.856 | 5.011 | 0.46 | 18.1 | 18.1 |
| 7 | | 33.0 | | SM | 43 | | 1.871 | 6.174 | 0.39 | 16.9 | 16.9 |
| 8 | | 39.0 | | SM | 52 | 50 | 1.871 | 7.297 | 0.34 | 16.9 | 16.9 |
| 9 | | 45.0 | | SM | 65 | 50 | 1.871 | 8.420 | 0.29 | 14.5 | 14.5 |
| 10 | | 50.0 | | SM | 80 | 50 | 1.871 | 9.355 | 0.25 | 12.7 | 12.7 |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



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| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------|-------------|-------------------------------|---|------------------------------------|---|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field S val | SPT N ue | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy |
| 1 | | 1.5 | | ML | 18 | | 1.761 | 0.264 | 1.00 | 18.0 | 18.0 |
| 2 | | 4.5 | | ML | 32 | | 1.778 | 0.800 | 1.00 | 32.0 | 32.0 |
| 3 | | 9.0 | | ML | 48 | | 1.795 | 1.616 | 0.84 | 40.4 | 40.4 |
| 4 | | 15.0 | | ML | 60 | 50 | 1.830 | 2.745 | 0.66 | 33.2 | 33.2 |
| 5 | BH-20(CH- | 21.0 | NOT | ML | 67 | 50 | 1.858 | 3.902 | 0.55 | 27.3 | 27.3 |
| 6 | 26387 M) | 24.0 | FOUND | ML | 76 | 50 | 1.879 | 4.510 | 0.50 | 24.9 | 24.9 |
| 7 | | 30.0 | | CL | 58 | 30 | 1.918 | 5.754 | 0.42 | 12.5 | 12.5 |
| 8 | | 36.0 | | CL | 67 | 30 | 1.946 | 7.006 | 0.35 | 10.5 | 10.5 |
| 9 | I | 42.0 | | CL | 75 | 30 | 1.973 | 8.287 | 0.29 | 8.8 | 8.8 |
| 10 | | 48.0 | | CL | 79 | 30 | 1.988 | 9.542 | 0.25 | 7.4 | 7.4 |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | |
|-----------------------------------|--------------|-------------------------|--|--|--|--|--|--|--|
| Consultant: | | | Client : | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|--|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | | |
| 1 | | 1.5 | | ML | 14 | | 1.768 | 0.265 | 1.00 | 14.0 | 14.0 | | |
| 2 | | 4.5 | | ML | 20 | | 1.793 | 0.807 | 1.00 | 20.0 | 20.0 | | |
| 3 | BH-21(CH- 26587 M) | 9.0 | NOT FOUND | ML | 31 | | 1.821 | 1.639 | 0.84 | 25.9 | 25.9 | | |
| 4 | , | 15.0 | | ML | 38 | | 1.824 | 2.736 | 0.67 | 25.3 | 25.3 | | |
| 5 | | 42.0 | | ML | 77 | 50 | 1.942 | 8.156 | 0.30 | 15.0 | 15.0 | | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy |
| 1 | | 1.5 | | ML | 15 | | 1.752 | 0.263 | 1.00 | 15.0 | 15.0 |
| 2 | BH-22(CH- | 4.5 | NOT | ML | 21 | | 1.789 | 0.805 | 1.00 | 21.0 | 21.0 |
| 3 | 26787 M) | 9.0 | 9.0 FOUND 45.0 | ML | 28 | | 1.826 | 1.643 | 0.84 | 23.4 | 23.4 |
| 4 | I | 45.0 | | CL | 60 | 30 | 1.916 | 8.622 | 0.28 | 8.4 | 8.4 |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | |
|-----------|-----------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|--|
| 1 | | 1.5 | | CL | 16 | | 1.761 | 0.264 | 1.00 | 16.0 | 16.0 | |
| 2 | | 4.5 | | CL | 23 | | 1.778 | 0.800 | 1.00 | 23.0 | 23.0 | |
| 3 | | 9.0 | | ML | 34 | | 1.795 | 1.616 | 0.84 | 28.6 | 28.6 | |
| 4 | | 15.0 | | CL | 38 | 30 | 1.830 | 2.745 | 0.66 | 19.9 | 19.9 | |
| 5 | BH-23(CH- 26980 M) | 21.0 | NOT FOUND | SM | 50 | | 1.858 | 3.902 | 0.55 | 27.3 | 27.3 | |
| 6 | , | 27.0 | | SM | 63 | 50 | 1.879 | 5.073 | 0.46 | 22.9 | 22.9 | |
| 7 | | 33.0 | | CL | 73 | 30 | 1.918 | 6.329 | 0.38 | 11.5 | 11.5 | |
| 8 | 1 | 39.0 | | CL | 77 | 30 | 1.946 | 7.589 | 0.32 | 9.7 | 9.7 | |
| 9 | | 45.0 | | CL | 85 | 30 | 1.973 | 8.879 | 0.27 | 8.1 | 8.1 | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | | | | COMP | UTATIO | NOF | CORRECT | ED N VALU | E | | |
|--------------------|---|----------------------------|------------------------|---------------|----------------------|-----|-------------------------------|---|------------------------------------|---|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy |
| 1 | | 1.5 | | CL | 14 | | 1.761 | 0.264 | 1.00 | 14.00 | 14.0 |
| 2 | | 4.5 | | CL | 21 | | 1.773 | 0.798 | 1.00 | 21.00 | 21.0 |
| 3 | | 9.0 | | CL | 27 | | 1.804 | 1.624 | 0.84 | 22.67 | 22.7 |
| 4 | BH-24(CH- | 15.0 | NOT | CL | 33 | 30 | 1.831 | 2.747 | 0.66 | 19.92 | 19.9 |
| 5 | 27187 M) 21.0 27.0 | 21.0 | FOUND | CL | 43 | 30 | 1.887 | 3.963 | 0.54 | 16.24 | 16.2 |
| 6 | | 27.0 | | CL | 58 | 30 | 1.946 | 5.254 | 0.45 | 13.41 | 13.4 |
| 7 | | 33.0 | | CL | 72 | 30 | 1.975 | 6.518 | 0.37 | 11.25 | 11.2 |
| 8 | | 39.0 | | CL | 89 | 30 | 2.005 | 7.820 | 0.31 | 9.42 | 9.4 |
| 1. 2. 3 4 | As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency. Where N is the corrected N value. In case of cohesionless, for angle of shearing resistance (\$\otheta\$, fig - 1 of IS : 6403 was used. In case of clay soil, if N>30 then it may be considered limited to 30. Overburden correction factor is considered as1 whereever its value is greater than 1. | | | | | | | | | | |
| | STANDARD PENETRATION TEST OF BH NO-24 | | | | | | | | | | |
| | | | | | | | | | | | |

| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | | | | COMP | UTATIO | NOF | CORRECT | ED N VALU | E | | |
|--------------------|---|----------------------------|------------------------|---------------|--------------------------|------------|-------------------------------|---|------------------------------------|---|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | bil Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy |
| 1 | | 1.5 | | CL | 13 | | 1.758 | 0.264 | 1.00 | 13.00 | 13.0 |
| 2 | | 4.5 | | CL | 20 | | 1.768 | 0.796 | 1.00 | 20.00 | 20.0 |
| 3 | | 9.0 | | CL | 30 | | 1.797 | 1.617 | 0.84 | 25.23 | 25.2 |
| 4 | BH-25(CH- | 15.0 | NOT | CL | 31 | 30 | 1.831 | 2.747 | 0.66 | 19.92 | 19.9 |
| 5 | 27410 M) | 21.0 | FOUND | CL | 33 | 30 | 1.862 | 3.910 | 0.55 | 16.37 | 16.4 |
| 6 | 27.0 33.0 | 27.0 | | CL | 48 | 30 | 1.892 | 5.108 | 0.46 | 13.69 | 13.7 |
| 7 | | 33.0 | | CL | 68 | 30 | 1.921 | 6.339 | 0.38 | 11.53 | 11.5 |
| 8 | | 39.0 | | CL | 81 | 30 | 1.944 | 7.582 | 0.32 | 9.73 | 9.7 |
| 1. 2. 3 4 | Jote: Above Strength parameters (C& φ) are calculated theoritically from N value. 1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency. Where N is the corrected N value. 2. In case of cohesionless, for angle of shearing resistance (φ), fig - 1 of IS : 6403 was used. 3 In case of clay soil, if N>30 then it may be considered limited to 30. 4 Overburden correction factor is considered as1 whereever its value is greater than 1. | | | | | | | | | | |
| | | ſ | 0 S | ΓANDARD 5 | PENE cc | orrected I | V value | 25 30 | 1 NO-25 | | |
| | | | 0.0 | | | | | | | | |
| | | | 5.0 | | | | | | | | |
| | | | 10.0 | | | | \rightarrow | | | Field SPT N value | |
| | | | 15.0 | | | | | | | Corrected N value | |
| | | | E 20.0 | | | | | | | | |
| | | 1 | u 25.0 – | | | | | | | | |
| | | " | م 30.0 – | | | | | | | | |
| | | | 35.0 | | | | | | | | |
| | | | | | | | | | | | |
| | | | 45.0 | | | | | | | | |
| 43.0 | | | | | | | | | | | |
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| Geotechnical Investigation Report | | | | | | | | | | |
|-----------------------------------|--------------|-------------------------|--|--|--|--|--|--|--|--|
| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | | | | COMP | UTATIO | NOF | CORRECT | ED N VALU | E | | |
|--|--|----------------------------|------------------------|---------------|----------------|-------------|-------------------------------|---|------------------------------------|---|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field S val | SPT N ue | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy |
| 1 | | 1.5 | | CL | 11 | | 1.763 | 0.264 | 1.00 | 11.00 | 11.0 |
| 2 | | 4.5 | | CL | 19 | | 1.782 | 0.802 | 1.00 | 19.00 | 19.0 |
| 3 | | 9.0 | | CL | 28 | | 1.815 | 1.634 | 0.84 | 23.46 | 23.5 |
| 4 | BH-26(CH- 27550 M) | 15.0 | NOT FOUND | CL | 34 | 30 | 1.844 | 2.766 | 0.66 | 19.85 | 19.8 |
| 5 | , | 21.0 | 21.0 27.0 | CL | 41 | 30 | 1.875 | 3.938 | 0.54 | 16.30 | 16.3 |
| 6 | | 27.0 | | CL | 53 | 30 | 1.913 | 5.165 | 0.45 | 13.58 | 13.6 |
| 7 | | 33.0 | | CL | 65 | 30 | 1.947 | 6.425 | 0.38 | 11.39 | 11.4 |
| 3 4 | ³ In case of clay soil, if N>30 then it may be considered limited to 30. <u>4</u> Overburden correction factor is considered as1 whereever its value is greater than 1. STANDARD PENETRATION TEST OF BH NO-26 | | | | | | | | | | |
| | | ſ | | | Co | orrected | N value | | | | |
| 0 5 0 5 0 5 0 0 5 0 0 5 0 0 5 0 0 0 5 0 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 | | | | | | | | | | | |
| | | | 25.0 30.0 35.0 | | / | | | • | | | |

| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | |
| 1 | | 1.5 | | CL | 14 | | 1.758 | 0.264 | 1.00 | 14.00 | 14.0 | |
| 2 | | 4.5 | | CL | 24 | | 1.768 | 0.796 | 1.00 | 24.00 | 24.0 | |
| 3 | BH-27(CH- | 9.0 | NOT | CL | 27 | | 1.802 | 1.622 | 0.84 | 22.68 | 22.7 | |
| 4 | 28050 M) | 15.0 | FOUND | CL | 36 | 30 | 1.839 | 2.759 | 0.66 | 19.87 | 19.9 | |
| 5 | | 21.0 | | CL | 45 | 30 | 1.885 | 3.959 | 0.54 | 16.25 | 16.3 | |
| 6 | | 27.0 | | CL | 54 | 30 | 1.929 | 5.208 | 0.45 | 13.50 | 13.5 | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | |
| 1 | | 1.5 | | CL | 12 | | 1.763 | 0.264 | 1.00 | 12.0 | 12.0 | |
| 2 | | 4.5 | | ML | 21 | | 0.772 | 0.347 | 1.00 | 21.0 | 21.0 | |
| 3 | | 9.0 | | ML | 28 | | 1.794 | 1.615 | 0.84 | 23.6 | 23.6 | |
| 4 | | 15.0 | | ML | 38 | | 1.836 | 2.754 | 0.66 | 25.2 | 25.2 | |
| 5 | BH-28(CH- 28350M) | 21.0 | NOT FOUND | CL | 47 | 30 | 1.883 | 3.954 | 0.54 | 16.3 | 16.3 | |
| 6 | , | 27.0 | | CL | 53 | 30 | 1.912 | 5.162 | 0.45 | 13.6 | 13.6 | |
| 7 | | 33.0 | | CL | 70 | 30 | 1.955 | 6.452 | 0.38 | 11.4 | 11.4 | |
| 8 | | 39.0 | | ML | 81 | 50 | 1.998 | 7.792 | 0.32 | 15.8 | 15.8 | |
| 9 | | 45.0 | | ML | 92 | 50 | 2.009 | 9.041 | 0.27 | 13.3 | 13.3 | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | |
| 1 | | 1.5 | | ML | 12 | | 1.761 | 0.264 | 1.00 | 12.0 | 12.0 | |
| 2 | | 4.5 | | ML-CL | 24 | | 1.778 | 0.800 | 1.00 | 24.0 | 24.0 | |
| 3 | BH-29(CH- | 9.0 | NOT | ML-CL | 27 | | 1.798 | 1.618 | 0.84 | 22.7 | 22.7 | |
| 4 | 28550 M) | 15.0 | FOUND | ML | 38 | | 1.829 | 2.744 | 0.66 | 25.2 | 25.2 | |
| 5 | | 21.0 | | ML | 47 | | 1.865 | 3.917 | 0.55 | 25.6 | 25.63 | |
| 6 | | 27.0 | | ML-CL | 61 | 30 | 1.898 | 5.125 | 0.46 | 13.7 | 13.66 | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | |
| 1 | | 1.5 | | ML | 17 | | 1.768 | 0.265 | 1.00 | 17.0 | 17.0 | |
| 2 | | 4.5 | | ML-CL | 22 | | 1.792 | 0.806 | 1.00 | 22.0 | 22.0 | |
| 3 | | 9.0 | | ML-CL | 30 | | 1.831 | 1.648 | 0.83 | 25.0 | 25.0 | |
| 4 | | 15.0 | | CL | 38 | 30 | 1.855 | 2.783 | 0.66 | 19.8 | 19.8 | |
| 5 | BH-30(CH- 28750 M) | 21.0 | NOT FOUND | CL | 44 | 30 | 1.871 | 3.929 | 0.54 | 16.3 | 16.3 | |
| 6 | , , | 27.0 | | ML | 56 | 50 | 1.907 | 5.149 | 0.45 | 22.7 | 22.7 | |
| 7 | | 33.0 | | ML | 64 | 50 | 1.941 | 6.405 | 0.38 | 19.0 | 19.0 | |
| 8 | | 39.0 | | ML | 73 | 50 | 1.971 | 7.687 | 0.32 | 16.0 | 16.0 | |
| 9 | | 45.0 | | ML | 84 | 50 | 1.995 | 8.978 | 0.27 | 13.4 | 13.4 | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------|---|------------------------------------|---|--|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | |
| 1 | | 1.5 | | CL | 16 | | 1.765 | 0.265 | 1.00 | 16.0 | 16.0 | |
| 2 | | 4.5 | | ML | 23 | | 1.786 | 0.804 | 1.00 | 23.0 | 23.0 | |
| 3 | BH-31(CH- 29050 M) | 9.0 | NOT FOUND | ML | 32 | | 1.845 | 1.661 | 0.83 | 26.6 | 26.6 | |
| 4 | | 15.0 | | ML-CL | 40 | 30 | 1.904 | 2.856 | 0.65 | 19.5 | 19.5 | |
| 5 | | 20.0 | | ML-CL | 51 | 30 | 1.926 | 3.852 | 0.55 | 16.5 | 16.52 | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| | COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | |
|-----------|----------------------------------|----------------------------|------------------------|---------------|----------------------|----|-------------------------------|---|------------------------------------|---|--|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field SPT N value | | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy | |
| 1 | | 1.5 | | ML-CL | 17 | | 1.754 | 0.263 | 1.00 | 17.0 | 17.0 | |
| 2 | | 4.5 | | ML-CL | 27 | | 1.769 | 0.796 | 1.00 | 27.0 | 27.0 | |
| 3 | BH-32(CH- | 9.0 | NOT | ML | 35 | | 1.804 | 1.624 | 0.84 | 29.4 | 29.4 | |
| 4 | 29550 M) | 15.0 | FOUND | ML | 44 | | 1.835 | 2.753 | 0.66 | 29.2 | 29.2 | |
| 5 | | 21.0 | | ML | 54 | 50 | 1.864 | 3.914 | 0.55 | 27.3 | 27.3 | |
| 6 | | 27.0 | | ML | 63 | 50 | 1.909 | 5.154 | 0.45 | 22.7 | 22.7 | |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance (ϕ), fig - 1 of IS : 6403 was used.

³ In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



| Geotechnical Investigation Report | | | | | | | | | | |
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| Consultant: | | | Client : | | | | | | | |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | |

| COMPUTATION OF CORRECTED N VALUE | | | | | | | | | | | |
|----------------------------------|--|----------------------------|------------------------|---------------|--------------|-------------|-------------------------------|---|------------------------------------|---|--|
| SI No. | Bridge No. | Depth from G.L in m. | Water table in m | Group of soil | Field val | SPT N ue | Density gm/cm ³ | overburden pressure in kg/cm ² | overburden correction factor | Corrected N value due to overburden | Corrected N value due to Dilatancy |
| 1 | 1 2 3 3 30125 M) 4 5 | 1.5 | NOT FOUND | ML-CL | 11 | | 1.772 | 0.266 | 1.00 | 11.0 | 11.0 |
| 2 | | 4.5 | | ML-CL | 28 | | 1.793 | 0.807 | 1.00 | 28.0 | 28.0 |
| 3 | | 9.0 | | ML-CL | 39 | 30 | 1.828 | 1.645 | 0.84 | 25.1 | 25.1 |
| 4 | | 15.0 | | ML-CL | 50 | 30 | 1.874 | 2.811 | 0.66 | 19.7 | 19.7 |
| 5 | | 20.0 | | ML-CL | 63 | 30 | 1.901 | 3.802 | 0.56 | 16.7 | 16.7 |

1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

Where N is the corrected N value.

2. In case of cohesionless, for angle of shearing resistance ($\phi\!\!\!/,\, fig$ - 1 of IS : 6403 was used.

 3 In case of clay soil, if N>30 then it may be considered limited to 30.

4 Overburden correction factor is considered as1 whereever its value is greater than 1.



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ANNEXURE –J GRAPHICAL REPRESENTATION OF SHEAR STRENGTH PARAMETER

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| Ge | eotechnical 1 | Investigation Repo | ort |
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ANNEXURE K ON-SITE LOG OF BOREHOLES

| Ge | Geotechnical Investigation Report | | | | | | | | | | | | | |
|---------------------------------|-----------------------------------|-------------------------|--|--|--|--|--|--|--|--|--|--|--|--|
| Consultant: | | | Client : | | | | | | | | | | | |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | | | | | |

| | | | | | | | | | Geol | ogical Lo | g | of Bore | eho | ole 1 | 3 | | | | | | 1.2 | | | |
|---|---|-----------|--|-------|---------|------------------------------|------------------------------------|-----------------------------------|--|--|------|--------------------|-------------|-------|---------------------------------------|------------------------------|---|----------------------------------|-------------|-------------------------|---|---|--|--|
| RE HOLE AINAGE I ILLAR ELI IL LEVEL ART DAT | REHOLENO : 13 NINAGEm. : 22000 LLAR ELEVATION : LEVYEL : RT DATE : 25-08-2021 | | | | | ORD DUNI MUTI GLE 1 | INATI DELE H WITH DMPL | ES VATION HORIZO .ETED : | X: Y: : : NTAL: | 700692.317 3121852.437 276.867 m 0° 06-09-2021 | | | | | LOCA TOTA TYPE DEPT DRILL | L DE OF C H OF LING | I PTH CORE WAT AGEN GEOL | BARRE ER TAI ICY .OGIST | il BLE (| (m) | Sohna 60.0 m Double Tube Not Found S.M ConsultantS Gauran Chuncker | | | |
| | | | | 1 | Size o | of Co | ore Pi | eces | Structural condition | Log | Core | % of e-Recovery | | | ./m | | er level | Wate | ər S | urned | ration | | | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | Description | 5 | 50 | 60 60 40 100 | Type of BIT | RQD % | Fracture Freq | Casing | Depth of wate | Nil Partial | Complete | Colour of Reti Water | Rate of Peneti (mm/min) | REMARK / OBSERVATIONS | | |
| 6 967 | 0.00 | | Clayey Silt(DS), Silty Sand(DS Wash) | | | | | | | | | | | | | | | | | | | | | |
| 5.367 | 1.50 | | Slightly Weathered, Highly Fractured, Highly Jointed, Light Grey,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 86 | | 8 | 6 | | Joints of 0°,5° | | | 18 | 1 | Nil | >15 | NX | | | | | 12.5 | As per the Surface as well as Subsurface data such it the lithology of the area, it can be stated that the Stratigraphy of the area is of North Delhi fold Belt whi is related to the Aravalli Sucsession. The Strata is Under the data water and with viewed on working in the strata is | | |
| 3.867 | 3.00 | | Slightly Weathered, Moderately Fractured, Highly Jointed, White to Light Grey,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 82 | | 7 | 11 | | Joints of 0°,10°, One Andulating Joint | | | 28.6 |] | Nil | >15 | | | | | | 13.63 | Prominnent Rock here with some tracts and bands of Phyllite and Schist. | | |
| 2.367 | 4.50 | | Slightly Weathered, Highly Fractured, Highly Jointed, Light Grey to Light Brown,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 95 | | 5 | | | Joints of 0°,5°,10° | | | 44.6 | | Nil | >15 | | | | | | 15 | | | |
| 0.867 | 6.00 | | Highly Weathered, Highly Fractured, Highly Jointed, Light Grey to Light Brown,Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 93 | 1 | 6 | | | Highly Fractured, Crushed Zone | | | 21.33 | | Nil | >15 | | | | | | 12.5 | | | |
| 9.367 | 7.50 | | Slightly Weathered, Highly Fractured, Highly Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 85 | | | 15 | | Highly Fractured, Joints of 0°,10°,15° | | | 70 | | 10 | >15 | | | | | Light Brown | 12 | | | |
| 7.867 | 9.00 | - | Highly Weathered, Highly Fractured, Highly Jointed, White to Light Brown, Fine Grained Literdacking Texture Text | 91 | 1 | 8 | | | Highly Fractured, | | | 37.33 | | Nil | >15 | | | | | - | 12.5 | | | |
| 6.367 | 10.50 | | Leaching, Very Hard Quartzite | 97 | | 3 | | | | | | 34 | | Nil | >15 | | | | | | 12.5 | | | |
| 4.867 | 12.00 | | Moderately Weathered, Highly Fractured, Highly Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 80 | | 2 | 7 | 11 | Joints of 0°,10°, 65°, 80° | | | 28 | | 17.3 | >15 | | | | | | 13.04 | | | |
| | 13.50 | | Highly Weathered, Highly Fractured, | 98 | 2 | | | | Highly Fractured, Joint of 80° | | | 21.33 | ond Bit | Nil | >15 | | | | | | 11.53 | | | |
| 31.367 | 15.00 | | Highly Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 100 | , | | | | Highly Fractured, Joints of 0°,10°,80° | • | | 34 | Dian | Nil | >15 | | | | | | 12.5 | | | |
| 60.367 | 16.50 | - | Slightly Weathered, Highly Fractured, Highly Jointed, Reddish Brown to Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 87 | | 8 | 5 | | | | | 32 | | Nil | >15 | | | | | | 14.28 | | | |
| 58.867 | 18.00 | | Slightly Weathered, Highly Fractured, Highly Jointed, Milky White to Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 84 | 1 | 4 | 11 | | -Juints of 0",5",10" | | | 32.85 | | Nil | >15 | | | | | | 12.5 | | | |
| 7.367 | 19.50 | | Slightly Weathered Highly Fractured | 87 | | 3 | 10 | | Highly Fractured, Joint of 0° | | | 30 | | 9 | >15 | | | | | | 12.5 | | | |
| 5.867 | 21.00 | | Highly Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite (Reddish Brown to Light Brown Staining) | 87 | | 5 | 8 | | Joints of 0°,5°,10° | | | 39.33 | | Nil | >15 | | | | | | 14.28 | | | |
| 4.367 | 22.50 | | | 75 | | 9 | 16 | | Joints of 0°,10°,65°, Closed Joint of 80° | | | 33.33 | | Nil | >15 | | | | | | 15 | | | |
| 2.867 | 24.00 | | Slightly Weathered, Highly Fractured, Highly Jointed, Reddish Brown to Light Brown and Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 82 | | 7 | 11 | | Joints of 0°,10°,45° | | | 39.33 28.66 | | Nil | >15 | | | | | | 12.5 | | | |
| 1.367 | 25.50 | | | 70 | | 4 | 26 | | | | | | | 9 | >15 | | | | | | 14.28 | | | |
| 9.867 | 27.00 | | Slightly Weathered, Highly Fractured, Highly Jointed, Milky White to Grey, Fine Grained, Interlocking Texture, Iron | 74 | | | 14 | 12 | Joints of 0°,10° | | | 34 |] | 18 | >15 | | | | | | 13.63 | | | |
| 0.267 | 28.50 | | Leaching, Very Hard, Quartzite | 64 | | | 8 | 28 | | | | 34 | | 24 | >15 | | | | | | 14.28 | | | |

| | | | | | (| Ge | eo | ote | chnical | Inve | stigati | or | n R | le | po | prl | t | | | | | | | | |
|---|---------------------|-----------|---|---------------|-------------|--------|-----------------------------------|----------------|--|--|-----------------------|-------------|-------|--------------------|--|-------------------------|--|--------------------------|-----------------------------|---------------------------------|---|--|--|--|--|
| Consi | ulta | nt | * | | | | | | | | | | | | | | Client : | | | | | | | | |
| BHUBANESWAR | | | | | 5 | | Job No:- 830 Report No:- SMC/2050 | | | | | | | | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | | | | |
| HIDC | HARYA A JO | INA R | AIL INFRASTRUCTURE DEVELOPI INTURE OF GOVERNMENT OF HARYANA | MENT AND M | COR | POR. | ATIC | ON LTE WAYS |). | | f Porcholo | | | | | | | | | Q | S M CONSULTANTS | | | | |
| | | | | | | | | | Geologica | al Log of | r Borenole | 13 | | | | | | | | | | | | | |
| ORE HOLE I HAINAGE m OLLAR ELE AIL LEVEL | NO n. EVATION | : | 13 25000 | | GRC AZIN | | ELEV | | X: Y: I: : | 700692.317 LOCATION 3121852.437 TOTAL DEPTI Z76.867 m TYPE OF COF | | | | | | | Sohna 'H 60.0 m RE BARREL Double Tube IATER TABLE (m) Not Found COLOCY | | | | | | | | |
| ARIDATE | - | : | 25-08-2021 | | DAT | E COI | MPLE | ETED: | ATAL. | 06-09-2021 DRILLING AG | | | | | | | | EOLOGIST Gaurav Chunekar | | | | | | | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | < 10mm | 0 azió | f Core | 75-150mm | >150mm | Structural condition | Log | % of Core-Recovery | Type of BIT | RQD % | Fracture Freq. / m | Casing | Depth of water level | Wa Lo Ioirio Ioirio | complete | Colour of Returned Water | Rate of Penetration (mm/min) | REMARK / OBSERVATIONS | | | | |
| 246.867 | 28.50 | | Slightly Weathered, Highly Fractured, Highly Jointed, Milky White to Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite (Completely weathered Gamet Pores) | 68 | | | 15 | 17 | Joints of 0°,10° | | 40 | | 20 | >15 | | | | | srown | 12.5 | As per the Surface as well as Subsurface da such as the lithology of the area, it can be st that the Stratigraphy of the area is of North C fold Belt which is related to the Aravalli Sucsession. The Strata is Highly Fractured a | | | | |
| | | | | 79 | | 21 | | | Joints of 0°,10°, Closed Joint of 80° | | 31.33 | | Nil | >15 | | | | | Light B | 14.28 | Higly Jointed. Quartzite is the Prominnent Ro here with some tracts and bands of Phyllite a Schist. | | | | |
| 245 367 | 31.50 | | Slightly Weathered, Highly Fractured, | | | | | | | <i>`````````````````````````````````````</i> | X///// | | | 1 1 | | | | | | | | | | | |

| 245.367 | 31.50 | Slightly Weathered, Highly Fractured, | 79 | 2 | 1 | | Joints of 0°,10°, Closed Joint of 80° | | 31.33 | | Nil | >15 | | Ligh | 14.28 | here with some tracts and bands of Phyllite and Schist. |
|---------|-------|---|----|---|-----|-----|--|--|-------|------------|------|------|--|------|-------|--|
| 243.867 | 33.00 | Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 80 | | 2 | D | | | 33.33 | | 8.6 | >15 | | | 12.5 | |
| 242.367 | 34.50 | | 76 | | 5 7 | 12 | Joints of 0°,5°,10° | | 24 | | 10.6 | >15 | | | 11.53 | |
| 240.867 | 36.00 | Slightly Weathered, Highly Fractured, Highly Jointed, Grey, Fine Grained, Highly Taylor Taylor, Iron Loophing, Vonc | 87 | | 5 8 | | Joints of 0°,10°, Closed Joint of 85° | | 35.33 | | 7.6 | >15 | | | 13.63 | |
| 239.367 | 37.50 | Hard, Quartzite (Minor Phyllite Band Noticed) | 76 | | 1 | 7 | Contact Joint of 85° | | 32.6 | | 7.6 | >15 | | | 14.28 | |
| 237.867 | 39.00 | | 94 | | e | ; | Highly Fractured, Highly Jointed | | 26.66 | | Nil | >15 | | | 11.53 | |
| 236.367 | 40.50 | | 85 | | 5 9 | | Joints of 0°,10°, 30°, 80° | | 32 | | 8.6 | >15 | | | 13.63 | |
| 234.867 | 42.00 | | 78 | | e | 16 | Joints of 0°,10°,Contact Joint of 80° | | 43.33 | | 9.3 | >15 | | | 16.66 | |
| 233.367 | 43.50 | | 83 | 3 | 3 1 | 1 | Joints of 0°,10°, Very Rough Joint of 80° | | 26 | iamond Bit | 7.6 | >15 | | | 12.5 | |
| 231.867 | 45.00 | | 78 | | 1 | 5 7 | Joints of 0°,10° | | 33.33 | | 15.6 | >15 | | | 14.28 | |
| 230.367 | 46.50 | | 97 | | 8 | | Highly Fractured, Joints of 10°,20°, 70°, 80° | | 30 | | Nil | >15 | | | 12.5 | |
| 228.867 | 48.00 | Slightly Weathered, Highly Fractured, Highly Jointed, Grey, Fine Grained, | 79 | | 8 8 | 10 | | | 22.66 | | 19 | >15 | | | 14.28 | |
| 227.367 | 49.50 | Interlocking Texture, Iron Leaching, Very Hard, Quartzite (Reddish Brown to Light Brown Staining) | 69 | | 2 7 | 22 | | | 34 | | 28.6 | 15-8 | | | 12.5 | |
| 225.867 | 51.00 | | 90 | | 4 | | Highly Fractured, Joints of 0°,10°,15° | | 27.33 | | Nil | > 15 | | | 13.63 | |
| 224.367 | 52.50 | | 92 | - | 2 6 | ; | | | 26 | | Nil | >15 | | | 14.28 | |
| 222.867 | 54.00 | | 91 | | 1 5 | | | | 34 | | Nil | >15 | | | 12.5 | - |
| 221.367 | 55.50 | | 81 | | 5 1 | 4 | Joints of 0°,10°, 15°, 20° | | 34 | | Nil | >15 | | | 12.5 | |
| 219.867 | 57.00 | | 88 | | 3 | | Joints of 10°, 15°, 20°, Very Rough Joint 80° | | 26.66 | | 8.6 | >15 | | | 163 | |
| 218.367 | 58.50 | | 88 | | | 12 | Joints of 0°,10°, 15°, 20° | | 28 | | 8 | >15 | | | 12.5 | |
| 216.867 | 60.00 | | 84 | - | 3 | 13 | Joints of 0°,10°, 15°, 30° | | 22 | | 13 | >15 | | | 12.5 | |

| | Geotechnical 3 | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| | HAR | YAN/ JOINT | A RAIL INFRASTRUCTURE DEVELOPM | ENT (| CORI NISTR | Y OF | ATIC RAIL | N LTD. WAYS | | | | | | | | | | | | | | ø | S M CONSULTANTS |
|------------|---------------|---------------|--|-------|---------------|--------|--------------|----------------|-------------------------|------------------------|------|--------------------|---------------|---------|-------|-------------------------|--------|-------------|--------------------|-------|-----------------|--------------------------|---|
| BORE HOLE | NO | : | 14 | | co- | ORDI | INATI | ES | Geologic x: | 700578.153 | of I | Boreh | ole | 14 | 1 | LOCA | TION | | | | | Sohna | |
| CHAINAGE r | n. EVATIO | : N : | 25195 | | GRC | | ELE | VATION | Y: : | 3122015.421 294.218 | | | | | - | | OF C | TH ORE B | ARREL | | | 75m Double Tub | e |
| START DATI | E | : | 11-08-2021 | | ANG | E CC | NITH | HORIZO | NTAL: | 0° 23-08-2021 | | | | | | DEP II DRILL NAME | ING A | GENC | ∢⊺ABI Y GIST | LE (| m) | S.M Consul Gaurav Chu | tants inekar |
| | | | | | Size o | of Co | re Pi | eces | Structural condition | Log | С | % of ore-Recove | ry | | | m/ | | level - | Water Loss | | rned | ation | |
| (m) no | Ē | bo | Lithological Description | | ε | E | m | F | ţi | | | | LI I | | | e Freq. | | of water | | ete | of Retu | Penetra in) | REMARK / OBSERVATIONS |
| Elevat | Depth | Litho-L | | <10mm | 10-25m | 25-75m | 75-150 | >150m | Descrip | | 8 | 8 88 | 100 Tune o | n ank i | RQD % | Fractu | Casing | Depth | Partial | Compl | Colour Water | Rate of (mm/n | |
| 294.218 | 0.00 | | | | _ | | | | | | | <i></i> | | | | | | | | | | | |
| 292.718 | 1.50 | | | 100 | | | | | Highly Fractured | | | 30 | | | NII | >15 | XN | | | | | 16.6 | As per the Sufficience as well as Subsurface durat such as the lithology of the area, it can be stated that the Stratigraphy of the area is of North Dehh fold Belt which is related to the Aravall Succession. The Strata is Highly Fractured and Highy Jointed. Quartzle is the Prominnent Rock here with some tracts and bands of |
| 201 218 | 3.00 | | Moderately Weathered, Highly Fractured, Highly Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 82 | | 5 | 13 | | | | | 48 | | | NII | >15 | | | | | | 15 | Phyllite and Schist. |
| 2011210 | 0.00 | | | 76 | | 11 | 13 | | Joints of 0°,5°,10°,65° | | | 38 | | | NII | >15 | | | | | | 16.6 | |
| 289.718 | 4.50 | - | Moderately Weathered, Moderately Fractured, Highly Jointed Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite (Small Taic | 54 | | з | 43 | | | | | 66 | | | 24 | >15 | | | | | | 20 | |
| 288.218 | 6.00 7.50 | | Hinygaals Noticed) Slightly Weatherd, Highly Fractured, Highly Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite | 82 | | 11 | 7 | | Highly Fractured | | | 45 | | | NII | >15 | | | | | Light Brown | 16.6 | |
| 285.218 | 9.00 | | Slightly to Moderately Weatherd, Highly Farctured, Highly Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite (Very Fine Grained Muscovite Flakes) | 88 | | в | 9 | | | | | 50 | | | 18 | >15 | | | | | | 11.5 | |
| 283.718 | 10.50 | | Moderately Weathered, Moderately Fractured, Highly Jointed Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 76 | | 11 | 13 | | Joints of 0° 5° 10° 65° | | | 51 | | | NII | > 15 | | | | | | 12.5 | |
| 282.218 | 12.00 | | Slightly to Moderately Weatherd, Highly Farctured, Highly Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 60 | | 4 | 9 | 27 | | | | 40 | ii. | | 21 | >15 | | | | | | 13.6 | |
| 280.718 | 13.50 | | Moderately Weathered, Highly Fractured, Highly Jointed Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 78 | | 4 | | 18 | | | | 34 | Diamond | חמוומות | 15 | >15 | | | | | | 16.6 | |
| 279.218 | 15.00 | | | 96 | | 4 | | | Highly Frontword | | | 21 | | | NII | >15 | | | | | | 12.5 | |
| 277.718 | 16.50 | | Highly Weathered, Highly Fractured, Highly Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 93 | | 7 | | | Fighty Placeted | | | 29 | | | NII | > 15 | | | | | | 12.5 | |
| 276.218 | 18.00 | | | 89 | | | | 11 | | | | 28 | | | 9 | >15 | | | | | | 16.6 | |
| 274.718 | 19.50 | | | 84 | | | 16 | | | | | 34 | | | 6 | > 15 | | | | | | 16.6 | |
| 273.218 | 21.00 | | | 81 | | 3 | 16 | | Joints of 0°,5°,10°,65° | | | 23 | | | NII | >15 | | | | | | 11.53 | |
| 271.718 | 22.50 | | | 78 | | 3 | 19 | | | | | 28 | | | 13 | >15 | | | | | | 10.71 | |
| 270.218 | <u>2</u> 4.00 | | Slightly Weathered, Highly Fractured, Highly Jointed, Light Grey, Fine Grained, | 83 | | | 17 | | | | | 23 | | | 6 | > 15 | | | | | | 13 | |
| 268.718 | 25.50 | 1 | Hard Quartzite | 92 | | 8 | | | | | | 20 | | | Nil | >15 | | | | | | 11.5 | |
| 267.218 | 27.00 |] | | 88 | | 2 | | 10 | | | | 25 | | | 9 | >15 | | | | | | 13.6 | |
| 265.718 | 28.50 | | | 90 | | 4 | 6 | | | | | 28 | | | Nil | >15 | | | | | | 12.5 | |
| 264.218 | 30.00 | | | 75 | | | 5 | 20 | | | | 25 | | | 18 | >15 | | | | | | 16.3 | |
| 262.718 | 31.50 | | | 75 | | 4 | 6 | 15 | Joints of 0°,5°,10° | | | 28 | | | 14 | > 15 | | | | | | 16.3 | |
| 261.218 | 33.00 | | Moderately Weathered, Modertely Fractured, Highly Jointed, Gery, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 69 | | | 11 | 20 | | | | 28 | | | 18 | >15 | | | | | | 19.7 | |
| 259.718 | 34.50 | | Highly Weathered, Highly Fractured | 87 | | | 5 | 8 | | | | 22 | | | 6 | >15 | | | | | | 16.6 | |
| 258.218 | 36.00 | | Highly Jointed, Gery, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 96 | | 4 | | | Joints of 0°,5°,10°,65° | | | 25 | | | NII | >15 | | | | | | 16.6 | |
| 256.718 | 37.50 | | | 79 | | 5 | 16 | | | | | 29 | | | 10 | ×15 | | | | | | 12.5 | |

| | Geotechnical | Investigation Repor | t |
|---------------------------------|---------------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| | HARY A J | 'ANA OINT V | RAIL INFRASTRUCTURE DEVELOPME ENTURE OF GOVERNMENT OF HARYANA ANI | INT C | ORP | ORA OF R | | <mark>N LTD</mark> . VAYS | | | | | | | | | | | | | Q | S M CONSUL/TANTS |
|-------------------------|-------------|----------------|--|-------|-------------|-------------|-------------|------------------------------|-------------------------|---------------------------------------|----|---------------------|-------------|-------|------------------|---------------|------------------------|-----|---------|---------------------------------------|------------------------------|---|
| | | | | | | | | | Geologica | I Log of | Во | rehole | 14 | | | | | | | | | |
| BORE HOLE CHAINAGE r | NO 1. | : | 14 25195 | | CO-0 | RDI | NATE | ES | X: Y: | 700578.153 3122015.421 | | | | | LOC. TOT | ATIO AL DI | N EPTH | I | | | Sohna 75m | |
| COLLAR ELI | VATION | : | | | GRO AZIM | UND UTH | ELE | VATION | l: : | 294.218 | | | | | TYPE | E OF | | | | L : F (m) | Double Tu Not Found | be |
| START DATI | | : | 11-08-2021 | | ANGI | | /ITH MPL | HORIZO | ONTAL: | 0° 23-08-2021 | | | | | DRIL | | AGI | | (| () | S.M Consu | litants |
| | | | | s | ize of | Core | e Pie | eces | Structural condition | Log | C | % of re-Recovery | | | ε | | - | W | ater | per | 5 Saurav Cr | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | Des cription | | 20 | 8 60 40 | Type of BIT | RQD % | Fracture Freq. / | Casing | Depth of wate level | Nil | Partial | Complete Colour of Returi Water | Rate of Penetrat (mm/min) | REMARK / OBSERVATIONS |
| 256.718 | 37.50 | | | | | | | | | \//////////////////////////////////// | | 28 | | | | | | | | | | As per the Surface as well as Subsurface data |
| 255.218 | 39.00 | | Ifath Washand Ifath Frankrid Ifath | 84 | | 9 | 7 | | Joints of 0°,5°,10°,65° | | | | | 7 | >15 | | | | | | 15 | such as the lithology of the area, it can be stated that the Stratigraphy of the area is of North Delhi fold Belt which is related to the Aravalli Sucsession. The Strata is Highly Fractured and Higly Jointed. Quartzite is the Prominnent Rock |
| 253.718 | 40.50 | | Jointed, Gery, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 96 | | 4 | | | Highly Fractured | | | 30 | | Nil | >15 | | | | | | 15 | here with some tracts and bands of Phyllite and Schist. |
| | | | | 87 | | 6 | 7 | | | | | 28 | | 7 | >15 | | | | | | 12.5 | |
| 252.218 | 42.00 | | | 81 | | 8 | 11 | | | | | 25 | | Nil | >15 | | | | | | 12.5 | |
| | | | | 85 | | | 6 | 9 | Joints of 0°,5°,10°,65° | | | 26 | | 6 | >15 | | | | | | 13.6 | |
| 249.218 | 45.00 | | | 83 | | 6 | 11 | | | | | 24 | 1 | Nil | >15 | | | | | | 21.12 | |
| 247.718 | 46.50 | | | 74 | | 20 | 6 | | | | | 26 | | NEL | 2 | | | | | | 19.07 | |
| 246.218 | 48.00 | | | | | 20 | | | | | | 27 | | | ~ 2 | | | | - | | 10.07 | |
| 244.718 | 49.50 | - | | 84 | | 4 | | 12 | | | | | | 18 | ~ | | | | _ | | 1/8 | |
| 243.218 | 51.00 | - | | 90 | | 4 | 6 | | | | | 22 | | Nil | ÷. | | | | | | 15.95 | |
| 241.718 | 52.50 | | | 90 | | 3 | 7 | | | | | 22 | Diamond B | Nil | >15 | | | | | | 15.78 | |
| 240.218 | 54.00 | | | 70 | | 2 | | 28 | | | | 22 | | Nil | >15 | | | | | | 18.75 | |
| 238.718 | 55.50 | | | 84 | | 16 | | | Joints of 0°,5°,10° | | | 26 | | Nil | >15 | | | | | | 13.63 | |
| 237 218 | 57.00 | | Slightly Weathered Highly Fractured | 91 | 1 | 8 | | | | | | 26 | | Nil | >15 | | | | | | 18.07 | |
| | | | Highly Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 93 | | | 7 | | | | | 22 | | 10 | >15 | | | | | | 20.27 | |
| 235.718 | 58.50 | | | 93 | | 2 | 5 | | | | | 21 | 1 | Nil | >15 | | | | | | 18.75 | |
| 234.218 | 60.00 | | | 91 | | | 9 | | | | | 22 | 1 | Nil | >15 | | | | | | 15.78 | |
| 232.718 | 61.50 | | | 100 | | | | | Joints of 0°,5°,10°,80° | | | 22 | 1 | Nil | >15 | | | | | | 16.4 | - |
| 231.218 | 63.00 | | | 86 | | 5 | 9 | | | | | 25 | | 13 | >15 | | | | | | 16.3 | - |
| 229.718 | 64.50 | | | 91 | | 2 | 7 | | liable Freedored | | | 28 | 1 | 11 | >15 | | | | | | 19.7 | - |
| 228.218 | 66.00 | | | 95 | | | 5 | | nighly Hactored | | | 28 | 1 | Nil | >15 | | | | | | 17.6 | |
| 226.718 | 67.50 | | | 82 | | 13 | 5 | | | | | 28 | 1 | Nil | >15 | | | | | | 14.8 | |
| 225.218 | 69.00 | | | 91 | | | 9 | | | | | 26 | \uparrow | 8 | >15 | | | | | | 16.6 | |
| 223.718 | 70.50 | | | 82 | | | 40 | | Joints of 0°,5°,10°,65° | | | 27 | T | 14 | >15 | | | | | | 45.45 | |
| 222.218 | 72.00 | | | 80 | | | 18 | | Joints of 0°,5°,65° | | | 26 | \dagger | 14 | >15 | | | | | | 10.75 | |
| 219.218 | 75.00 | | | 100 | | 9 | .1 | | Highly Fractured | | | 22 | | Nil | >15 | | | | | | 12.50 | |

| | ieotechnical : | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HRIDC | HARY | ANA DINT \ | RAIL INFRASTRUCTURE DEVELOPMI /ENTURE OF GOVERNMENT OF HARYANA AN | ENT (ID MIR | CORP | ORATI | <mark>ON LTD</mark> . LWAYS | | | | | | | | | | | | | ASTRO HULCONSULTANTS |
|------------|-----------|---------------|--|-----------------|--------|--------|--------------------------------|---------------------------|------------------------------|-----------------------|-----------|----------|---------|-------|---------|------------|---|---------|------------------------|--|
| | | | | | | | | Geol | ogical L | og of Bore | eho | ole 1 | 5 | | | | | | | |
| BORE HOLE | NO (m. | : | 15 25380 | | co-c | RDINA' | TES | X: Y: | 700451.868 3122157.745 | | | | TOTAL | DEP | тн | | | | Sohna 70.0 m | |
| COLLAR ELI | | : | | | AZIM | | LUODIZO | : : | | | | | DEPTH | OF CO | NATI | ER T | ABLE | E (m) | 61.0 m | be |
| START DATE | = | : | 12-08-2021 | | DATE | COMP | LETED : | NTAL: | 0 ⁻ 28-08-2021 | | | | NAME | NG A | GEN | CY DGIS | т | - | S.M Consu Gaurav Ch | litants unekar |
| | | | | s | ize o | Core F | Pieces | Structural condition | Log | % of Core-Recovery | | | ε | | level | Wa Lo | ter ss | peu. | tion | |
| (E) | | 5 | Lithological Description | | | - | | s | | | ΒІТ | | Freq. | | f water | | | fRetu | enetra | REMARK / OBSERVATIONS |
| levatio | epth (n | tho-Lo | | Omm |)-25mm | 5-75mm | 50mm | scripti | | | /pe of | % OS | acture. | asing | bepth o | - Line | - And | olour | ate of F m/mir | |
| <u> </u> | ā | 5 | | v | ¢ | 3 | 7 | <u> </u> | | 20 46 20 | F | æ | œ. | Ö | | ž á | | 50 | × ~ 5 | |
| 295.532 | 0.00 | | | | | | | | | 26 | | | | | | | | - | | As per the Surface as well as Subsurface data such as |
| | | | | 91 | | 4 5 | | | | | | 0 | >15 | × | | | | oht Rev | 12.5 | the lithology of the area, it can be stated that the Stratigraphy of the area is of North Delhi fold Belt which is related to the Aravalli Succession. The Strata is |
| 294.032 | 1.50 | | | | | + | | | | 28 | | | | ~ | | | | 1 | | Highly Fractured and Higly Jointed. Quartzite is the Prominnent Rock here with some tracts and bands of |
| | | | | 83 | | 9 8 | | | | | | 7 | >15 | | | | | | 16.6 | Phyllite and Schist. |
| 292.532 | 3.00 | | | | | - | - | | | 42 | | | | _ | | | | - | | |
| | | | | 75 | | 6 19 | | | | | | 7 | >15 | | | | | | 16.3 | |
| 291.032 | 4.50 | | | | | _ | | | | 36 | | | | | | | | | | - |
| | | | | 72 | | 15 13 | | | | | | 0 | >15 | | | | | | 15.6 | |
| 289.532 | 6.00 | | | | | _ | - | | | 46 | | | | | | | | | | - |
| 288.032 | 7 50 | | Moderately Weathered, Highly Fractured, Jointed, Light Grey, Fine Grained, | 59 | | 22 19 | | loints of 0" 5 10" 15" | | | | 0 | >15 | | | | | | 13.04 | |
| 200.002 | 1.00 | | Interlocking Texture, Iron Leaching, very Hard, Quartzite | | | | | 001113 01 0 , 3, 10 , 13 | | 24 | | _ | 2 | | | | | | | - |
| 286.532 | 9.00 | | | /8 | | 9 13 | | | | | | <i>'</i> | ~ | | | | | | 17.64 | |
| | | | | 78 | | 8 14 | | | | 34 | | 14 | 15 | | | | | | 16.3 | |
| 285.032 | 10.50 | | | | | | | | | | | | ^ | | | | | | | |
| | | | | | | | | | | 20 | | | 5 | | | | | | | |
| 202 522 | 12.00 | | | 8/ | 1 | 12 | | | | | | 0 | ~ | | | | | | 16.66 | |
| 203.332 | 12.00 | | | 90 | | 10 | | | | 23 | nd Bit | 0 | 15 | | | | | | 18.75 | |
| 282.032 | 13.50 | | | | | - | | | | | Diamor | - | ^ | | | | | - | | - |
| | | | | 100 | | | | | | 10 | | 0 | >15 | | | | | | 15 | |
| 280.532 | 15.00 | | | | | | | | | 16 | | | | | | | | | | - |
| | | | | 91 | | 9 | | Joints of 0°, 5, 10°, 25° | | | | 0 | >15 | | | | | | 12.5 | |
| 279.032 | 16.50 | | | | | | | | | 22 | | | | | | | | | | - |
| | | | | 84 | | 5 11 | | | | | | 0 | >15 | | | | | | 12.5 | |
| 277.532 | 18.00 | | | | | _ | | | | A1 | | | | | | | | - | | - |
| | | | | 68 | 2 | 8 22 | | | | | | 17 | >15 | | | | | | 14.28 | |
| 276.032 | 19.50 | | | | | | | Joints of 0°, 5, 10°, 15° | | 28 | | | 6 | | | | | | | - |
| 274.532 | 21.00 | | | 82 | | 12 6 | | | | | | 0 | ~ | | | | | | 14.28 | _ |
| | | | | 95 | | 5 | | | | 26 | | 0 | >15 | | | | | | 16.66 | |
| 273.032 | 22.50 | | | | | | | | | 20 | | | | | | | | - | | - |
| | | | | 80 | | 7 | 13 | | | 30 | | 18 | >15 | | | | | | 13.63 | |
| 271.532 | 24.00 | | Slightly Weathered, Highly Fractured, | | | _ | | | | | | | | | | | | - | | - |
| 270.032 | 25.50 | | Jointed, Light Grey, Fine Grained, Interlocking Texture, Iron Leaching, very Hard, Quartzite | 97 | | 3 | | | | 27 | | 0 | >16 | | | | | | 12.5 | - |
| 268.532 | 27.00 | | | 85 | | 96 | | | | 36 | | 0 | >15 | | | | | | 16.66 | _ |
| | | | | 82 | | 9 9 | | | | 33 | | 8 | >15 | | | | | | 16.66 | |
| 267.032 | 28.50 | | | | | | | Joints of 0°, 5, 10°, 35° | | 20 | | | 6 | | | | | | | - |
| 265.532 | 30.00 | | | 91 | 2 | 1 | | | | | | 0 | ~ | | | | | | 15.7 | |
| | | | | 84 | | 16 | | | | 23 | | o | >15 | | | | | | 16.66 | |
| 264.032 | 31.50 | | | 0.1 | 2 | 4 12 | | | | 21 | \square | | 15 | | | | | | 16.66 | 1 |
| 262.532 | 33.00 | | | 81 | 2 | 4 13 | | | | | Ц | J | `^ | | | | | | 10.00 | 4 |
| 261 022 | 34 50 | | | 78 | | 2 20 | | | | 30 | | 7 | >15 | | | | | | 14.7 | |
| 201.032 | 04.00 | | | 82 | | 18 | | | | 32 | | 0 | 15 | | | | | | 17.04 | 1 |
| 259.532 | 36.00 | | | | | | - | Joints of 0°, 5, 10°, 45* | | 34 | \vdash | | | | | + | | - | | - |
| 258.032 | 37.50 | | | 84 | | 9 7 | | | | | | 0 | >15 | | | | | | 15.6 | |

| | Geotechnical | Investigation Repor | t |
|---------------------------------|---------------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| | HARY. A JO | ANA DINT V | RAIL INFRASTRUCTURE DEVELOPI /ENTURE OF GOVERNMENT OF HARYANA | MENT AND M | COF | RY O | RATI F RAI | I <mark>ON LT</mark> ILWAYS | D. | | | | | | | | | | | | | S M CONSUL/TANTS AN IEO 0001 COMPANY BHUDANESHWAR |
|---|----------------------|---------------|---|---------------|--------------------------------------|--------------------|-------------------------------|--------------------------------|----------------------------------|--|-----|--------------------|-------------|-------|---|--|--------------------------------|----------------------------------|--------------------|------------------------|--|---|
| | | | | | | | | | Geologica | I Log of | B | orehole | 15 | 5 | | | | | | | | |
| BORE HOLE CHAINAGE H COLLAR ELI RAIL LEVEL START DATI | NO (m. EVATION | : : : | 15 25380 2008-2021 | | CO-O GROI AZIM ANGI DATE | UND UTH LE W | NATE ELEV ITH I MPLI | S ATION HORIZO | X: Y: : NTAL: | 700451.868 3122157.745 295.532 0° 25-08-2021 | | | T | | LOC TOT TYP DEP DRIL NAM | ATION AL DE E OF O TH OF LLING | PTH COR WA AGE GEO | E BAR ITER 1 INCY ILOGI | REL TABLI ST | E (m) | Sohna 70.0 m Double Tu 61.0 m S.M Consu Gaurav Ch | be Itants unekar |
| | | | | Si | ze of | Core | e Pie | eces | Structural condition | Log | Col | % of e-Recovery | | | m / . | ator | | Wa Lo | ter ss | urned | ration | |
| (m) Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | Description | | 20 | 60 80 100 | Type of BIT | RQD % | Fracture Freq | Casing Domh of ur | | Nil | Complete | Colour of Ret Water | Rate of Penet (mm/min) | REMARK / OBSERVATIONS |
| | | | | 83 | | 10 | 7 | | Joints of 0°, 5, 10°, 45° | | | 30 | | 6 | >15 | | | | | | 18.51 | As per the Surface as well as Subsurface data such as the lithology of the area, it can be stated |
| 256.532 | 39.00 | | | 94 | 1 | 5 | | | | | | 25 | | 0 | >15 | | | | | | 16.12 | that the Stratigraphy of the area is of North Deini fold Belt which is related to the Aravalli Sucsession. The Strata is Highly Fractured and |
| 255.032 | 40.50 | | | 63 | | 13 | 8 | 16 | | | | 40 | | 22 | >15 | | | | | | 15.7 | Hinlu Jointed Auertzite is the Prominnent Rock |
| 233.332 | 42.00 | | | 66 | | 11 | 23 | | Joints of 0°, 5, 10°, 15° | | | 28 | | 8 | >15 | | | | | | 15 | |
| 252.032 | 43.50 | | | 07 | 1 | | 17 | | | | | 30 | | 6 | 15 | | | | | | 15.7 | |
| 250.532 | 45.00 | | | 02 | 1 | - | 1/ | | | | | 26 | | 0 | ^ | | | | | | 15.7 | - |
| 249.032 | 46.50 | | | 85 | | 4 | 11 | | | | | | | 0 | >15 | | | | | | 15 | |
| 247.532 | 48.00 | | | 69 | | 4 | 27 | | Joints of 0°, 5, 10°, 55° | | | 38 | | 27 | >15 | | | | | | 15.7 | |
| 246.032 | 49.50 | | | 85 | | 5 | 10 | | | | | 29 | | 10 | >15 | | | | | | 16.6 | - |
| 244.532 | 51.00 | | | 90 | | | 10 | | Joints of 0°, 5, 10°, 15° | | | 22 | | 0 | >15 | | | | | | 17.6 | - |
| 243.032 | 52.50 | | | 76 | | 3 | 21 | | | | | 26 | ond Bit | 15 | >15 | | | | | | 14.8 | |
| 241.532 | 54.00 | | Slightly Weathered, Highly Fractured, Jointed, Light Grey, Fine Grained, | 88 | | | | 12 | | | | 20 | Diam | 10 | >15 | | | | | | 15.9 | |
| | | | Interlocking Texture, Iron Leaching, very Hard, Quartzite | 83 | | | 17 | | Joints of 0°, 5, 10°, 35° | | | 26 | | 0 | >15 | | | | | | 15.7 | |
| 240.032 | 55.50 | | | 100 | | | | | Joints of 0°, 5, 10°, 90° | | | 20 | | 0 | > 15 | | | | | | 15.7 | |
| 238.532 | 57.00 | | | 87 | | 6 | 7 | | | | | 25 | 1 | 0 | >15 | | | | | | 16.6 | |
| 237.032 | 58.50 | | | 92 | + | 8 | | | Highly Fractured | | | 34 | | 0 | -15 | | | | | | 16.3 | |
| 235.532 | 60.00 | | | 76 | | | 24 | | | | | 28 | | 24 | 15 > | | | | | umo | 14.2 | |
| 234.032 | 61.50 | | | | | - | | | 1-1-1f 00 F 400 4F0 | | | 20 | | | 5 | | • | | | eyish Bro | 45.7 | |
| 232.532 | 63.00 | | | 92 | _ | _ | 8 | | Joints of 0°, 5, 10°, 15° | | | 32 | | 8 | 5 >1 | | | | | Gre | 15.7 | |
| 231.032 | 64.50 | | | 84 | | | 16 | | | | | 24 | | 16 | 7 | | | | | | 14.2 | |
| 229.532 | 66.00 | | | 79 | _ | 7 | 14 | | | | | 31 | | 14 | >15 | | | | | | 12.5 | |
| 228.032 | 67.50 | | | 83 | | | 7 | 10 | Joints of 0°, 5, 10°, 30° 75° | | | 27 | | 9 | >15 | | | | | nt Brown | 14.28 | - |
| 226.532 | 69.00 | | | 73 | | 4 | 23 | | - | | | 28 | | 8 | >15 | | | | | Ligt | 12.5 | • |
| 225.532 | 70.00 | | | 67 | | 6 | 27 | | | | | 57 | | 10 | >15 | | | | | | 12.5 | |

| | Geotechnical C | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HRIDC | HAR) A J | (ANA IOINT \ | RAIL INFRASTRUCTURE DEVELOPM | ENT (| | PORAT | ION LTD | | | | | | | | | | | | 3 | S M CONSULTANTS |
|-----------------------|-------------|-----------------|--|-------|--------|---------|-----------|--|---------------------------|---------------|---------|-----|----------|-------|-----------|-----------|------------|----------|-----------------|--|
| | | | | | | | | Geologica | al Log of I | Borehole 1 | 5(/ | A) | | | | | | | | |
| BORE HOLE CHAINAGE | NO m. | : | 15A (Ditch) 25488 | | co- | ORDIN/ | TES | X: Y: | 700374.567 3122232.681 | | | | LOCA | L DEF | тн | | | | Sohna 50m | |
| RAIL LEVEL | EVATION | | | | AZI | MUTH | TH HORIZO | : DNTAL: | 0° | | | | DEPT | HOF | WA' | TER T | ABLE | i (m) | 10m | De |
| | - | | | | DAT | E COM | PLETED | : | 01-10-2021 | % of | 1 | r – | NAME | OF C | SEO | | ST ater | 1 | Gaurav Ch | unekar |
| ÷ | | | | 5 | Size (| of Core | Pieces | Structural condition | Log | Core-Recovery | | | q. / m | | tter leve | L | oss | eturned | stration | |
| ation (n | (E) پر | -Fog | Lithological Description | Ę | m | u uu | E | aption | | | of BIT | % | ture Fre | бu | th of wa | | al | ur of R | of Pen /min) | REMARK / OBSERVATIONS |
| Elev | Dept | Lith | | < 10m | 10-25 | 25-75 | > 150 | Desc | | 9 8 8 9 30 | Type | RaD | Frac | Casi | - Dep | ii i | Com | Colo | Rate (mm | |
| 276.442 | 0.00 | | | | | | | | | | | | | | | | | | | As per the Surface on well as Subsurface data such as |
| | | | | 90 | 1 | 4 5 | 5 | | | | | 0 | >15 | | | | | | 15 | the lithology of the area, it can be stated that the Stratigraphy of the area is of North Delhi fold Belt which |
| 274.942 | 1.50 | - | | | | | | - | | 30 | | - | | | | | | - | | Is related to the Aravalli Sucsession. The Strata is Highly Fractured and Higly Jointed. Quartzite is the Prominnent Rock here with some tracts and bands of |
| | | | Moderately Weathered, Highly Fractured, | 78 | 4 | з | 15 | Joints of 0°, 5°, 10°, 15° | | | | 10 | >15 | | | | | | 14 | Phyllite and Schist. |
| 273.442 | 3.00 | - | Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite (Very Fine Grained Pyrite | | | | | - | | 32 | | - | | | | | | - | | |
| | | | Crystals) | 79 | | 2 | 1 | | | | | 21 | >15 | | | | | | 15 | |
| 271.942 | 4.50 | | | | | | | | | 35 | | | | | | | | | | |
| 270 442 | 6.00 | | | 88 | | 12 | | | | | | 0 | >15 | | | | | | 13 | |
| 270.442 | 0.00 | | | | | | | 1 | | | | | | | | | | | | |
| | | | | 72 | | 2 | в | | | | | 28 | 15-8 | | | | | | 18 | |
| 268.942 | 7.50 | - | | | | | | 30************************************ | | | - | | | | | | | - | | |
| | | | | 90 | 3 | 7 | | | | | | 0 | >15 | | | | | | 14 | |
| 267.442 | 9.00 | - | | | | | | 1 | | | 1 | | | | | | | 1 | | |
| 265.942 | 10.50 | | | 70 | 3 | 4 2 | 3 | | | | | 30 | 15-1 | | Ļ | | | | 15 | |
| | | | | | | | | | | 35 | | | | | | | | Brown | | |
| | | | | 78 | | 2 | 2 | | | | | 22 | >15 | | | | | Light | 14 | |
| 264.442 | 12.00 | | | 82 | 1 | 3 1 | 1 | Joints of 0°, 5°,15°, 45° | | 32 | nond Bi | 8 | 15 | | | | | | 15 | |
| 262.942 | 13.50 | - | | 02 | - | 5 1 | | | | | Diar | | ^ | | | | | - | 1.5 | |
| | | | | 65 | 2 | | 33 | | | | | 32 | 15-8 | | | | | | 15 | |
| 261.442 | 15.00 | | | | | | | | | 28 | | | | | | | | | | |
| 070.040 | 40.50 | | | 89 | | 2 9 | | Joints of 0°, 5°,15°, 80° | | | | 8 | >15 | | | | | | 18 | |
| 259.942 | 16.50 | | | | | | | | | 41 | | | | | | | | | | |
| 259 442 | 18.00 | | | 90 | 1 | 2 | r | | | | | 7 | >16 | | | | | | 16 | |
| 230.442 | 10.00 | | | | | | | 1 | | 36 | | | 5 | | | | | | | |
| 256.942 | 19.50 | | Slightly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking | 81 | 2 | 1 | / | Joints of 0°, 5°,10°, 15° | | | | 16 | 1 | | | | | | 15 | |
| | | | Quartzite (Very Fine Grained Pyrite Crystals) | 76 | | 4 | 20 | | | 45 | | 20 | >15 | | | | | | 15 | |
| 255.442 | 21.00 | | | | ⊢ | | | | | 30 | 1 | - | 5 | | | \vdash | | 1 | | |
| 253.942 | 22.50 | | | 80 | | 5 1 | 5 | | | <u> </u> | | 15 | * | | | | | | 15 | |
| | | | | 88 | 1 | 5 6 | 5 | Joints of 0°, 5°, 10°, 35° | | 36 | 1 | 0 | -15 | | | | | | 14 | |
| 252.442 | 24.00 | | | | | | | | | | | Ĺ | | | | \square | | | | |
| 250.942 | 25.50 | | | 99 | 1 | | | | | 27 | | 0 | >15 | | | | | Grey | 15 | |
| 249.442 | 27.00 | | | 83 | | 2 1 | 5 | | | 40 | 1 | 15 | >15 | | | | | | 16 | |
| | | 1 | | 77 | | 2 | 3 | 1 | | 32 | 1 | 23 | >15 | | | | | | 14 | |
| 247.942 | 28.50 | - | | | - | | | Joints of 0°, 5°,10°, 15° | | 34 | ┢ | | 5 | | | \vdash | | - | | |
| 246.442 | 30.00 | - | | 87 | | 13 | | - | | | | ° | 1 | | | | | 1 | 16 | |
| 244.942 | 31.50 | | | 78 | | 2 | 2 | | | 34 | | 22 | >15 | | | | | uwo | 15 | |
| | | 1 | | 83 | | 1 | 7 | 1 | | 30 | Γ | 15 | >15 | | | | | Light Br | 14 | |
| 243.442 | 33.00 | | | | ┝ | | | | | 30 | ┝ | - | 5 | | | \vdash | | - | | |
| 241.942 | 34.50 | | | 90 | | 2 8 | 3 | Joints of 0°, 5°,10°, 70° | | | | 8 | 1 | | | \square | | 1 | 13 | |
| 240 442 | 36.00 | | | 94 | | 6 | | | | 36 | | 0 | >15 | | | | | | 15 | |
| | 50.00 | 1 | | 97 | Γ | 3 | | Joints of 0°, 5°,10°, 15° | | 37 | Γ | 23 | >15 | | | | | 1 | 15 | |

| | ieotechnical : | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| INDE | HAR) A. | <mark>(ana</mark> Joint | RAIL INFRASTRUCTURE DEVELOP | MEN And | t CC Minis |) <mark>RPO</mark> Stry C | <mark>rat</mark> i Df Rai | <mark>ion l</mark> i Ilways | FD. | | | | | | | | | | | | S M CONSUL/TANTS AN ISO 0001 COMPANY BHUDANESHWAR |
|--|----------------------|----------------------------|--|------------|---------------------|------------------------------|------------------------------|--------------------------------|----------------------------|---|-----------------------------|-------------|-------|----------------------------|-----------------------------------|---------------------------|------|---------|-----------------------------|--|---|
| | | | | | | | | | Geological L | .og of l | Borehole 1 | 5(/ | 4) | | | | | | | | |
| BORE HOLE Chainage I Collar El Rail Level | NO (m. Evation | :: | 15A (Ditch) 25488 | | co-c gro Azim | ordin Und I Iuth | iates Elev | S ATION | X: Y: : | 700374.567 3122232.68 276.442 | | | | loc Tot, Typi Dep | ation Al de E of (Th of | N EPTH Cori = Wa | E BA | RRE | L LE (m) | Sohna 50.0 m Double Tu 10.0 m | ibe |
| START DAT | E | : | 15-09-2021 | | ANG DATI | LE W F CON | ITH H VPI F | iorizo :TFD· | NTAL: | 0° 01-10-2021 | | | | DRIL | LING | AGE | | / | | S.M Consu | ultants |
| | | | | Si | ze of | f Core | Piec | ces | Structural condition | Log | % of Core-Recovery | | | E | | GEU | W | ater | peu | | unekar |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | < 10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | Description | | 20 40 60 80 100 | Type of BIT | RQD % | Fracture Freq. / | Casing | Depth of wate | Ϊ | Partial | Complete Colour of Retur | Rate of Penetrat (mm/min) | REMARK / OBSERVATIONS |
| 238.942 | | | | | | | | | | ¥///////////////////////////////////// | X////// | 1 | | | | | | | Т | | As ner the Surface as well as Subsurface data |
| 237.442 | 39.00 | | | 89 | 1 | 10 | | | | | 40 | | 7 | >15 | | | | | | 15 | such as the lithology of the area, it can be stated that the Stratigraphy of the area is of |
| 235.942 | 40.50 | | | 90 | | | 10 | | | | 50 | | 10 | >15 | | | | | | 13 | North Delhi fold Belt which is related to the Aravalli Sucsession. The Strata is Highly Fractured and Higly Jointed. Quartzite is the |
| 234.442 | 42.00 | | | 90 | | 10 | | | | | 34 | | 0 | >15 | | | | | | 14 | Prominnent Rock here with some tracts and bands of Phyllite and Schist. |
| 232.942 | 43.50 | | Slightly Weathered, Highly Fractured, | 84 | | 2 | 14 | | Joints of 0°, 5°,10°, 15° | | 32 | tit | 8 | >15 | | | | | Ę | 13 | |
| 231.442 | 45.00 | | Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard, Quartzite (Very Fine Grained Pyrite | 81 | | 6 | 13 | | | | 35 | iamond B | 0 | > 15 | | | | | ight Brow | 16 | |
| 229.942 | 46.50 | | Crystals) | 98 | 2 | | | | | | 30 | | 0 | >15 | | | | | | 13 | |
| 228.442 | 48.00 | | | 92 | 1 | | 7 | | lainta af 00 E0 400 700 | | 36 | | 7 | >15 | | | | | | 15 | |
| 226.942 | 49.50 | | | 86 | 2 | 4 | 8 | | Junits of 0°, 5°, 10°, 70° | | 40 | | 8 | > 15 | | | | | | 15 | |
| 226.442 | 50.00 | | | 98 | | | 2 | | Joints of 0°, 5°,10°, 15° | | 40 | | 0 | > 15 | | | | | | 15 | |

| | Geotechnical 3 | Investigation Repor | t |
|-------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HID | HARY/ A JC | ANA F | RAIL INFRASTRUCTURE DEVELOPME ENTURE OF GOVERNMENT OF HARYANA AND | NT C D MIN | ORP ISTRY | ORAT OF R/ | | LTD. | | | | | | | | | | | | | K | S M CONSULTANTS |
|---------------------------------------|----------------------|---------|---|---------------|--------------|-----------------|----------------|--------------|-----------------------------|--|-----|---------------------|-----------|-------|----------------------|---------------------------|---------------------|------|-------------------------|------------------|-----------------------------|--|
| BORE HOLE CHAINAGE I COLLAR ELI | NO (m. EVATION | : | 16 25586 | - | CO- | | ELE | ES VATION | Geologi x: Y: | cal Log of 700297.426 3122294.327 287.324 | fBo | orehole | 16 | 5 | LOC. TOT/ TYPE | ATION AL DEI E OF C | PTH | BARI | REL | () | | Sohna 62.0 m Double Tube |
| START DAT | = | : | 26-08-2021 | | ANG | E CO | ITH MPL | HORIZO | NTAL: | 0° 10-09-2021 | | | | | DEP | | AGE | | T | . (111) | | S.M Consultants Gaurav Chunekar |
| svation (m) | pth (m) | tho-Log | Lithological Description | 0mm | Size o | of Cor uuug2 | e Pie uuugi | eces | Structural condition | Log | Co | % of re-Recovery | pe of BIT | 1D % | acture Freq. / m | sing | spth of water level | Wa | iter oss appendit | four of Returned | te of Penetration m/min) | REMARK / OBSERVATIONS |
| ă | å | ž | | , € | 10- | 52 | 75- | ž | <u> </u> | | 5 | 6 8 8 <u>5</u> | Ţ | 8 | Fr | ů | ă | ž | 2 3 | 883 | 8 <u>8</u> | |
| 287.324 | 0.00 | | Moderately Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite (DS and DS Wash Collected) | 93 | | 2 | 5 | | | | | 16 | | 0 | >15 | X | | | | | 12.5 | As per the Surface as well as Subsurface data such as the lithology of the area, it can be stated that the Stratigraphy of the area is of North Dalhi fold Belt which is related to the Aravalli Sucsession. The Strata is Highly Fractured and Higly Jointed. Quartzle is the |
| 284.324 | 3.00 | | | 93 | | | 7 | | | | | 25 | | 0 | >15 | | | | | | 14.8 | Prominnent Rock here with some tracts and bands of Phyllite and Schist. |
| 282.824 | 4.50 | _ | Moderately Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard | 90 | | 4 | 6 | | Highly Fractured | | | 32 | | 0 | >15 | | | | | | 13.63 | _ |
| 281.324 | 6.00 | _ | Quartzite | 88 | | 5 | 7 | | | | | 32 | | 0 | >15 | | | | | | 13.63 | _ |
| 279.824 | 7.50 | | | 97 | | 3 | | | | | | 30 | | 0 | >15 | | | | | | 12.5 | |
| 278.324 | 9.00 | | | 84 | | | 16 | | - | | | 31 | | 10 | >15 | | | | | _ | 14.28 | _ |
| 276.824 | 10.50 | _ | Slightly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard | 83 | 1 | 3 | 13 | | - | | | 30 | | 0 | >15 | | | | | Light Brown | 12.5 | - |
| 275.324 | 12.00 | _ | Quartzite | 78 | | 6 | 16 | | Joints of 0°,10°,15°,20° | | | 34 | | 0 | >15 | | | | | _ | 16.6 | |
| 273.824 | 13.50 | | | 74 | | 4 | 9 | 13 | | | | 31 | iamond B | 15.33 | >15 | | | | | | 12.5 | |
| 070 004 | 15.00 | | | 74 | | | 11 | 15 | | | | 27 | | 10.3 | >15 | | | | | | 13.04 | |
| 270 824 | 16.50 | | | 80 | | | | 20 | Closed Joint of 80* | | | 36 | | 19 | >15 | | | | | | 13.63 | |
| 269 324 | 18.00 | | | 85 | | | | 15 | | | | 28 | | 15.3 | >15 | | | | | | 15 | - |
| 267.824 | 19.50 | | | 56 | 1 | | 10 | 33 | Joints of 0°,10°,15°,20° | | | 46 | | 36.3 | 15-8 | | | | | | 12.5 | _ |
| 266.324 | 21.00 | | | 71 | | | 19 | 10 | | | | 48 | | 0 | >15 | | | | | | 11.53 | |
| 264.824 | 22.50 | _ | | 72 | | | | 28 | | | | 44 | | 14 | >15 | | | | | | 12.5 | - |
| 000 004 | | | Slightly Weathered, Moderately Fractured, Jointed, Grey, Fine Grained, Interlockina | 74 | | | 26 | | Joints of 0°,10°,15°,45° | | | 43 | | 11 | >15 | | | | | uwo | 13.63 | |
| 263.324 | 24.00 | - | Texture, Iron Leaching, Very Hard Quartzite | 65 | | | 6 | 29 | | | | 42 | | 28 | 15-8 | | | | | Light Bn | 13.04 | |
| 260.324 | 27.00 |] | | 78 | | | 22 | | Joints of 0°, 10°, 15°, 20° | | | 34 | | 15 | >15 | | | | | | 13.63 | |
| 258.824 | 28.50 | | | 53 | | | | 47 | | | | 5 3 | | 47 | 15-8 | | | | | | 15 | |
| 257.324 | 30.00 | | | 76 | | | 24 | | Joints of 0°,10°,15°, 70° | | | 31 | | 8 | >15 | | | | | | 11.5 | |
| 255.824 | 31.50 | | | 79 | | | | 21 | | | | 39 | | 34 | 15-8 | | | | | | 15 | |
| 254.324 | 33.00 | | | 83 | | | 17 | | | | | 30 | | 14 | >15 | | | | | | 12.5 | |
| 252.824 | <u>34.50</u> | | | 71 | | 2 | | 27 | Joints of 0°,10°,15° | | | 36 | | 25 | >15 | | | | | | 16.6 | |
| 251.324 | 36.00 | | | 78 | | Ц | | 22 | | | | 30 | | 22 | >15 | | | | | | 13.6 | |
| 249.824 | 37.50 | | | 65 | | | 5 | 30 | | | | 37 | | 22 | >15 | | | | | | 15 | |

| | ieotechnical : | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HRIDC | HAR | <mark>yana</mark> Joint | RAIL INFRASTRUCTURE DEVELOP | MEN A AND | IT CO MINI | <mark>orpo</mark> Stry C | O <mark>RAT</mark> OF RA | T <mark>ION L</mark> | TD. s | | | | | | | | | | | | | M CONSULTANTS NISO 0001 COMPANY JUBANESHWAR |
|---|----------------------|----------------------------|--|--------------|---------------------------|---|--------------------------------|-------------------------------|------------------------------|--|------|------------|-------------|-------|--------------------------------------|---|---------------------|-----------------------------|------------------|---------------------------|-------------------------------|---|
| | | | | | | | | | Geologic | al Log o | f Bo | orehole | 16 | 5 | | | | | | | | |
| BORE HOLE CHAINAGE H COLLAR ELI RAIL LEVEL START DATI | NO (m. EVATION | :: | 16 25586 26-08-2021 | | GRC AZIN ANG DAT | ORDIN DUND E MUTH GLE WI TE CON | IATE: ELEV ITH H MPLE | S ATION HORIZC ETED: | X: Y: : : INTAL: | 700297.426 3122294.327 287.324 0° 10-09-2021 | | | | | LOCA TOTA TYPE DEPT DRIL | ATION AL DEP E OF CO TH OF I LING A | TH DRE E WATE | BARR ER TA CY DGIS | REL ABLE T | E (m) | | Sohna 62.0 m Double Tube 50.0 m S.M Consultants Gaurav Chunekar |
| | | | | S | ize o | of Core | Pie | ces | Structural condition | Log | | % of | | | 2 | | | Wate | er | pə | uo | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | Description | | 20 | | Type of BIT | RQD % | Fracture Freq. / r | Casing Depth of water | level | Partial | Complete | Colour of Return Water | Rate of Penetrati (mm/min) | REMARK / OBSERVATIONS |
| 243.324 | 39.00 | | Slightly Weathered, Moderately Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very | 85 | | 1 | 15 | | · Joints of 0°,10°,15° | | | 30 | | 8 | >15 | | | | | ht Brown | 12.5 | As per the Surface as well as Subsurface data such as the lithology of the area, it can be stated that the Stratigraphy of the area is of North Delhi fold Belt which is related to the Aravalli Sucsession. The Strata is Hidhly Fractured and |
| 246.824 | 40.50 | | Hard Quartzite | 69 | | 3 | 5 | 23 | | | | 34 | | 20 | >15 | | | | | Lig | 10.71 | Higly Jointed. Quartzite is the Prominnent Rock here with some tracts and bands of Phyllite and Schist |
| 245.324 | 42.00 | | Slightly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 86 | | 1 | 14 | | Highly Fractured | | | 36 | | 0 | >15 | | | | | | 12.5 | |
| 243.824 | 43.50 | | Slightly Weathered, Moderately Fractured, Jointed, Grey, Fine Grained, | 64 | | 1 | 18 | 18 | Joints of 0°,10°,15°, 75° | | | 42 | ļ | 16.6 | >15 | | | | | | 13.63 | |
| 242 324 | 45.00 | | Hard Quartzite | 55 | | | | 45 | Joints of 0°,10°,15° | | | <i>4</i> 4 | | 44 | 15-8 | | | | | | 11.53 | |
| 240.824 | 46.50 | | Slightly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 85 | | 1 | 15 | | Highly Fractured | | | 37 | | 0 | >15 | | | | | | 14.28 | |
| 239.324 | 48.00 | | Slightly Weathered, Moderately | 46 | | | | 54 | | | | 53 | | 51.3 | 8-5 | | | | | | 12.5 | |
| 237.824 | 49.50 | | Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite | 62 | 1 | 2 | 26 | 11 | Joints of 0°,10°,15° | | | 45 | and Bit | 15.3 | > 15 | | | | | | 11.53 | |
| 236.324 | 51.00 | | | 68 | | 4 | | 28 | | | | 38 | Diamo | 26.6 | 15-8 | _ | * | | | Brown | 12.5 | - |
| 234.824 | 52.50 | | Slightly Weathered, Moderately Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very | 60 | | 3 | | 37 | Open Joint 80° (Phyllite | | | 40 | | 29.3 | 15-8 | | | | | Light | 10.71 | |
| 233.324 | 54.00 | | Hard, Quartzite (Weathered Medium Grained Garnet Grains, Contact of Phyllite Band Noticed) | 72 | | 1 | 16 | 12 | Band Contact) | | | 43 | | 16.3 | >15 | | | | | | 10.71 | |
| 231.824 | 55.50 | | | 60 | | 1 | 17 | 23 | | | | 43 | | 21 | >15 | | | | | | 12.5 | |
| 230.324 | 57.00 | | | 76 | | 1 | 24 | | | | | 31 | | 8 | >15 | | | | | | 13.63 | |
| 228.824 | 58.50 | | Slightly Weathered, Moderately Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very | 80 | | | | 20 | Joints of 0°,10°,15° | | | 30 | | 17.6 | >15 | | | | | | 13.63 | |
| 227.324 | 60.00 | | Hard Quartzite | 75 | | | | 25 | | | | 25 | ļ | 20 | >15 | | | | | Light Brown | 12.5 | |
| 225.824 | 61.50 | | | 70 | | 1 | 10 | 20 | | | | 32 | | 24.3 | >15 | | | | | | 11.53 | |
| 224.324 | 62.00 | | | 83 | | 1 | 17 | | Closed Joint of 70° | | | 66 | | 8.6 | > 15 | | | | | | 14.28 | |

| | Geotechnical 3 | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| | HARYA A JOI | NA F | RAIL INFRASTRUCTURE DEVELOPMENT ENTURE OF GOVERNMENT OF HARYANA AND M | T COI | RPOI RY O | RATI F RAI | ON L | TD. s | | | | | | | | | | | | | | R.S. | ACTIO HEL CONSULTANTS |
|--------------------------|----------------|-----------|---|-------|--------------|---------------|--------------|---------------|--|----------------------------|-----------------------|------------------|----------------------------------|-------------|-------|----------------|--------|------------|--------------|----------|-------|----------------------------|---|
| BORE HOLE | NO | : | 17 | | co- | ORD | INATE | s | Geo | 700117.355 | g of Boreh | ole | 17 | | | LOCA | TION | | | | | | Sohna |
| CHAINAGE H COLLAR ELI | (m. EVATION | : | 25785 232.394 | | GRO | | ELE | VATIO | Y: *: | 3122388.462 282.461 | | | | | | TOTA TYPE | OF CO | H RE BA | RRE | L |) | | 62.0 m Double Tube |
| START DATI | | : | 22-12-2021 | | ANG | E CO | VITH DMPL | HORIZ ETED | ONTAL: | 90° 27-01-2022 | | | | | | DRILI | ING A | SENC' | SIST | | n) | | S.M Consultants Gaurav Chunekar |
| | | | | s | ize c | f Co | re Pie | ces | Structural co | ondition | % of Core-Recovery | Sta Pene T | ndard tration est | | | m / . | | | Wate Loss | r s | Della | ation | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | Description | Log | 20 60 80 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq. | Casing | NII NII | Partial | Complete | Vater | Rate of Penetr (mm/min) | REMARK / OBSERVATIONS |
| 282.461 | 0.00 | | | | | | | | | | | | | | | | | | | | | | An anatha Cudana an unit an Cubaudana data auch a |
| 280.961 | 1.50 | | Brown colour, very fine to fine grained, clayey silt deposit | | | | | | very fine to fine grained, clayey silt deposit | | 0 | | | | NA | NA | XN | | | | | 30.61 | Ins per the Sufface as well as Substitute out such as the lithology of the area, it can be stated that the Stratigraphy of the area is of North Delhi fold Belt which is related to the Aravalli Succession. The Strata is Highly Fractured and Highy Jointed. Quartzite is the |
| 279 461 | 3.00 | | | | | | | | | | 0 | 12 | 45 | | NA | NA | | | | | | 33.3 | Prominnent Rock here with some tracts and bands of Phyllite and Schist. |
| 273.401 | 3.00 | | Brown colour, very fine to fine project | | | | | | very fine to fine grained | | 0 | | | | NA | NA | | | | | | 27.27 | |
| 277.961 | 4.50 | | clayey silt deposit | | | | | | clayey silt deposit | | 0 | 16 | 45 | | NA | NA | | | | | | 27.27 | |
| 276.461 | 6.00 | | | ╞ | | | | | | | 30 | | | | NA | NA | | | | | Brown | 30 | - |
| 274.961 | 9.00 | | | | | | | | | | 0 | 26 | 45 | | NA | NA | | | | | ŀ | 31.57 | - |
| 273.461 | 12.00 | | Brown colour, very fine to fine grained, | | | | | | very fine to fine grained, | | 0 | 21 | 45 | | NA | NA | | | | | - | 30 | - |
| 271.961 | 15.00 | | | | | | | | onycy on with grano | | 0 | 37 | 45 | | NA | NA | | | | | - | 21.42 | - |
| 270.461 | 16.50 | | Brown colour, very fine to fine grained, sub | | | | | | It shows very fine to fine grained, sub angular to | | 0 | >50 | 23 | Bit | NA | IA I | | - | - | | - | 21.12 | - |
| 268.961 | 18.00 | | clayey sit. | <10 | 23 | 35 | | | sub rounded pebbels clayey silt. Joints of 0°,45° | | 17 | | 20 | Diamond | 0 | -15 N | | - | | | | 12 | - |
| 267.461 | 19.50 | | | <10 | 20 | 31 | | | Closed Joint of 10* | | 22 | | | | 0 | 15 | | - | | | | 6.89 | |
| 265.961 | 20.50 | | Highly Weathered, Highly Fractured, | | | | | | | | 25 | | | | - | ^ | | _ | | | | | - |
| 264.461 | 22.00 | | Texture, Iron Leaching, Hard Quartzite. | <10 | | | | 174 | It shows highly fractured | | 32 | | | | 11.6 | >10 | | | | | | 10 | - |
| 262.961 | 23.00 | | | <10 | | 70 | | | weathered rock | | 33 | - | | | 0 | 15-8 | | | | | | 11.11 | - |
| 261.461 | 24.50 | | | <10 | | | 175 | | | | 48 | | | | 0 | 0.8 >15 | | | | | | 10.71 | - |
| 259.961 | 25.00 | | Moderately Wanthoord Medicine | | | 35 | 125 | | Joints of 0",10",15° | | 55 | | | | 25 | 58 15t | | | | | | 5.5 | - |
| 258.461 | 26.00 | | Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite. | <10 | | 42 | | 376 | Joints of 0°, 15°,80° | | 44 | | | | 32.6 | 0.8 15 tc | | | | | | 7.4 | - |
| 256.961 | 27.50 | | | <10 | | 66 | 175 | 190 | Joints of 0°,10°,15°,20° | | | | | + | 12.66 | 58 15 t | | | \parallel | | - | 12.5 | 4 |
| 255.461 | 28.00 | | Linkly Wanthan 1979 7 | | | 70 | 214 | | | | | | | - | 25.8 | 15 tc | | | Ц | | - | 6.6 | 4 |
| 253.961 | 29.50 | | Hignly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Hard Quartzite. | <10 | | 130 | | | It shows highly fractured weathered rock | | 58 76 | | | | 7.6 | 5 15 to 8 | | | | | | 11.53 | |
| 252.461 | 30.00 | | Slightly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking | <10 | | 49 | 93 | 152 | Joints of 0°,10°,15°, 70° | | 47 | | | | 0 | 15 >1£ | _ | | | | | 7.14 | - |
| 250.961 | 31.00 | | Texture, Iron Leaching, Very Hard Quartzite | <10 | | 60 | 80 | -155 | | | 54 | | | | 0 | >15 > | - | | | | | 11.53 | - |
| 249.461 | 32.50 | | Slightly Weathered, Moderately Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard | <10 | | 50 | 395 | | It shows highly angular fractured and jointed, weai strength | | 54 | | | | 15.53 | >15 | | | | | ŀ | 11.11 | |
| 247.961 | 33.50 | | Uuarizite Slightly Weathered, Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture, Iron Leaching, Very Hard Quartzite. (crushed zone) | <10 | 17 | 75 | 90 | | | | 34.66 | | | | 0 | 15 to 8 | | | | | ŀ | 11.53 | |
| 244.961 | 36.50 | 1111 | Light Brown colour, Coarse grained, Sand. (SPT Rebounded) | | | | | | Coarse grained, Sand. (SPT Rebounded) | | 0 | >50 | 3 | | NA | M | | | | | Brown | 21.42 | |

| | Geotechnical 3 | Investigation Repor | t |
|-------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| | HAR | YAN/ Joint | A RAIL INFRASTRUCTURE DEVELOP | MEN | IT COP MINIST | RY O | RATIOI F RAILW | N LT WAYS | D. | | | | | | | | | | | | | | | M CONSULTANTS NISO 0001 COMPANY IUDANESHWAR |
|--|----------------------|---------------|---|----------|---|----------------------------------|----------------------------------|----------------------------------|---|---|------|---------------------------------|-------------------------|-----------------------------|-------------|-------|---|--|--|------------------------------|-------------|-----------------------------|---------------------------------|---|
| | | | | | | | | | Geolo | ogical Lo | og o | of Borel | nole | e 17 | | | | | | | | | | |
| BORE HOLE CHAINAGE H COLLAR ELI RAIL LEVEL START DAT | NO (m. EVATION | : : : : : | 17 25785 232.394 22-12-2021 | | CO-OR GROU AZIMU ANGLE DATE | DIN/ ND E TH WIT COM | ATES LEVAT TH HOR PLETE |) 10N : : RIZON :D : | X: Y: : NTAL: | 700117.355 3122388.462 282.461 90° 27-01-2022 | | | | | | | Loc Tot Typ Dep Drii NAM | ation al de e of th of lling <u>ie of</u> | N EPTH CORE F WAT AGEP GEOL | BARF ER T. ICY OGIS | REL ABLE | : (m) | | Sohna 62.0 m Double Tube 38.6 m S.M Consultants Gaurav Chunekar |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm \$ | 10-25mm 25-75mm | 25-150mm | Pieces | 3 | Structural cor | Log | Cor | % of re-Recovery 09 08 00 | Star Pene N value | Depth of Ionation Ion prepu | Type of BIT | RQD % | Fracture Freq. / m | Casing | Depth of water level | Wati Los | Complete 53 | Colour of Returned Water | Rate of Penetration (mm/min) | REMARK / OBSERVATIONS |
| 244.961 243.461 | 38.00 | | Light Brown colour, Coarse grained, Sand. (SPT Rebounded) | | | | | | Coarse grained, Sand. (SPT Rebounded) | | | 0 | >50 | 2 | | NA | NA | | | | | Brown | 23 | As per the Surface as well as Subsurface data such as the lithology of the area, it can be stated that the Stratigraphy of the area is of North Delhi fold Belt which is related to the Aravalli Succession. The Strata is Highly Fractured and |
| 241 961 | 39.50 | | | | | | | | | | | v | >50 | 2 | | NA | NA | | | | | | 14.28 | Higly Jointed. Quartzite is the Prominnent Rock here with some tracts and bands of Phyllite and |
| 240.461 | 41.00 | | | <10 | 6 | 0 | 16 | 55 H | Highly Fractured | | | 32 | | | | 11 | 15 to 8 | | | | | | 10.71 | |
| 238.961 | 42.50 | | | <10 | | 1: | 10 18 | 30 J | Joints of 0°, 10°, 15° | | | 41.33 | | | | 19.3 | 15 to 8 | | | | | | 12.5 | |
| 237.461 | 44.00 | | | <10 | | 15 | 50 47 | 73 J | Joints of 0° | | | 54 | | | | 41.53 | 15 to 8 | | | | | | 11.11 | - |
| 235.961 | 45.50 | | | <10 | 10 |)7 2 | 57 | ۲ | Highly Fractured, Joints of 0° | | | 30 | | | | 16.6 | 15 to 8 | | | | | | 12 | _ |
| 234.461 | 47.00 | - | Moderatey to Slightly Weathered, Moderately to Highly Fractured, Jointed, Grey, Fine Grained, Interlocking Texture | <10 | | 18 | 80 | | | | | 37.33 | | | | 0 | 15 to 8 | | _ | | | | 11.53 | - |
| 232.961 | 48.50 | | Iron Leaching, Very Hard Quartzite | <10 | 5 | 6 3: | 16 | | | | | 41.33 | | | nd Bit | 21.0 | 3 15 to 8 | | | | | | 10.86 | - |
| 231.461 | 50.00 | | | <10 | 27 | '9 | | , | Highly Fractured, Joints of 0°,10°,15° | | | 30 | | | Diamo | 0 | 3 15 to 8 | | _ | | | | 10.34 | - |
| 229.961 | 51.50 | | | <10 | 25 38 | 3 | | | | | | 36.66 | | | | 0 | 15 to 8 | | | | | | 12 | - |
| 228.461 | 53.00 | | | <10 | 7 | 1 32 | 23 18 | 30 | | | | 34.66 | | | | 12 | 15 to 8 | | _ | | | | 11.53 | - |
| 226.961 | 54.50 | | | <10 | 13 | 15 19 | 92 | ŀ | Highly Fractured, Joints of 0° | | | 33.33 | | | | 6.8 | 15 to 8 | | | | | | 11.11 | |
| 225.461 | 56.00 | | Highly Westhered Light Proves | <10 | | 18 | 81 | | | | | 28 | | | | 6.73 | 15 to 8 | | | | | | 15 | _ |
| 223.961 | 58.00 | | Moderately Fractured, Light Blown, Moderately Fractured, Loose material, Red, very fine to Fine Grained, weak silt stone with clay material (Crushed zone) | <10 | 5 | 0 | 16 | v 50 G | very fine to Fine Grained, weak silt stone with clay material | | | 38 | | | | 8 | 15 to 8 | | | | | | 12.96 | |
| 222.461 | 59.50 | | , | <10 | 7 | 0 | | | | | | 38.33 | | | | 0 | 15 to 8 | | | | | | 13 | |
| 220.961 | 61.00 | | Slightly Weathered, Moderately Fractured, Jointed, Grey, Fine Grained, | <10 | 3 | 0 23 | 35 18 | 30 | Joints of 0°,10°,15° | | | 40.6 | | | | 27.6 | 15 to 8 | | | | | | 12 | |
| 220.461 | 62.00 | | Interiocking Texture, Iron Leaching, Very Hard Quartzite | <10 | 4 | 8 34 | 45 19 | 90 | | | | // 78 // | | | | 12.6 | 15 to 8 | | | | | | 9.5 | |

| | Geotechnical 3 | Investigation Repor | t |
|-------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW/ | LTD. Ays | | G | eol | ogi | cal | L | og (| of I | Drill | Hol | e F | BH-1 | 8 | | | | | 3 | S M CONSULTANTS |
|---|--------------------------------|-----------|--|-------------|------------------------------|---------------------------------|-------------------------------------|---------------|--------------------|---------------------------------|-------------------------------------|----------------------|-------------------|----------------------------------|-------------|-------|---------------------------------------|--|--|---------------------------------|--------------|------------------------|--|
| BORE HOLE N CHAINAGE (m. COLLAR ELEV RAIL LEVEL START DATE ENDING DATE | O .) YATION | : : : | BH-18 25990 02-02-2022 07-02-2022 | | co-c groi Azim Angi |)RDIN UND E IUTH LE WI | ATES :LEVA ⁻ TH HO | TION RIZOI | X Y NTAL | : 6 : 3 : 2 : - : 9 | 39996 31225 280.25 90° | 1.797 15.20 53 | 7)4 | | | | LOC/ TOT/ TYPE DEPT DRILL | ATION AL DEI E OF C TH OF LING / E OF C | i PTH ORE WAT AGEN GEOL | BARRE ER TAE ICY OGIST | ≟L 3LE (m | : : 1] : : | Patuka 55m Double Tube 26.20m S.M. Consultants Gaurav Chunekar |
| | | | | Si | ze of | Core | Piec | es | Co | % ore-R | of | ery | Star Pene T | ndard tration est | | | m / . | | ar level | Wa Lo | iter SSS | urned | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 80 | 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq | Casing | Depth of wate | Partial | Complete | Colour of Ret Water | REMARK / OBSERVATIONS |
| 200.200 | | | [] | | | | | | | | | | | | | | | | | 1 | | 1 | General Description: This Borehole is Located on the upland part of the Alignment |
| 279.753 | 0.50 | | • | | | \vdash | | | | | | | | | | | | | | | | | on a ground elevation of 280.253 m. The stratigraphy of area is prominently of Silty clay which comes under Alluvial Type of |
| 278.753 | 1.50 | | | | | | | | | | | | 11 | 45 | | | | | | | | | Category. Silty clay and with gravels is majorly tracked in the borehole. |
| 277.253 | 3.00 | | | | | ┢── | | | - | | | | | | | | | | | | | | |
| 275.753 | 4.50 | | | | \vdash | ┝ | - | \vdash | ╞ | | | | | | | | | | | | | | |
| 274.253 | 6.00 | | | | <u> </u> | <u> </u> | | <u> </u> | - | | | | 20 | 45 | | | | | | | | | |
| 271.253 | 9.00 | | grained,medium to dense compacted, silty clay with none | | <u> </u> | | | <u> </u> | - | | | | | | | | | | | | | | |
| 268.253 | 12.00 | | to low plasticity | | | | | | | | | | 24 | 45 | | | | | | | | | |
| | | | | | | | | | | | | | 31 | 45 | | | | | | | | | |
| 265.253 | 15.00 | | | | - | - | - | - | - | | | | 35 | 45 | | | | | | | | | |
| 262.253 | 18.00 | | | ├ | <u> </u> | <u> </u> | | <u> </u> | ╞ | | | | 35 | 40 | | | | | | | | | |
| 259.253 | 21.00 | | | <u> </u> | <u> </u> | ┝ | | <u> </u> | ┝ | | | | 40 | 45 | | | | | | | | | |
| 256.253 | 24.00 | | | | | | | | | | | | 47 | 45 | Nx | | | | | Partial - | | ROWN | |
| 253.253 | 27.00 | | | | | | | | | | | | 49 | 45 | | | | | | | | а | |
| 250 253 | 30.00 | | | | | | | | | | | | 57 | 45 | 1 | | | | | | | | |
| 230.200 | 00.00 | | • | | | | | | | | | | 64 | 45 | | | | | | | | | |
| 241.200 | 33.00 | | | | | | | | | | | | 69 | 45 | | | | | | | | | |
| 244.253 | 36.00 | | | | | | | | - | | | | 77 | 45 | | | | | | | | | |
| 241.253 | 39.00 | | Brown colour, fine grained, dense | | | \vdash | | | | | | | 84 | 45 | | | | | | | | | |
| 238.253 | 42.00 | | clay with gravels. | | | - | | | $\left - \right $ | | | | | | | | | | | | | | |
| 235.253 | 45.00 | | | ┝── | <u> </u> | <u> </u> | | <u> </u> | - | | | | >50 | 41 | | | | | | | | | |
| 233.253 | 47.00 | | | | <u> </u> | L | | <u> </u> | Ļ | | | | >50 | 36 | ļ | | | | | | | | |
| 230.253 | 50.00 | | | <u> </u> | | | | | | | | | >50 | 29 | | | | | | | | | |
| 227.253 | 53.00 | | | | | | | | | | | | >50 | 22 | | | | | | | | | |
| 225.253 | 55. <u>00</u> | | | | | | | | | | | | >50 | 17 | | | | | | Ļ | | Ļ | |
| | | | | | | | | | | | | | | | | | | | | | | | - |

| | Geotechnical 3 | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW. | LTD. Ays | | G | eol | ogi | ca | l L | og | of I | Drill | Hol | e F | 8H-1 | 9 | | | | | 3 | S M CONSULTANTS AN ISO 0001 COMPANY BIUDANESHWAR |
|--|--------------------------------|-----------|--|-------------|------------------------------|---------------------------------|-----------------------|--------|---------------|--------------------------|---------------------------|-------------------------|-------------------|----------------------------------|-------------|-------|---------------------------------------|---|--------------------------------|--------------------------------|--------------|--------------------------|--|
| BORE HOLE N CHAINAGE (m COLLAR ELEV RAIL LEVEL START DATE ENDING DATE | io .) /Ation | | BH-19 26210 25-07-2021 25-07-2021 | | co-c groi Azim Angi | ORDIN UND E IUTH LE WI | ATES LEVA TH HO | Tion | X Y NTA | : 0 : 3 : 4 : - | 6997 3122 278.1 | 76.449 635.17 116 | 9 79 | | | | LOCA TOTA TYPE DEPT DRILL | TION L DEF OF C H OF LING A | I PTH ORE WAT AGEN | BARRI ER TA ICY OGIST | EL BLE (m | : : : : | Patuka 50m Double Tube Not found S.M. Consultants Gauray Chunekar |
| | | | | Si | ze of | Core | Piec | es | с | % ore-R | % of Reco | very | Star Pene T | ndard tration | | | E | | level | Wa | ater oss | | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 | 80 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq. | Casing | Depth of water | Partial | Complete | Colour of Retur Water | REMARK / OBSERVATIONS |
| 278.116 | | | | | | | | | | | | | | | | | | | | • | | • | General Description: This Borehole is |
| 277.616 | 0.50 | | | | | | | | | | | | | | - | | | | | | | | Located on the upland part of the Alignment on a ground elevation of 278.116 m. The stratigraphy of area is prominently of Silty |
| 276.616 | 1.50 | | | | | | | | | | | | 17 | 45 | - | | | | | | | | Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly tracked in the borehole. |
| 275.116 | 3.00 | | | | | | | | | | | | | | - | | | | | | | | |
| 273.616 | 4.50 | | | | | | | | | | | | 23 | 45 | | | | | | | | | |
| 272,116 | 6.00 | | | | | | | | | | | | | | | | | | | | | | |
| 260 116 | 0.00 | | | | | | | | | | | | 30 | 45 | | | | | | | | | |
| 203.110 | 3.00 | | | | | | | | | | | | | | | | | | | | | | |
| 266.116 | 12.00 | | Brown colour, fine grained,medium to dense compacted,clayey silt with none | | | | | | | | | | | | - | | | | | | | | |
| 263.116 | 15.00 | | to low plasticity | | | | | | | | | | 35 | 45 | | | | | | | | | |
| 260.116 | 18.00 | | | | | | | | | | | | | | | | | | | | | | |
| 257.116 | 21.00 | | | | | | | | | | | | 35 | 45 | | | | | sent | tial | | NMC | |
| | | | | | | | | | | | | | | | | | | | βþ | Pai | | BRO | |
| 254.116 | 24.00 | | | | | | | | | | | | 20 | 45 | | | | | | | | | |
| 251.116 | 27.00 | | | | | | | | | | | | | 40 | | | | | | | | | |
| 248.116 | 30.00 | | | | | | | | | | | | | | - | | | | | | | | |
| 245.116 | 33.00 | | | | | | | | | | | | 43 | 45 | | | | | | | | | |
| 242.116 | 36.00 | | | | | | | | | | | | | | | | | | | | | | |
| 239.116 | 39.00 | | | | | | | | | | | | 52 | 45 | | | | | | | | | |
| 236.116 | 42.00 | | Brown colour, fine grained, dense | | | | | | | | | | | | | | | | | | | | |
| 233.116 | 45.00 | | sand | | | | | | | | | | 65 | 45 | | | | | | | | | |
| 230.116 | 48.00 | | | | | | | | | | | | | | | | | | | | | | |
| 228.116 | 50.00 | | | | | | | | | | | | 80 | 45 | | | | | | | | | |

| Geotechnical Investigation Report | | | | | | | | | | | | |
|-----------------------------------|--------------|----------------------|--|--|--|--|--|--|--|--|--|--|
| Consultant: | | | Client : | | | | | | | | | |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | | | |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS RE OF GO | FUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW | I LTD. AYS | (| Ge | olc | gi | са | al Lo | g of | Dril | l Ho | le | BH | -20 | | | | | 3 | S M CONSULTANTS AN 150 9001 COMPANY BHUDANESHWAR | | | | | | |
|--|--------------------------------|-------------------|---|---|---|---|---|---|---|--|---------------------------------|-----------|----------------------------------|-------------|-------|---|---|--|--------------------------------|--------------|---|--|--|-----|------|--|----|--|
| BORE HOLE N CHAINAGE (m COLLAR ELEV RAIL LEVEL START DATE ENDING DATE | io .) /Ation | : : : : : | BH-20 26387 16-02-2021 25-03-2021 | | co-c groi Azim Angl | ORDIN UND E UTH _E WI | ATES LEVA TH HC | tion Rizo | X Y NTA | : 69 : 31 : 27 : : AL : | 9630.889 22738.22 6.795 m | 92 273 | | | | Loc. Tot, Type Dep" Dril NAM | ATION AL DE E OF C TH OF LING | I PTH ORE WAT AGEN GEOL | BARRI ER TAI CY OGIST | EL BLE (m | : | Patuka 48.00 m Absent S.M. Consultants Gaurav Chunekar | | | | | | |
| | | | | Si | ze of | Core | Piec | es | c | % o Core-Red | Standard Penetration Test | | | | ./ m | | r level | Wa Lo | ater oss | urned | | | | | | | | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 60 | 80 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq. | Casing | Depth of wate | Partial | Complete | Colour of Reti Water | REMARK / OBSERVATIONS | | | | | | |
| 276.795 | | | | | | | | | | | | | | | | | | | 1 | | 1 | General Description: This Borehole is Located on the upland part of the Alignment | | | | | | |
| 276.295 | 0.50 | | | | | | | | | | | 18 | 45 | | | | | | | | | on a ground elevation of 276.795 m. The stratigraphy of area is prominently of Silty Sand which comes under Alluvial Type of | | | | | | |
| 275.295 | 1.50 | | Brown Colour, Fine Grained, | | | | | | | | | | | | | | | | | | | Category. Silty Sand and Clay is majorly tracked in the borehole. | | | | | | |
| 273.795 | 3.00 | | medium to Dense Compacted , Clayey Silt with None to Low Plasticity | | | | | | | | | 32 | 45 | | | | | | | | | | | | | | | |
| 272.295 | 4.50 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 270.795 | 6.00 | | | - | | | | | | | | | | | | | | | | | | | | | | | | |
| 267.795 | 9.00 | | Denue Colour Fire Oreined | | | | | | - | | | 10 | | | | | | | | | | | | | | | | |
| 264.795 | 12.00 | | Dense Compacted, Silty Sand | | | | | | | | | | | | | | | | | | | | | | | | | |
| 261.795 | 15.00 | | | | | | | | | | | 60 | 45 | | | | | | | | | | | | | | | |
| 258.795 | 18.00 | | Brown Colour, Fine Grained, Very Dense Compacted, Clayey Silt with None to Low Plasticity | Brown Colour, Fine Grained, /ery Dense Compacted, Clayey Silt with None to Low Plasticity | Brown Colour, Fine Grained, Very Dense Compacted, Clayey Silt with None to Low Plasticity | Brown Colour, Fine Grained, Very Dense Compacted, Clayey Silt with None to Low Plasticity | Brown Colour, Fine Grained, Very Dense Compacted, Clayey Silt with None to Low Plasticity | Brown Colour, Fine Grained, Very Dense Compacted, Clayey Silt with None to Low Plasticity | Brown Colour, Fine Grained, Very Dense Compacted, Clayey Silt with None to Low Plasticity | | | | | | | | | | | | | | | ent | tial | | MN | |
| 255.795 | 21.00 | | | | | | | | | | | 67 | 45 | | | | | Abs | Par | | BRO | | | | | | | |
| 252.795 | 24.00 | | | | | | | | | | | 76 | 45 | | | | | | | | | | | | | | | |
| 249.795 | 27.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 246.795 | 30.00 | | | | | | | | | | | 58 | 45 | | | | | | | | | | | | | | | |
| 243.795 | 33.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 240.795 | 36.00 | | Brown Colour, Very Fine Grained, Hard Consistency, Silt | | | | | | | | | 67 | 45 | | | | | | | | | | | | | | | |
| 237 795 | 39.00 | | Grained, Hard Consistency, Sitt and Clay with low Compressibility | | | | | | | | | | | | | | | | | | | | | | | | | |
| 234 705 | 42.00 | | | | | | | | | | | 75 | 45 | | | | | | | | | | | | | | | |
| 207.100 | 4E 00 | | | | | | | | l | | | | | | | | | | | | | | | | | | | |
| 228.795 | 48.00 | | | | | | | | | | | 79 | 45 | | | | | | | | | | | | | | | |

| Geotechnical Investigation Report | | | | | | | | | | | | |
|-----------------------------------|--------------|----------------------|--|--|--|--|--|--|--|--|--|--|
| Consultant: | | | Client : | | | | | | | | | |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd | | | | | | | | | |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS RE OF GO | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW | I LTD. Ays | | Ge | olo | gi | cal | Lo | og (| of | Dril | l Ho | le | BH | -21 | | | | | 3 | S M CONSULTANTS AN ISO 9091 COMPANY BHUBANESHWAR | | | | |
|-------------|--------------------------------|-------------------|--|---------------------|---------------------------|---------|-------|-----|----------|------------|-------------|--------------|---------------------|--------------------------|-----------|------|-------------|-------|-------------|----------|--------------|----------------------|--|--|--|--|--|
| BORE HOLE N | o | : | 21 | | co-c | ORDIN | ATES | | x | : 69 | 99457 | 7.333 | | | | | LOC | ATIO | N | | | : | Patuka | | | | |
| CHAINAGE (m | .) | : | 26587 | | GRO | | | | Y | : 31 | 12283 | 37.40 2 m | 9 | | | | тот | | PTH | | | : 45 | | | | | |
| COLLAR ELEV | | | | | | AZIMUTH | | | | | | | | | | | | EOFO | ORE WAT | BARRE | EL BIF (m | : E (m) - Aba ant | | | | | |
| START DATE | RT DATE : 19-02-2021 | | | | ANGLE WITH HORIZONTAL : D | | | | | | | | | | | | DRIL | LING | AGEN | CY | DEE (II | | S.M. Consultants | | | | |
| ENDING DATE | | : | 28-03-2021 | | | | | | 1 | | | | | | | | NAN | IE OF | GEOL | OGIST | | : Gaurav Chunekar | | | | | |
| | | | | Size of Core Pieces | | | | | | % re-Re | of ecove | ery | Penetration Test | | | | m / # | | er level | Wa Lo | ater oss | turned | | | | | |
| vation (m) | oth (m) | 10-Log | Lithological Description | mm | 25mm | 75mm | 150mm | 0mm | | | | | alue | oth of hetration m | be of BIT | % O | icture Frec | sing | oth of wate | tial | nplete | our of Rei ter | REMARK / OBSERVATIONS | | | | |
| Ē | Del | Lit | | <u>5</u> | 10- | 25- | 75- | 15 | 20 | 40 | 8 | 100 | ² z | Del Per in c | Ţ, | Ra | Fra | ö | Del | Pai | Ī | ပီ နိ | | | | | |
| 274.993 | | 1 | | | I | 1 | 1 | | <u> </u> | | | | | | | | 1 | I | | | 1 | | General Description: This Borehole is | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | Located on the upland part of the Alignment | | | | |
| 274.493 | 0.50 | | | | | | | | | | | | 14 | 45 | | | | | | | | | on a ground elevation of 274.993 m. The stratigraphy of area is prominently of Silty Sand which comes under Alluvial Type of | | | | |
| 273.493 | 1.50 | | | | | | | | | | | | | | | | | | | | | | Category. Silty Sand and Clay is majorly tracked in the borehole. Fragmented and bouldered rock strata of | | | | |
| 271.993 | 3.00 | | | | | | | | | | | | 20 | 45 | | | | | | | | | Sandstone and Quartzite has also been noticed from 18.0m to 36.0m. However sandstone was more prominent in both of | | | | |
| 270.493 | 4.50 | | Brown Colour, Very Fine | | | | | | _ | | | | 20 | 40 | | | | | | | | | them. | | | | |
| 268.993 | 6.00 | | Compacted, Clayey Silt with none to Low Plasticity | | | | | | | | | | | | | | | - | | | | | | | | | |
| 265.993 | 9.00 | | | | | | | | | | | | 31 | 45 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 262.993 | 12.00 | | | | | | | | | | | | 38 | 45 | | | | | | | | | | | | | |
| 259.993 | 15.00 | | | | | | | | | | | | | .0 | | | | | | | | | | | | | |
| 256.993 | 18.00 | | Fragmented Rock Strata of Yeollwish Brown, Fine Grained, Hard to Medium Hard, Sandstone | | | | | | | 6 | | | | | | 4.50 | | | | | | | | | | | |
| 253.993 | 21.00 | | Fragmented Rock Strata of Yeollwish Brown, Medium to Coarse Grained, Hard Sandstone | | | | | | | 3.5 | | | | | | Nil | | | Absent | Partial | | BROWN | | | | | |
| 250.003 | 24.00 | | Fragmented Rock Strata of Yeollwish Brown, Fine Grained, Medium Hard, Sandstone | | | | | | | 4 | | | | | | Nil | | | | | | | | | | | |
| 247.993 | 27.00 | | Fragmented Rock Strata of Yeollwish Brown, Very Fine to Fine Grained, Medium Hard, Sandstone | | | | | | | 6 | | | | | | Nil | | | | | | | | | | | |
| 244.993 | 30.00 | | Fragmented Rock Strata of Very Fine to Fine Grained, Hard to Medium Hard, Sandstone and Qaurtzite | | | | | | | 9 | | | | | | Nil | | | | | | | | | | | |
| 241.993 | 33.00 | | Fragmented Rock Strata of Yeollwish Brown, Medium to Coarse Grained, Hard Sandstone | | | | | | | 6 | | | | | | Nil | | | | | | | | | | | |
| 238.993 | 36.00 | | Fragmented Rock Strata of Yeollwish Brown, Medium to Coarse Grained, Hard Sandstone | | | | | | | 4.6 | | | | | | Nil | | | | | | | | | | | |
| 235.993 | 39.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 232.993 | 42.00 | | Brown Coour, Very Fine Grained, Very dense Compacted, Clayey Silt with none to Low Plasticity | | | | | | | | | | 75 | 45 | | | | | | | | | | | | | |
| 229.993 | 45.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Geotechnical 3 | Investigation Repor | t |
|-------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS E OF GC | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILWA | LTD. Ays | | Ge | olc | ogi | са | al Lo | og | of | Dril | l Ho | le | BH | -22 | 2 | | | 1 | 6 | S M CONSUL/TANTS AN ISO 0001 COMPANY BHUBANESHWAR |
|---|--------------------------------|------------------|---|-------------|-----------------------------|---------------------------------|------------------------|--------|---------------|------------------------|--------------------------|------------------------|---------------|----------------------------------|-------------|-------|----------------------------------|---|------------------------------------|----------------------|---------------|-------------------------|---|
| BORE HOLE N CHAINAGE (m COLLAR ELEV RAIL LEVEL START DATE | io .) /Ation | | BH-22 26787 08-04-2021 11-04-2021 | | co-c gro Azin Angi | ORDIN UND E IUTH LE WI | ATES ELEVA TH HC | TION | X Y NTA | : 6 : 3 : 2 : | 59927 31229 274.32 | 3.757 16.53 21 m | 6 | | | | LOC TOT TYP DEP DRIL | CATION CAL DE E OF (PTH ON LLING | N EPTH CORE = WAT AGEN | BARR ER TA ICY | EL \BLE (r | : : n] : : | Patuka 45.00 m Absent S.M. Consultants Gauray Chungkar |
| | | | | Si | ze of | Core | Piec | es | c | % Core-R | 6 of ecov | ery | Stan Penet | ndard tration est | | | ε, | | level | W | ater .oss | rned . | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 80 | 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq. | Casing | Depth of water | Partial 🕨 | Complete | Colour of Retu Water | REMARK / OBSERVATIONS |
| 274.321 | | | Brown Colour, Very Fine | | | | | | 1 | | | | | | | | | | | | | 1 | General Description: This Borehole is |
| 273.821 | 0.50 | | Grained, Silt and Clay with Low Compressibility | | | | | | | | | | | | | | | | | | | | on a ground elevation of 274.321 m. The stratigraphy of area is prominently of Silty |
| 272.821 | 1.50 | | | | | | | | | | | | 15 | 45 | | | | | | | | | Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly tracked in the borehole. |
| 271.321 | 3.00 | | | | | | | | | | | | | | | | | | | | | | Fragmented and bouldered rock strata of Sandstone and Quartzite has also been noticed from 18 m. to 39 m. However |
| 269 821 | 4 50 | | Brown Colour, Fine Grained, Medium Compacted, Clayey Silt with none to Low Plasticity | | | | | | | | | | 21 | 45 | | | | | | | | | sandstone was more prominent in both of them. |
| 200.021 | 4.00 | | | | | | | | | | | | | | | | | | | | | | |
| 268.321 | 6.00 | | | | | | | | | | | | 28 | 45 | | | | | | | | | |
| 265.321 | 9.00 | | | | | | | | | | | | | | | | | | | | | | |
| 262.321 | 12.00 | | Gravels and Pebbles of Quartzite and Sanstone | | | | | | 1 | | | | | | | | | | | | | | |
| 200.021 | 10.00 | | | | | | | | | 3.0 | | | | | | Nil | | | | | | | |
| 256.321 | 18.00 | | Fragmented Rock Strata of Yeollwish Brown, Medium to | | | | | | | | | | | | | | | - | sent | tial | | NMC | |
| 050.004 | 04.00 | | Coarse Grained, Hard Sandstone | | | | | | | 2.3 | | | | | | Nil | | | Ab | Pai | | BRC | |
| 255.521 | 21.00 | | | | | | | | | 3.0 | | | | | | Nii | | | | | | | |
| 250.321 | 24.00 | | | | | | | | | 2.0 | | | | | | | | _ | | | | | |
| 247.321 | 27.00 | | | | | | | | | 2.0 | | | | | | Nil | | | | | | | |
| 244.321 | 30.00 | | Fragmented Rock Strata of Yeollwish Brown, Fine Grained, | | | | | | | 3.0 | | | | | | Nil | | | | | | | |
| 241.321 | 33.00 | | Hard Sandstone | | | | | | | 2.3 | | | | | | Nil | | | | | | | |
| 238.321 | 36.00 | | | | | | | | | 4.0 | | | | | | Nil | | | | | | | |
| 235 321 | 39.00 | | | | | | | Î | | 4.0 | | | | | | Nil | | | | | | | |
| 200.021 | 42.00 | | Brown Colour, Very Fine | | | | | | T | | | | | | | | | | | | | | |
| 232.321 | 42.00 | | and Clay with Low Compressibility | | | | | F | | | | | 91 | 45 | | | T | | | | | | |
| 229.321 | 45.00 | | | | | | | | | | | | | | | | | 1 | | ↓ | | . ↓ | |

| | Geotechnical 3 | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL II A JOINT VENTUR | NFRAS E OF GC | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW | LTD. Ays | (| Ge | olo | gio | cal | L | og |) of | Dril | ll Ho | ole | BH- | ·23 | | | | | 3 | S M CONSULTANTS AN ISO 0001 COMPANY BHUBANESHWAR |
|--|---------------------------------|---|--|-------------|------------------------------|---------------------------------|-----------------------|---------------|----------------|------------|-----------------------|---------------------------|-------------------|----------------------------------|-------------|-------|---|--|------------------------------------|-------------------------------|--------------|-------------------------|--|
| BORE HOLE N CHAINAGE (m COLLAR ELEV RAIL LEVEL START DATE ENDING DATE | io .) /Ation | : | Bh 23 26980 04-04-2021 06-04-2021 | | co-c groi Azim Angl | UND E UND E UTH LE WIT | ates Leva Th Ho | tion Rizoi | X Y NTAL | | 6990 3122 274.8 | 97.908 972.13 850 M | 8 38 | | | | LOCA TOTA TYPE DEPT DRILL NAME | ATION AL DEF OF C TH OF LING A E OF C | i ore i wat agen geolo | BARRI ER TA CY DGIST | EL BLE (m | :: | Patuka 45 m Absent S.M. Consultants Gaurav Chunekar |
| | | | | Si | ze of | Core | Piec | es | Co | ہ ore-F | % of Reco | very | Star Pene T | ndard tration est | | | m/ | | evel. | W L | ater oss | Irned | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 | 80 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq. | Casing | Depth of water | Partial | Complete | Colour of Retu Water | REMARK / OBSERVATIONS |
| 274.850 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | General Description: This Borehole is |
| 274.350 | 0.50 | | - | | | | | | | | | | - | | | | | | | | | | Located on the upland part of the Alignment on a ground elevation of 274.850 m. The stratigraphy of area is prominently of Silty |
| 273.350 | 1.50 | | Brown Colour, Very Fine | | | | | | | | | | 16 | 45 | | | | | | | | | Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly |
| 271 850 | 3.00 | | Grained, stiff to very stiff Consitency, Silt and Clay with | | | | | | | | | | | | | | | | | | | | tracked in the borehole. |
| | 0.00 | | Low Compressibilty | | | | | | | | | | 23 | 45 | | | | | | | | | |
| 270.350 | 4.50 | | - | | | | | | | | | | | | | | | | | | | | |
| 268.850 | 6.00 | | | | | | | | | | | | | | | | | | | | | | |
| 265.850 | 9.00 | | Brown Colour, Fine grained, Dense Compacted, Clayey Silt with None to Low Plasticity | | | | | | | | | | 34 | 45 | | | | | | | | | |
| | 10.00 | | | | | | | | | | | | | | | | | | | | | | |
| 259.850 | 12.00 | | Brown Colour, Very Fine Grained, Hard Consitency, Silt and Clay with Low Compressibilty | | | | | | | | | | 38 | 45 | | | | | | | | | |
| 256.850 | 18.00 | | | | | | | | | | | | | | | | | | Absent | Partial | | BROWN | |
| 253.850 | 21.00 | | Brown Colour, Fine grained, Dense Compacted, Silty Sand | | | | | | | | | | 50 | 45 | | | | | | | | | |
| 250.850 | 24.00 | | Brown Colour, Very Fine Grained, Silt and Clay with low Compressibility | | | | | | | | | | | | | | | | | | | | |
| 247.850 | 27.00 | | Brown Colour, Fine grained, Very Dense Compacted, Silty Sand | | | | | | | | | | 63 | 45 | | | | | | | | | |
| 244.850 | 30.00 | | Brown Colour, Fine Grained, Clayey Silt with None to Low Plasticity | | | | | | | | | | | | | | | | | | | | |
| 241.850 | 33.00 | | Brown Colour, Very Fine Grained, Hard Consistency, Silt and Clay with low | | | | | | | | | | 73 | 45 | | | | | | | | | |
| 238.850 | 36.00 | | Brown Colour, Fine grained, Silty Sand | | | | | | | | | | | | | | | | | | | | |
| 235.850 | 39.00 | | Brown Colour, Very Fine | | | | | | | | | | 77 | 45 | | | | | | | | | |
| 232.850 | 42.00 | | Grained, Hard Consistencey, Silt and Clay with low Compressibility | | | | | | | | | | | | | | | | | | | | |
| 229.850 | 45.00 | | | | | | | | | | | | 85 | 45 | | | | | | | | | |

| | Geotechnical | Investigation Repor | t |
|-------------|---------------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTU | INFRAS RE OF GO | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILWA | I LTD. Ays | | Ge | olo | gi | cal | Lo | og | of | Dril | ll Ho | ole | BH | -24 | ļ | | | | 3 | S M CONSULTANTS AN 180 0001 COMPANY BHUBANESHWAR |
|--------------|-------------------------------|--------------------|---|---------------|---------|---------|----------|--------|------|------------|------------|-----------|-------------------|----------------------------------|-------------|-------|---------------|--------|--------------|---------|-------------|-----------------------|---|
| BORE HOLEN | 0 | | BH-24 | | co-0 | | ATES | | x | . 6 | 59888 | 85.647 | 7 | | | | 100 | | J | | | | Patuka |
| CHAINAGE (m | .) | : | 27187 | | 00 0 | | | | Ŷ | : 3 | 31230 | 009.68 | 31 | | | | тот | AL DE | • PTH | | | : | 40.00 m |
| COLLAR ELEV | ATION | : | | | GRO | UND E | LEVA | TION | | : 2 | 274.0 | 75 M | | | | | TYP | EOFO | ORE | BARRI | EL | : | |
| RAIL LEVEL | | : | | | AZIN | IUTH | | | | : | | | | | | | DEP | TH OF | WAT | ER TA | BLE (m | :) | Absent |
| START DATE | | : | 04-04-2021 | | ANG | LEWI | тн но | RIZO | NTAL | : | | | | | | | DRIL | | | CY | | : | S.M. Consultants |
| | | | | Si | ze of | Core | Piec | es | Co | % ore-R | of ecov | very | Star Pene T | ndard tration est | | | t. / m | | er level | W: | ater oss | turned . | |
| Elevation (m | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 | 80 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Free | Casing | Depth of wat | Partial | Complete | Colour of Re Water | REMARK / OBSERVATIONS |
| 274.075 | | | | | | | | | | | | | | | | | | | | | | | |
| 273.575 | 0.50 | | | | | | | | | | | | | | _ | | | | | | | | General Description: This Borehole is Located on the upland part of the Alignment on a ground elevation of 274.075 m. The stratigraphy of area is prominently of Silty |
| 272.575 | 1.50 | | | | | | | | | | | | 14 | 45 | | | | | | | | | Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly |
| 271.075 | 3.00 | | | | | | | | | | | | | | | | | | | | | | tracked in the borehole. |
| 269 575 | 4 50 | | | | | | | | | | | | 21 | 45 | | | | | | | | | |
| 200.010 | 4.50 | | Brown Colour, Fine Grained, Medium to dense Compacted, | | | | | | | | | | | | | | | | | | | | |
| 268.075 | 6.00 | | Clayey Silt with None to Low Plasticity | | | | | | | | | | | | - | | | - | | | | | |
| 265.075 | 9.00 | | | | | | | | | | | | 27 | 45 | _ | | | | | | | | |
| 262.075 | 12.00 | | | | | | | | | | | | | | | | | | | | | | |
| 259.075 | 15.00 | | | | | | | | | | | | 33 | 45 | | | | | Ŧ | | | z | |
| 256.075 | 18.00 | | | | | | | | | | | | | | | | | | Absen | Partia | | BROWI | |
| 253.075 | 21.00 | | | | | | | | | | | | 43 | 45 | | | | | | | | | |
| 250.075 | 24.00 | | | | | | | | | | | | | | | | | | | | | | |
| 247.075 | 27.00 | | | | | | | | | | | | 58 | 45 | | | | | | | | | |
| 244.075 | 30.00 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Brown Colour, Very Fine Grained, Hard Consistency, Silt and Clay with low | | | | | | | | | | 72 | 45 | | | | | | | | | |
| 241.075 | 33.00 | | Compressibility | | | | | | - | | | | | | | | | | | | | | |
| 238.075 | 36.00 | - | | | | | | | - | | | | _ | | - | | _ | - | | | | | |
| 235.075 | 39.00 | | | | | | | | | | | | 89 | 45 | | | | | | | | | |
| 232.075 | 40.00 | | | | | | | | | | | | | | | | | | | | | | |

| | Geotechnical | Investigation Repor | t |
|-------------|---------------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL II A JOINT VENTUR | NFRAS E OF GC | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW | I LTD. Ays | | Ge | olo | gio | cal | L | og | of | Dril | l Ho | ole | BH | -25 |) | | | | 3 | S M CONSULTANTS AN ISO 9001 COMPANY BHUBANESHWAR |
|--------------|---------------------------------|------------------|--|---------------|---------|---------|----------|--------|------|------------|--------------|-----------|-------------------|----------------------------------|-------------|-------|---------------|--------|--------------|-------------|-------------|-----------------------|--|
| BORE HOLE N | 0 | : | BH-25 | | co-c | ORDIN | ATES | | x | . 6 | 6986 | 66.173 | 3 | | | | LOC | | N | | | : | Patuka |
| CHAINAGE (m. | .) | : | 27410 | | | | | | Y | : 3 | 3123 | 023.03 | 37 | | | | тот | AL DE | PTH | | | : | 40.00 m |
| COLLAR ELEV | ATION | : | | | GRO | UND E | LEVA | TION | | : 2 | 273.5 | 565 m | | | | | TYP | EOFO | ORE | BARR | EL | : | |
| RAIL LEVEL | | : | | | AZIM | IUTH | | | | : | | | | | | | DEP | TH OF | WAT | ER TA | BLE (m |) : | Absent |
| START DATE | | : | 12-04-2021 14-04-2021 | | ANG | | нно | RIZOI | NIAL | . : | | | | | | | DRIL | LING | AGEN GEOL | CY OGIST | | : | S.M. Consultants Gauray Chunekar |
| | | | | Si | ze of | Core | Piec | æs | Co | % ore-R | % of Reco | very | Star Pene T | ndard tration est | | | q. / m | | er level | W L | ater oss | turned | |
| Elevation (m | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 | 80 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Free | Casing | Depth of wat | Partial | Complete | Colour of Re Water | REMARK / OBSERVATIONS |
| 273.565 | | | 1 | | | | | | | | | | 1 | | | | | | | | | | |
| 273.065 | 0.50 | | | | | | | | | | | | | | | | | | | | | | General Description: This Borehole is Located on the upland part of the Alignment on a ground elevation of 273.565 m. The attrictional of a promised by a failure |
| 272.065 | 1.50 | | | | | | | | _ | | | | 13 | 45 | | | | | | | | | Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly |
| 270.565 | 3.00 | | | | | | | | | | | | | | | | | | | | | | tracked in the borehole. |
| 202.005 | 4.50 | | | | | | | | | | | | 20 | 45 | | | | | | | | | |
| 209.000 | 4.30 | | | | | | | | | | | | | | | | | | | | | | |
| 267.565 | 6.00 | | | | | | | | | | | | | | - | | | - | | | | | |
| 264.565 | 9.00 | | | | | | | | | | | | 30 | 45 | | | | | | | | | |
| 261.565 | 12.00 | | - | | | | | | | | | | | | - | | | - | | | | | |
| 258.565 | 15.00 | | Brown Colour, Very Fine | | | | | | | | | | 31 | 45 | | | | | t. | | | N | |
| 255.565 | 18.00 | | Grained, stiff to Hard Consistency, Silt and Clay with low Compressibility | | | | | | _ | | | | | | | | | | Abser | Partie | | BROW | |
| 252.565 | 21.00 | | | | | | | | | | | | 33 | 45 | | | | | | | | | |
| 249.565 | 24.00 | | | | | | | | | | | | | | | | | | | | | | |
| 246.565 | 27.00 | | | | | | | | | | | | 48 | 45 | | | | | | | | | |
| 243.565 | 30.00 | | | | | | | | | | | | | | | | | | | | | | |
| 040 505 | | | 1 | | | | | | | | | | 68 | 45 | | | | 1 | | | | | |
| 240.565 | 33.00 | | | | - | | | - | | | | | | | | | | | | | | | |
| 237.565 | 36.00 | | - | | | | | | - | | | | | | | | | | | | | | |
| 234.565 | 39.00 | | | | | | | | | | | | 81 | 45 | | | | | | | | | |
| 231.565 | 40.00 | | | | | | | | | | | | | | | | | | | | | | |

| | Geotechnical 3 | Investigation Repor | t |
|-------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS E OF GO | TRUCTURE DEVELOPMENT CORPORATION VVERNMENT OF HARYANA AND MINISTRY OF RAILW | I LTD. Ays | | Ge | olo | ogi | cal | L | og | of | Dril | l Ho | ole | BH | -26 | | | | | (小) | S M CONSUL/TANTS AN ISO 4001 COMPANY BHUBANESHWAR |
|--|--------------------------------|------------------|---|---------------|----------------------------|---------------------------------|--------------|--------|----------------|------------|-----------------------|--------------------------|-------------------|----------------------------------|-------------|-------|--------------------------------------|---|------------------------------------|-----------------------|---------------|-------------------------|---|
| BORE HOLE N CHAINAGE (m. COLLAR ELEV RAIL LEVEL START DATE | o .) 'Ation | | BH-26 26880 12-04-2021 | | co-c gro Azin Ang | ORDIN UND E IUTH LE WI | ATES LEVA | TION | X Y NTAL | | 6985 3123 273.1 | 26.193 024.41 12 M | 9 | | | | LOCA TOTA TYPE DEPT DRIL | ATION AL DE E OF C TH OF LING | N PTH Core I Wati Agen | BARRE ER TAE CY | EL BLE (m) | : : | Patuka 35.00 m Absent S.M. Consultants |
| ENDING DATE | | : | 14-04-2021 | Si | ze of | Core | Piec | es | Co | ہ ore-F | % of Reco | very | Star Pene T | ndard tration est | | | NAM u | E OF | | OGIST Wa Lo | ater oss | irned : | Gaurav Chunekar |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 | 80 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq. | Casing | Depth of water | Partial | Complete | Colour of Retu Water | REMARK / OBSERVATIONS |
| 273.112 272.612 | 0.50 | | | | | | | | | | | | | | | | | | | 1 | | | General Description: This Borehole is Located on the upland part of the Alignment on a ground elevation of 273.565 m. The |
| 271.612 | 1.50 | | - | | | | | | | | | | 11 | 45 | | | | | | | | | stratigraphy of area is prominently of Silty Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly |
| 270.112 | 3.00 | | - | | | | | | | | | | | | | | | | | | | | tracked in the borenole. |
| 268.612 | 4.50 | | - | | | | | | | | | | 19 | 45 | | | | | | | | | |
| 267.112 | 6.00 | | - | | | | | | | | | | | | | | | | | | | | |
| 264.112 | 9.00 | | - | | | | | | | | | | 28 | 45 | | | | | | | | | |
| 261.112 258.112 | 12.00 | | Brown Colour, Very Fine Grained,stiff to Hard Consistency, Silt and Clay with | | | | | | | | | | 34 | 45 | | | | | Absent | Partial | | BROWN | |
| 255.112 | 18.00 | | low Compressibility | | | | | | | | | | | | | | | | | | | | |
| 252.112 | 21.00 | | - | | | | | | | | | | 41 | 45 | - | | | | | | | | |
| 249.112 | 24.00 | | | | | - | | - | | | | | 50 | | | | | | | | | | |
| 246.112 | 27.00 | | | | | | | - | | | | | 53 | 45 | | | | | | | | | |
| 243.112 | 30.00 | | | | | | | | | | | | 6F | AE | | | | | | | | | |
| 240.112 | 33.00 | | | | | | | | | | | | 60 | 45 | | | | | | | | | |
| 237.112 | 35.00 | | | | | | | | | | | | | | | | | | | | | | |

| | Geotechnical 3 | Investigation Repor | t |
|-------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS RE OF GO | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW | I LTD. AYS | | Ge | olo | ogio | cal | L | og | of | Dril | l Ho | le | BH | -27 | | | | | 3 | S M CONSULTANTS AN ISO 9001 COMPANY BHUBANESHWAR |
|--|--------------------------------|---|---|---------------|-----------------------------|------------------------|------------------------|---------------|----------------|-------------------|------------------------------------|-------------------------|--------------------|---------------------------------|-------------|-------|---|---|---|------------------------------|--------------|-----------------------|---|
| BORE HOLE N CHAINAGE (m COLLAR ELEV RAIL LEVEL START DATE ENDING DATE | io .) /ATION | : | BH 27 28050 14-04-2021 16-04-2021 | | co-c gro Azim Angi | UND E IUTH LE WI | ATES ELEVA TH HO | tion Rizoi | X Y NTAL | : 0 : 2 : - | 5980: 3123(272.2 90° | 26.203 029.18 210 | 3 | | | | Loc Tot, Typi Dep Dril NAM | ATION AL DE E OF C TH OF LING | N PTH CORE WAT AGEN GEOL | BARR ER TA CY OGIST | EL BLE (m | : : : : | Patuka 30.00 m Absent S.M. Consultants Gaurav Chunekar |
| - | | | | Si | ze of | Core | Piec | es | Co | % ore-R | 6 of leco | very | Star Pene To | ndard tration est | | | q. / m | | er level | W L | ater oss | turned | |
| Elevation (m | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 09 | 100 | N Value | Depthof Penetration in cm | Type of BIT | RQD % | Fracture Fre | Casing | Depth of wat | Partial | Complete | Colour of Re Water | REMARK / OBSERVATIONS |
| 272.210 | | - | | | | | | | | | • | | - | | | | | - | | - | | | Description This Description |
| 271.710 | 0.50 | | | | | | | | | | | | | | | | | | | Î | | Î | General Description: This Borehole is Located on the upland part of the Alignment on a ground elevation of 272.210. The stratigraphy of area is promised to 6 Situ |
| 270.710 | 1.50 | | | | | | | | | | | | 14 | 45 | | | | | | | | | Standyraphy of area is prominency of only Sand which comes under Alluvial Type of Category. Silty Sand and Sandy Clay is majority tracked in the borehole |
| 269.210 | 3.00 | | | | | | | | | | | | | | | | | | | | | | |
| 267.710 | 4.50 | | Brown Colour, Fine grained, Low Dense to Medium Densed | | | | | | | | | | 24 | 45 | | | | | | | | | |
| 266.210 | 6.00 | | Compactness, Silty Sand | | | | | | | | | | | | | | | | | | | | |
| 263.210 | 9.00 | | | | | | | | | | | | 27 | 45 | | | | | | | | | |
| 260.210 | 12.00 | | | | | | | | | | | | | | | | | | ant | ial | | NW | |
| 257.210 | 15.00 | | | | | | | | | | | | 36 | 45 | | | | | Abs | Part | | BRO | |
| 254.210 | 18.00 | | Brown Colour, Very Fine to Fine Grained, Hard Consitency, Sand | | | | | | | | | | | | | | | | | | | | |
| 251,210 | 21.00 | | and Clay with Low Compressibilty | | | | | | | | | | 45 | 45 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 248.210 | 24.00 | | | | | | | | <u> </u> | | | | | | | | | | | | | | |
| 245.210 | 27.00 | | Brown Colour, Very Fine to Fine Grained, Hard Consitency, Sand | | | | | | | | | | 54 | 45 | | | | | | | | | |
| | | | and Clay with Low Compressibilty | | | | | | | | | | | | | | | | | | | | |
| 242.210 | 30.00 | | 1 | | | | | | | | | | | | | | | | | | | • | |

| | Geotechnical C | Investigation Repor | t |
|---------------------------------|----------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW | I LTD. Ays | | Ge | olo | gio | ca | IL | _0 | go | of | Dril | l Ho | ole | BH | -28 | ; | | | | 3 | S M CONSULTANTS AN ISO 9001 COMPANY BHUDANESHWAR |
|--|--------------------------------|---|---|---------------|-----------------------------|-------------------------|------------------------------------|---------------|--------|-----|------------------------------|----------------------------|--------------|---------------------|----------------------------------|-------------|-------|--|---|--|-------------------------------|--------------|-------------------------|--|
| BORE HOLE N CHAINAGE (m COLLAR ELEV RAIL LEVEL START DATE ENDING DATE | io .) /Ation | : | BH-28 27680 04-04-2021 08-04-2021 | | co-c gro Azim Angi | UND E IUTH LE WIT | ATES LEVA ⁻ TH HO | tion Rizoi | X Y | : | 697 312 272 90° | 7726 2303 2.799 。 | 217 2.039 | 9 | | | | Loc Tot Typi Dep Dril NAM | ATIO AL DE E OF (TH OF LING IE OF | N EPTH CORE WAT AGEN GEOL | BARRI ER TA CY OGIST | EL BLE (n | : :] : : | Patuka 45.00 m Absent S.M. Consultants Gaurav Chunekar |
| | | | | Si | ze of | Core | Piec | es | С | ore | % o -Rec | of cove | ry | Stan Penet Te | idard tration ∋st | | | / m | | level | W L | ater oss | rned | |
| Elevation (m) | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 | 80 | 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq. | Casing | Depth of water | Partial | Complete | Colour of Retu Water | REMARK / OBSERVATIONS |
| 272.799 | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | General Description: This Borehole is Located on the upland part of the Alignment |
| 272.299 | 0.50 | | | | | | | | | | | | _ | 10 | 45 | | | | | | | | | on a ground elevation of 272.799 m. The stratigraphy of area is prominently of Silty Sand which comes under Alluvial Type of |
| 271.299 | 1.50 | | | | | | | | | | | | | 12 | 45 | | | | - | | | | | Category. Silty Sand and Clay is majorly tracked in the borehole. |
| 269.799 | 3.00 | | | | | | | | | | | | | | | | | | | | | | | |
| 268.299 | 4.50 | | | | | | | | | | | | | 21 | 45 | | | | | | | | | |
| 266 799 | 6.00 | | Brown Colour, Fine grained, Low Dense to Medium Densed | | | | | | | | | | | | | | | | | | | | | |
| 200.733 | 0.00 | | Compactness, Only Cana | | | | | | | | | | | 28 | 45 | | | | | | | | | |
| 263.799 | 9.00 | | | | | | | | | | | | | | | | | | | | | | | |
| 260.799 | 12.00 | | | | | | | | | | | | | | | | | | - | | | | | |
| 257.799 | 15.00 | | | | | | | | | | | | | 38 | 45 | | | | | | | | | |
| 254.799 | 18.00 | | | | | | | | | | | | | | | | | | | Absen | - Partia | | BROW | |
| 251.799 | 21.00 | | | | | | | | | | | | | 47 | 45 | | | | | | | | | |
| 248.799 | 24.00 | | Brown Colour, Fine Grained, | | | | | | | | | | | | | | | | | | | | | |
| 245 700 | 27.00 | | with Low Compressibility. | | | | | | | | | | | 53 | 45 | | | | | | | | | |
| 245.155 | 27.00 | | | | | | | | | | | | | | | | | | | | | | | |
| 242.799 | 30.00 | | | | | | | | | | | | | 70 | 45 | | | | | | | | | |
| 239.799 | 33.00 | | | | | | | | | | | | _ | 70 | 45 | | | - | | | | | | |
| 236.799 | 36.00 | | | | | | | | | | | | | | | | | | | | | | | |
| 233.799 | 39.00 | | Hard Consitency, Sand and Clay with Low Compressibility. | | | | | | | | | | | 81 | 45 | | | | | | | | | |
| 230.799 | 42.00 | | | | | | | | | | | | | | | | | | | | | | | |
| 227 799 | 45 00 | | | | | | | | | | | | | 92 | 45 | | | | 1 | | | | | |

| | Geotechnical | Investigation Repor | t |
|-------------|---------------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS E OF GO | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW | LTD. AYS | (| Ge | olo | gio | ca | al Log | of | Dri | ll Ho | ole | BH | -29 |) | | | | 3 | S M CONSULTANTS AN 180 0001 COMPANY BHUBANESHWAR |
|--|--------------------------------|------------------|---|-------------|------------------------------|----------------------------------|-----------------------|--------|---------------|---|------------------------|-------------------|-------------------------|-------------|-------|---|---|--|--------------------------------|--------------|-----------------------|---|
| BORE HOLE N CHAINAGE (m COLLAR ELEV RAIL LEVEL START DATE ENDING DATE | o .) Vation | :: | BH-29 28550 17-04-2021 18-04-2021 | | co-o grou Azim Angl | DRDIN/ UND E UTH _E WIT | ates Leva Th ho | Tion | X Y NTA | : 69752 : 31230 : 269.96 : AL : 90° | 6.227 34.05 54 m | 7 | | _ | | Loc Tot Typ Dep Drii NAM | ATION AL DE E OF C TH OF LING | N PTH CORE WAT AGEN <u>GEOL</u> | BARRE ER TAI CY OGIST | EL BLE (m | : : | Patuka 30.00 m Absent S.M. Consultants Gaurav Chunekar |
| | | | | Si | ze of | Core | Piec | es | с | % of Core-Recov | ery | Star Pene T | ndard tration est | | | q. / m | | ter level | Wa Lo | ater oss | eturned | |
| Elevation (m | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 6 0 8 | 100 | N Value | Depth of Penetration | Type of BIT | RQD % | Fracture Fre | Casing | Depth of wat | Partial | Complete | Colour of Re Water | REMARK / OBSERVATIONS |
| 269.964 | | | 1 | | | | 1.5 | ~ | | | | | | | | _ | - | | | | | |
| 269.464 | 0.50 | | | | | | | | | | | | | _ | | | | | | | | General Description: This Borehole is Located on the upland part of the Alignment on a ground elevation of 269.964 m. The stratigraphy of area is promipantly of Sitty |
| 268.464 | 1.50 | | | | | | | | | | | 12 | 45 | | | | | | | | | Sandigraphy of acta is promittening of only Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly tracked in the herebole |
| 266.964 | 3.00 | | | | | | | | | | | | | | | | | | | | | tracked in the borehole. |
| 265.464 | 4.50 | | Brown Colour, Very Fine | | | | | | | | | 24 | 45 | | | | | | | | | |
| 263.964 | 6.00 | | Grained, Hard Consistency, Silt and Sand with low Compressibility. | | | | | | | | | | | | | | | | | | | |
| 260.964 | 9.00 | | | | | | | | | | | 27 | 45 | | | | | | | | | |
| 257.964 | 12.00 | | | | | | | | | | | | | | | | | nt | al | | NN | |
| | | | | | | | | | | | | 38 | 45 | | | | | Abse | — Parti | | BROV | |
| 254.964 | 15.00 | | | | | | | | | | | | | | | | | | | | | |
| 251.964 | 18.00 | | | | | | | | | | | | | | | | | | | | | |
| 248.964 | 21.00 | | | | | | | | | | | 47 | 45 | | | | | | | | | |
| 245.964 | 24.00 | | Brown Colour, Very Fine Grained, Hard Consistency, Silt and Clay with low | | | | | | | | | | | | | | | | | | | |
| | | | outhroadminty | | | | | | | | | 61 | 45 | | | | | | | | | |
| 242.964 | 27.00 | | | | | | | | | | | | | | | | | | | | | |
| 239.964 | 30.00 | | | | | | | | | | | | | | | | | | ¥ | | ↓ | |

| | Geotechnical | Investigation Repor | t |
|-------------|---------------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| на | RYANA RAIL I A JOINT VENTUR | INFRAS RE OF GC | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILW | LTD. AYS | | Ge | olc | ogio | cal | l Lo | bg | of | Dril | l Ho | ole | BH- | 30 | | | | | 8 | S M CONSULTANTS |
|--|--------------------------------|---|---|-------------|----------------------------|---------------------------------|------------------------|----------------|----------------|------------------------|---------------------------------|------------------------|-------------------|----------------------------------|-------------|-------|---|---|---|--------------------------------|--------------|--------------------------|---|
| BORE HOLE N CHAINAGE (m COLLAR ELEV RAIL LEVEL START DATE ENDING DATE | io .) /ATION | : | BH-30 28750 17-04-2021 19-04-2021 | | co-c gro Azin Ang | ORDIN UND E IUTH LE WI | ATES ELEVA TH HC | TION ORIZO1 | X Y NTAL | : 6 : 3 : 2 : | 9732 1230 70.80 0° | 6.462 43.28)8 m | 6 | | | | LOCA TOTA TYPE DEPT DRILI NAMI | ATION AL DE E OF C TH OF LING | N PTH ORE I WAT AGEN GEOLO | BARRE ER TAI CY OGIST | EL BLE (m | : : : 1) : : | Patuka 45.00 m Absent S.M. Consultants Gaurav Chunekar |
| | | | | Si | ze of | Core | Piec | es | Co | % ore-Re | of ecov | ery | Star Pene T | ndard tration est | | | / m | | r level | Wa Lo | ater oss | urned | |
| B08 022 | Depth (m) | Litho-Log | Lithological Description | < 10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 60 80 | 100 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Freq. | Casing | Depth of wate | Partial | Complete | Colour of Retu | REMARK / OBSERVATIONS |
| 270.308 | 0.50 | | _ | | | | | | | | | | | | | | | | | 1 | | 1 | General Description: This Borehole is Located on the upland part of the Alignment on a ground elevation of 270.808 m. The |
| 269.308 | 1.50 | | Brown Colour, Von Eine | | | | | | | | | | 17 | 45 | | | | | | | | | stratigraphy of area is prominently of Silty Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly |
| 267.808 | 3.00 | | Grained, Hard Consistency, Silt and Sand with low | | | | | | | | | | | | | | | | | | | | tracked in the borehole. |
| 266.308 | 4.50 | | Compressionity. | | | | | | | | | | 22 | 45 | | | | | | | | | |
| 264.808 | 6.00 | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | 30 | 45 | | | | | | | | | |
| 261.808 | 9.00 | | | | | | | | | | | | | | - | | | | | | | | |
| 258.808 | 12.00 | | Brown Colour, Ven/ Fine | | | | | | | | | | | | | | | | | | | | |
| 255.808 | 15.00 | | Grained, Hard Consistency, Silt and Clay with low Compressibility | | | | | | | | | | 38 | 45 | | | | | | | | | |
| 252.808 | 18.00 | | | | | | | | | | | | | | | | | | | | | | |
| 249.808 | 21.00 | | | | | | | | | | | | 44 | 45 | | | | | Vbsent | artial | | ROWN | |
| | | | | | | | | | | | | | | | | | | | 1 | | | | |
| 246.808 | 24.00 | | Brown Colour, Very Fine Grained, Hard Consistency, Silt and Sand with low | | | | | | | | | | 56 | 45 | - | | | | | | | | |
| 243.808 | 27.00 | | Compressibility. | | | | | | | | | | | | | | | | | | | | |
| 240.808 | 30.00 | | | | | | | | | | | | | | - | | | | | | | | |
| 237.808 | 33.00 | | | | | | | | | | | | 64 | 45 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 234.808 | 36.00 | | Brown Colour, Very Fine | | | | | | | | | | | | | | | | | | | | |
| 231.808 | 39.00 | | and Clay with low Compressibility | | | | | | | | | | 73 | 45 | | | | | | | | | |
| 228.808 | 42.00 | | | | | | | | | | | | | | | | | | | | | | |
| 225.808 | 45.00 | | | | | | | | | | | | 84 | 45 | | | | | | | | | |

| G | Geotechnical | Investigation Repor | t |
|-------------|---------------------|----------------------|--|
| Consultant: | | | Client : |
| BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HAI | RYANA RAIL A JOINT VENTU | INFRAS RE OF GO | TRUCTURE DEVELOPMENT CORPORATION Vernment of Haryana and Ministry of Railw | <mark>I LTD.</mark> Ays | | Ge | olo | ogio | cal Log of | Dri | ll Ho | le | BH- | 31 | | | | | 3 | S M CONSULTANTS AN ISO 0001 COMPANY BHUDANESHWAR |
|--------------|-----------------------------|--------------------|---|----------------------------|---------|---------|-------------|--------|-----------------------|------------------|----------------------------------|-------------|-------|--------------|--------|--------------|----------|-------------|-----------------------|---|
| BORF HOLEN | 0 | | BH-31 | | CO-0 | | ATES | | χ · 697028.61 | 7 | | | | | TION | | | | | Patuka |
| CHAINAGE (m. | .) | | 29050 | | | | | | γ <u>3123078.4</u> | 75 | | | | τοται | DEP | тн | | | | 20.00 m |
| COLLAR ELEV | , ATION | ÷ | | | GRO | UND E | LEVA | TION | 267.159 m | | | | | TYPE | OF CO |) REF | BARRE | 1 | | |
| RAIL LEVEL | | : | | | AZIM | IUTH | | | | | | | | DEPTH | IOFV | VATE | R TAE | - BLE (m | 1 : | Absent |
| START DATE | | : | 19-04-2021 | | ANG | LEWI | гн но | RIZOI | NTAL : 90° | | | | | Drilli | ING A | GEN | CY | | : | S.M. Consultants |
| ENDING DATE | | : | 19-04-2021 | | | | | | | | | | | NAME | OF GI | EOLO | ogist | | : | Gaurav Chunekar |
| 9 | | | | Si | ze of | Core | Piec | es | % of Core-Recovery | Sta Pene T | ndard etration est | | | q. / m | | ter level | Wa Lo | iter iss | sturned | |
| Elevation (m | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 40 60 80 | N Value | Depth of Penetration in cm | Type of BIT | RQD % | Fracture Fre | Casing | Depth of wat | Partial | Complete | Colour of Re Water | REMARK / OBSERVATIONS |
| 267.159 | | 1 | ſ | 1 | | | | 1 | | | | | | | | | | | | |
| 266.659 | 0.50 | | | | | | | | | | | | | | | | | | | General Description: This Borehole is Located on the upland part of the Alignment on a ground elevation of 267.159 m. The |
| 265.659 | 1.50 | | | | | | | | | 16 | 45 | | | | | | | | | stratigraphy of area is prominently of Silty Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly |
| 264.159 | 3.00 | | | | | | | | | | | | | | | | | | | tracked in the borehole. |
| 262.659 | 4.50 | | Brown Colour, Very Fine | | | | | | | 23 | 45 | | | | | | | | | |
| 261.159 | 6.00 | | Grained, Hard Consistency, Silt and Sand with low | | | | | | | | | | | | | | | | | |
| 050 (50 | | | | | | | | | | 32 | 45 | | | | | Absent | artial — | | ROWN | |
| 258.159 | 9.00 | | | | | | | | | | | | | | | | | | | |
| 255.159 | 12.00 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | 40 | 45 | | | | | | | | | |
| 252.159 | 15.00 | | | | | | | | | | | | | | | | | | | |
| 249.159 | 18.00 | | Brown Colour, Very Fine Grained, Hard Consistency, Silt | | | | | | | | | | | | | | | | | |
| 247.159 | 20.00 | | and Clay with low Compressibility | | | | | | | 51 | 45 | | | | | | | | • | |

| | Geotechnical | Investigation Repor | t |
|---------------------------------|--------------|----------------------|--|
| Consultant: | | | Client : |
| S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

| HA | RYANA RAIL I A JOINT VENTUR | NFRAS E OF GC | TRUCTURE DEVELOPMENT CORPORATION VERNMENT OF HARYANA AND MINISTRY OF RAILWA | LTD. Ays | | Ge | olc | ogi | ca | l L | og | of | Dri | ll Ho | ole | BH | -32 | 2 | | | | 3 | S M CONSULTANTS AN ISO 9001 COMPANY BHUDANESHWAR |
|--------------|--------------------------------|------------------|--|-------------|----------|-------|-------|-------|----------|------------|--------------|----------|------------------|-------------------------|---------|----|--------|---------|-----------|----------|-------------|---------|---|
| | • | | DU 22 | | <u> </u> | | | | v | | 6965 | 42.399 |) | | | | 1.00 | | | | | | Patuka |
| CHAINAGE (m. | 0) | | 29550 | | 00-0 | KUIN | AIES | | Ŷ | | 3123 | 193.28 | 37 | | | | тот | | і РТН | | | : | 30.00 m |
| COLLAR ELEV | ATION | | | | GRO | UND E | LEVA | TION | | | 266.6 | 684 m | | | | | TYP | EOFC | ORE | BARRE | EL | | |
| RAIL LEVEL | | : | | | AZIM | UTH | | | | | | | | | | | DEP | THOF | WAT | ER TA | BLE (m | 1 : | Absent |
| START DATE | | : | 19-04-2021 | | Angl | EWI | тн но | orizo | NTA | L : 1 | 90° | | | | | | DRIL | LING | AGEN | СҮ | `` | : | S.M. Consultants |
| ENDING DATE | | : | 20-04-2021 | | | | | | - | | | | | | | 1 | NAN | IE OF (| GEOL | OGIST | | : | Gaurav Chunekar |
| 6 | | | | Sia | ze of | Core | Piec | ces | с | % ore-F | % of Reco | very | Sta Pene 1 | ndard tration est | | | q. / m | | ter level | Wa Lo | ater oss | eturned | |
| <u>ل</u> | 2 | 5 | Lithological Description | | | | ۶ | | | | | | | 5 | ВΙΤ | | Fre | | val | | | f R | REMARK / OBSERVATIONS |
| tior | E) | Ļ | | ε | шш | ш | Dmr | Ę | | | | | e | of ratio | of | % | ure | Ð | l of | = | olete | ч, | |
| eva | pth | tho | | Omi | -251 | -751 | -15(| 50n | | | | | Valt | pth net | pe | å | acti | asin | pth | irtia | L L | olot | |
| <u> </u> | ă | Ē | | v | 10 | 25 | 75 | 7 | 20 | 40 | 60 | 80 10 | ź | å å s | ŕ | Ř | Ē | ü | ŏ | Ра | ပိ | ŏ≥ | |
| 266.684 | | | | | | | 1 | | - | | | | r | 1 | | | 1 | | | | 1 | | Conoral Departmention This Perchala is |
| 266.184 | 0.50 | | | | | | | | | | | | | | | | | | | Î | | Î | Located on the upland part of the Alignment on a ground elevation of 266.684 m. The |
| | | | | | | | | | | | | | 17 | 45 | | | | | | | | | stratigraphy of area is prominently of Silty Sand which comes under Alluvial Type of |
| 265.184 | 1.50 | | | | | | | | | | | | | -10 | | | | | | | | | Category. Silty Sand and Clay is majorly |
| | | | | | | | | | | | | | | | | | | | | | | | tracked in the borehole. |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 263.684 | 3.00 | | | | | | | | - | | | | | | | | _ | - | | | | | |
| | | | | | | | | | | | | | 27 | 45 | | | | | | | | | |
| 262.184 | 4.50 | | | | | | | | | | | | | - | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 260 694 | 6.00 | | Brown Colour, Very Fine | | | | | | | | | | | | | | | | | | | | |
| 200.004 | 0.00 | | Grained, Hard Consistency, Silt | | | | | | ┼ | | | | | | | | | | | | | | |
| | | | Compressibility. | | | | | | | | | | 25 | 45 | | | | | | | | | |
| 057.004 | 0.00 | | | | | | | | | | | | 30 | 40 | | | | | | | | | |
| 207.004 | 9.00 | | | | | | | - | + | | | | | | | | _ | - | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | ÷ | _ | | z | |
| 254.684 | 12.00 | | | | | | | | - | | | | | | | | _ | | sen | rtia | | Ň | |
| | | | | | | | | | | | | | | | | | | | Αb | Ра | | BR | |
| | | | | | | | | | | | | | 44 | 45 | | | | | | | | | |
| 251.684 | 15.00 | | | | | | | | | | | | | | | | | _ | | | | | |
| | | | | | | | | | | | | | 1 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 248.684 | 18.00 | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Brown Colour, Verv Fine | | | | | | | | | | 54 | 45 | | | | | | | | | |
| 246.684 | 21.00 | | Grained, Hard Consistency, Silt | | | | | | | | | | 1 | | | | | | | | | | |
| | | | and Clay with low | | | | | 1 | | | | | | | 1 | | 1 | 1 | | | | | |
| | | | Compressibility | | | | | | | | | | | | | | | | | | | | |
| 243,684 | 24,00 | | | | | | | | | | | | 1 | | | | | | | | | | |
| | 200 | | 1 | | | | | t – | \vdash | | | | 1 | 1 | | | + | | | | | | |
| | | | | | | | | | | | | | 63 | 45 | | | | | | | | | |
| 240 694 | 27 00 | | Brown Colour, Very Fine | | | | | | | | | | 0.0 | -10 | | | | | | | | | |
| 240.004 | 21.00 | - | and Clav with low | | | | - | - | ┢ | | | | | - | | | + | | | | | | |
| | | | Compressibility | | | | | | | | | | 1 | | | | | | | | | | |
| | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 238.684 | 30.00 | I | I | | | I | L | I | L | | | | | <u> </u> | L | | | 1 | | ۷ | 1 | Ĺ | 1 |
| | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | Ge | eo | te | ch | nie | ca |]] | [nv | /e | sti | gat | io: | n F | Re | ро | rt | | | | |
|--------------|--------------------------|-----------|--|----------|---------|-----------------|----------|--------|------|------------|--------------|------------|-------------------|-------------------------|-------------|-------|--------------|--------|-------------|--------------|-------------|-----------------------|--|
| Consu | ltant: | | | | | | | | | | | | | | | | | | | Clí | ent | t: | |
| | <mark>5.М</mark> . вн | UB | ANESWAR | | Jo | b I | No: | - 8 | 30 | | R | ер | ort | No: | - SI | мс/ | '20 | 50 | | D | Har eve | yar lop | na Rail Infrastructure Iment Corporation Ltd |
| HA HA | ARYANA RAIL I | NFRAS | IRUCTURE DEVELOPMENT CORPORATIO | N LTD. | | <u> </u> | | | | | | <u></u> | D#:I | | | БЦ | 22 | | | | 100 | MO | S M CONSUL/TANTS |
| | A JOINT VENTUR | e of go | VERNMENT OF HARYANA AND MINISTRY OF RAILW | /AYS | | Ge | 010 | gi | | L | og | OT | וחט | | ne | DU | -33 | | | | 1 | 3 | BHUBANESHWAR |
| BORE HOLE N | NO | : | BH-33 | | CO-C | Ordin | ATES | | х | : 6 | 69607 | 2.339 | | | | | LOC | ATION | I | | | : | Patuka |
| CHAINAGE (m | n.) | : | 30125 | | 000 | | | TION | Y | : 3 | 31233 | 63.52 , | 6 | | | | TOT | AL DE | PTH | | | : | 20.00 m |
| COLLAR ELE | VATION | : | | | GRO | UND E II ITH | LEVA | TION | | : 2 | 265.58 | 1 m | | | | | TYPE | EOFC | ORE | | 1 | : | |
| START DATE | | | 20-04-2021 | | ANG | LEWI | TH HO | RIZO | NTAL | : 9 | 90° | | | | | | DEP | LING | WAT AGEN | er tai Cy | SLE (M | () : : | Absent S.M. Consultants |
| ENDING DATE | | : | 21-04-2021 | | | | | | 1 | | | | | | | | NAM | EOFO | GEOL | ogist | | : | Gaurav Chunekar |
| 5 | | | | Si | ze of | Core | Piec | es | Co | % ore-R | 6 of ecov | ery | Star Pene T | ndard tration est | | | q. / m | | ter level | Wa Lo | ater oss | eturned | |
| Elevation (n | Depth (m) | Litho-Log | Lithological Description | <10mm | 10-25mm | 25-75mm | 75-150mm | >150mm | 20 | 40 | 80 | 100 | N Value | Depth of Penetration | Type of BIT | RQD % | Fracture Fre | Casing | Depth of wa | Partial | Complete | Colour of Re Water | REMARK / OBSERVATIONS |
| 265.581 | | _ | | | , | | 1. | ~ | | | • | , | _ | | | _ | _ | - | | _ | | | |
| 265.081 | 0.50 | | | | | | | | | | | | | | | | | | | | | | General Description: This Borehole is Located on the upland part of the Alignment on a ground elevation of 265.581 m. The |
| 264.081 | 1.50 | | Brown Colour, Very Fine | | | | | | | | | | 18 | 45 | - | | - | | | | | | stratigraphy of area is prominently of Silty Sand which comes under Alluvial Type of Category. Silty Sand and Clay is majorly tracked in the berehole |
| 262.581 | 3.00 | | Grained, Hard Consistency, Silt and Sand with low Compressibility. | | | | | | | | | | | | | | | | | | | | |
| 261.081 | 4.50 | | | | | | | | | | | | 28 | 45 | - | | | | | | | | |
| 259.581 | 6.00 | | | | | | | | | | | | | | | | | | | | | | |
| 256.581 | 9.00 | | | | | | | | | | | | 39 | 45 | | | - | | Absent | Partial - | | BROWN | |
| 050 504 | 10.00 | | | | | | | | | | | | | | | | | | | | | | |
| 253.581 | 12.00 | | Brown Colour, Very Fine | \vdash | | | | | | | | | | | | | | | | | | | |
| 250.581 | 15.00 | | Grained, Hard Consistency, Silt and Clay with low Compressibility | | | | | | | | | | 50 | 45 | | | | | | | | | |
| 247.581 | 18.00 | | | | | | | | | | | | | | | | - | | | | | | |
| 245.581 | 20.00 | | | | | | | | | | | | 63 | 45 | | | - | | | | | | |

| | 6 | Geotechnical | Investigation Repor | t |
|--------|---------------------------------|---------------------|----------------------|--|
| Consu | ltant: | | | Client : |
| S.M.C. | S.M. CONSULTANTS BHUBANESWAR | Job No:- 830 | Report No:- SMC/2050 | Haryana Rail Infrastructure Development Corporation Ltd |

ANNEXURE L CORE SAMPLES

| Geotechnical Investigation Report | | | | |
|-----------------------------------|--------------|----------------------|--|--|
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Borehole 13 (Ch no. 25000)



BH 13. Box 1 (Depth 0m-15.0m).



BH 13. Box 2 (Depth 15.0m-28.50m)

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|-----------------------------------|--------------|----------------------|--|--|
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BH13. Box 3. (Depth 28.5m-43.5m)



BH13. Box 4. (Depth 43.5m- 60.0m)

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Borehole 14 (Ch no. 25195)



BH 14. Box 1. (Depth 0m-10.5m)



BH 14. Box2. (Depth 10.5m-27.5m)

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BH 14. Box 3. (Depth 27.5m-43.5m)



BH 14. Box 4. (Depth 43.5m-63.0m)

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Borehole 15 (Ch no. 25380)



BH 15. Box 1. (Depth 0m- 16.5m)



BH 15. Box 2. (Depth 16.5m -33.0m) - 434 -

| Geotechnical Investigation Report | | | | |
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BH 15. Box 3. (Depth 33.0m- 48.0m)



BH 15. Box 4. (Depth 48m-66m)

| Geotechnical Investigation Report | | | | |
|-----------------------------------|--------------|----------------------|--|--|
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BH 15. Box 5. (Depth 66.0m-70.0m)

Borehole 15(A) (Ch no. 25488)



BH 15(A) Box 1. (Depth 0-13.5m)

| Geotechnical Investigation Report | | | | |
|-----------------------------------|--------------|----------------------|--|--|
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BH 15(A) Box 2. (Depth 13.5m-27.0m)

CLIENT . HRIDC LOCATION - SOHNA Bh. - Ditch Char - 24820 (2420) 24820 Box no. - 3 Depth - 27.00m to 40.50m 29.5 \$2 34

Bh 15(A) Box 3. (Depth 27.0m-40.5m)

| Geotechnical Investigation Report | | | | |
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BH 15(A) Box 4. (Depth 40.5m-50.0m)

Borehole 16. (Ch no. 25586)



BH 16. Box 1. (Depth 0 m- 15.0m)

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BH 16. Box 2. (Depth 15.0m-27.0m)



BH 16. Box 3. (Depth 27.0m- 40.5m)

| Geotechnical Investigation Report | | | | |
|-----------------------------------|--------------|----------------------|--|--|
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BH 16. Box 4. (Depth 40.5m -51.0m)



Bh 16. Box 5. (Depth 51.0m- 62.0

| Geotechnical Investigation Report | | | | |
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Borehole 17. (Ch no. 25785)



BH 17 Box 1. (Depth 0.00m -27.50m)

BH-17 OH- 25 120 BOX NO-DEPTH- 27 50M 70 39.59M 27

BH 17 Box 2. (Depth 27.50m -39.50m)

| Geotechnical Investigation Report | | | | |
|-----------------------------------|--------------|----------------------|--|--|
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BH 17 Box 3. (Depth 39.50m -51.50m)



BH 17 Box 4. (Depth 51.50m -62.00m)



EXPLORING ALTERNATE ALIGNMENTS, FINAL LOCATION SURVEY, GEOLOGICAL MAPPING, GEO-TECHNICAL INVESTIGATION, DETAIL DESIGN OF TUNNEL & ITS APPROACHES INCLUDING VIADUCT IF ANY AND OTHER ANCILLARY WORK IN SOHNA-MANESAR SECTION OF HRDC PROJECT.



HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.



S.M. CONSULTANTS, S.M.TOWER, PLOT NO.-130, MANCHESWAR INDUSTRIAL ESTATE, RASULGARH, BHUBANESWAR-751010, ODISHA

GEOLOGICAL INTERPRETIVE REPORT

 Prepared & Submitted By

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| DPD/GC/CIVIL | |
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| Client |
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Client:



HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED. **Consultant:**



S.M. CONSULTANTS, S.M.TOWER, PLOT NO.-130, MANCHESWAR INDUSTRIAL ESTATE, RASULGARH, BHUBANESWAR-751010

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1 Introduction:

1.1 Scope of the Geological Interpretative Report

This GIR presents the status of knowledge regarding the geological, structural and hydrogeological conditions along the alignment. In order to optimize the design, a geological assessment was done as part of the work. The assessment included field and laboratory work. This report summarizes subsurface and site conditions that are expected to be encountered during the tunnelling works. The subsurface and site conditions are derived from geotechnical information and data gathered from field.

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1.3 Indian Standard codes

- [1] IS 1893 (part-1): 2016, Criteria for earthquake resistance design of structure.
- [2] IS: 2720(part-1)-1983 (Reaffirmed 2015): Preparation of soil sample
- [3] IS: 2720(part-2)-1973 (Reaffirmed 2015): Moisture Content
- [4] IS: 2720(part-3) (sec-1)-1980 (Reaffirmed 2016): Specific Gravity
- [5] IS: 2720(part-4)-1985 (Reaffirmed 2015): Grain Size Analysis
- [6] IS: 2720(part-5)-1985 (Reaffirmed 2015): Atterberg's Limits
- [7] IS: 2720(part-11)-1993 (Reaffirmed 2016): Triaxial Shear Strength
- [8] IS: 2720(part-13)-1986 (Reaffirmed 2016): Direct Shear Strength
- [9] IS: 2720(part-15)-1986 (Reaffirmed 2016): Consolidation Test

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2 Geological Overview: 2.1 Introduction:

The area in the report lies within the district of Gurgaon of Haryana. The concerned region is a part of the survey of India toposheet No. 53H/04 and spanned between longitude 77°58'36"& 77°06'00" and latitude 28°14'0" & 28°10'30" (Figure 2.1). The area is 20km away from Gurgaon. The important towns in the area are Sohna, Gurgaon, Palwal. These towns are connected with important cities of the state and Delhi by metaled roads.
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Figure 2.1: District Map of Haryana.

Delhi Bombay National Highway (NH-6) passes through Gurgaon State Highway No 43 passes through Sohna. Gurgaon is a railway station on the Delhi Rewari section of the meter gauge line of the Northern Railway whereas Faridabad and Palwal are on Delhi Bombay broad gauge line. Most of the villages in the area are connected by all-weather metaled roads. The area has a semi-arid type of climate. Summer is extremely hot with the temperature up to 47°C. The winters are quite cold. The minimum temperature recorded in Gurgaon during

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1968-70 was 2.0°C. The related humidity is maximum in August (above 80%) and minimum in June (above 35%). In the month of November, the wind velocity in the morning remains about2.5km/hr. whereas in June it is generally 8 km/hr. The general wind direction is westerly. The summer monsoon starts at the end of June or early July and lasts up to September. Rainfall is generally restricted to this monsoon, though winter months also get some scanty rains.



Figure 2.2: Graph showing month wise rainy days for Gurgaon district. (Climate-data.org).

The average annual rainfall is about 600 mm. The climatic condition of the area is much varied characterized by hot and moist sub-humid climate. It has mainly 4 seasons. The summer season is from March to Mid-June, the period from Mid-June to September is the Rainy season, October and November constitute the post-monsoon season, and winter is from December to February as shown inFigure 2.2. The best time to visit this district is during winter. Ministry of housing and urban affair, Government of India has done vulnerability mapping for Haryana state which includes multiple hazard zonation maps. The results are given below inFigure 2.3.

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Figure 2.3: Wind Hazard map of Haryana (adopted from BMTPC.

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2.2 Seismicity

According to National Center for Seismology the state of Haryana comprises three earthquake zone. The western part comes under zone II, the central part zone III and the eastern- south-eastern part in zone IV. The region around the site of construction comes under the zone IV of earthquake. Being within the earthquake zone IV the area of interest is at high risk with reference to the seismic activity. This region is liable to MSK VIII on Medvedev–Sponheuer–Karnik Scale, a macro seismic intensity scale or lower, and is classified as the High Damage Risk Zone. Map below shows the seismic zones of Haryana State (Figure 2.4).



Figure 2.4: Seismic map of state Haryana (adopted from National Centre for seismology).

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2.3 <u>Regional Geology:</u>

The rocks exposed in the area consist of Mesoproterozoic rocks of the North Delhi Fold belt which occur as long, linear, discontinuous chain of hills. The overall Delhi fold belt shows a NE-SW trend and extends from Gujrat (Deri- Ambaji) in the south to Delhi in the north. In the north and south the belt is overlain by Indo-Gangatic alluvium with sparse outcrop jutting out from the plain. Towards west it shows an unconformable contact with Marwar craton along a Phulad lineament and in the east the belt shows a faulted contact with Banded Gneissic Complex of pre-Delhi origin along Kaliguman lineament. The North Delhi Fold Belt has been divided into two groups by Heron (1935): the lower arenaceous Alwar Group and the upper argillaceous Use the "Insert Citation" button to add citations to this document.

Ajabgarh Group. The Alwar Group comprises arkosic schists, phyllites, quartzites and meta- conglomerates whereas, the Ajabgarh Group comprises calc-schists, biotite schists, calc-silicates and marbles.

The regional structure of Delhi fold belt is considered as a broad synclinorium having N to NNE trend (Heron 1953) with core occupied by Delhi group, within the broad synclinorium four generations of deformation (D1 - D4) (Figure 2.5) are seen in Delhi fold belt (Naha and Mohanty 1988). D1 and D2 are ubiquitous in all scales while D3 and D4 are seen only in some sectors. D1 folds are tight to isoclinal with a pervasive axial planar cleavage (S1). There are multiple occurrences of boudinage in D1 fold, which are parallel to axial planer cleavage (Naha et al., 1984). D2 folds ranges from open to isoclinal with vertical axial plane striking NNE -SSW to NE-SW. A crenulation cleavage (S2) is developed parallel to axial planes of the fold. D2 fold is coaxial with DF1 fold. Due to D2 various superposed folds have been developed in DFB, most common is Ramsay Type III fold (non-planar cylindrical) (Roy and Das 1985). DF3 folds are kink folds with sub horizontal axial planes. It has affected S1 and S2 cleavages and axial surfaces of DF1 and DF2 folds. At some places DF3 has conjugate axial plane striking NE-SW and SE-NW. It is formed by vertical compression (Naha and Mohanty 1988). Due to interference from D3 fold there is development of Ramsay Type II fold (non-planer non-cylindrical fold) in the DF1 and Ramsay Type-I fold (planer non-cylindrical fold) in DF2 (Roy and Das 1985).DF4 fold are

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upright chevron fold, having NW-SE striking axial plane. They are formed by horizontal compression in an NE-SW direction (Naha and Mohanty 1988).

The different phases of deformation have led to metamorphism ranging from greenschist to amphibolite facies.



Figure 2.5: Regional structure of Delhi fold belt (Naha and Mohanty 1988).

3 PROJECT GEOLOGY

3.1 Local Site Geology:

The region around the site consists of metamorphosed arenaceous rocks of the Alwar group. The Lithology is dominated by Quartzites with some intercalations of phyllites near the southern portal.

The Quartzites are metasedimentary rocks that comprise greater than 80% quartz along with feldspar and mica minerals, the mineral grains show an equigranular interlocking texture.

The phyllites are low-grade metamorphic rocks, they have a marked fissility (a tendency to split into sheets or slabs) due to the parallel alignment of platy minerals; they have a sheen on their surfaces due to tiny plates of micas.

The quartzites near to surface showed high weathering and were highly friable and noncohesive while as we move deeper (> 15 m) the quartzite becomes more resistive and less weathered. Quartz is a tectosilicate mineral that ranks 7 on the Mohr hardness scale, since it crystallizes later according to the Bowen reaction series it is also resistive to weathering. Feldspar on the other hand ranks 6 on the Mohr hardness scale and crystallizes earlier thus is prone to weathering.

In the southern part intercalation of phyllites/schist along with quartzite are observed.

3.2 <u>Structural Study:</u>

The compositional changes in quartzite beds defines the bedding in the area and the regional trend of bedding plane is NE-SW with a steep dip towards SE.

A superposed fold was observed at 28°12′33.57″, 77°02′57.08″. DF2 and DF3 deformation phases of Delhi group was observed in the area. DF1 is the prominent fold pattern which was super posed with DF2 folding phase. Signatures of later brittle shearing, possibly related to DF4 phase, was also observed near the proposed portal face. The fold showed Ramsay's Type III folding pattern i.e., nonplanar cylindrical (Figure 3.1). The fold

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hinge showed a plunge of 20° towards 220. The Type III fold pattern in the rest of the Delhi system of rocks are result of superposition of DF2 over DF3 deformation. The portal face lies perpendicular to the axial plane of the fold. The earlier generation of fold is isoclinal in nature where both the limbs dip towards south.

Near the fold area some quartz tension gashes were observed. Gash veins open up when rock gets stretched due to shearing and the tension fractures forms oblique to the shear zone which is later filled with mineral precipitate. In the present area the gash veins indicate a dextral shearing.

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Figure 3.1: Superposed fold observed at 28 12' 33.57", 77 02'57.08"

At location 28° 12' 20.93'', 77° 02' 40.50'' another evidence of brittle-ductile shear zone was observed within the quartzite outcrop (Figure 3.2). Prominent en-echelon fractures were observed within the outcrop which were rotated to form a sigmoidal structure, the fractures were not filled with mineral precipitate. The shear plane was dipping towards NE with a normal slip where the eastern block was showing a downthrown movement and the

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western block an upthrown movement. The last phase, in the mode of brittle shearing, led to the DF4 deformation. The joints are also encountered persistently at places around the site (Figure 3.4, Figure 3.5).



Figure 3.2: Shear zone observed at location 28 12' 20.93", 77 02' 40.

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Figure 3.3: Gash veins showing a dextral slip.



Figure 3.4: Multiple joint sets observed throughout the area.

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Figure 3.5: Multiple joint sets were observed throughout the area.

Orientation of the joints measured in field (Table 3.1) has been plotted on stereonet and contouring was done following Schimidt's 1% area rule (Figure 3.6) .The diagram shows 6 distinct cluster of the poles to the joint planes, hence we designate the sets as J1, J2, J3, J4, J5, and J6 (Table 3.2).

| S. NO | Strike | Dip | Dip Direction |
|-------|--------|-----|---------------|
| 1. | 034 | 11 | NW |
| 2. | 028 | 13 | NW |
| 3. | 029 | 13 | NW |
| 4. | 027 | 15 | NW |
| 5. | 027 | 15 | NW |
| 6. | 026 | 16 | NW |
| 7. | 029 | 18 | NW |
| 8. | 033 | 18 | NW |
| 9. | 028 | 19 | NW |
| 10. | 032 | 19 | NW |
| 11. | 042 | 21 | NW |
| 12. | 040 | 22 | NW |
| 13. | 036 | 23 | NW |
| 14. | 041 | 24 | NW |
| 15. | 037 | 25 | NW |

 Table 3.1: Orientation of the joints at places around the site.

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| S. NO | Strike | Dip | Dip Direction |
|-------|--------|-----|---------------|
| 16. | 036 | 26 | NW |
| 17. | 043 | 27 | NW |
| 18. | 040 | 28 | NW |
| 19. | 037 | 30 | NW |
| 20. | 038 | 30 | NW |
| 21. | 178 | 31 | W |
| 22. | 172 | 32 | W |
| 23. | 175 | 32 | W |
| 24. | 170 | 34 | W |
| 25. | 174 | 34 | W |
| 26. | 172 | 36 | W |
| 27. | 178 | 37 | W |
| 28. | 172 | 38 | W |
| 29. | 178 | 38 | W |
| 30. | 178 | 39 | W |
| 31. | 003 | 40 | W |
| 32. | 006 | 40 | W |
| 33. | 004 | 41 | W |
| 34. | 005 | 43 | W |
| 35. | 008 | 43 | W |
| 36. | 119 | 45 | NE |
| 37. | 008 | 46 | W |
| 38. | 009 | 46 | W |
| 39. | 119 | 46 | NE |
| 40. | 008 | 47 | W |
| 41. | 002 | 49 | W |
| 42. | 116 | 49 | NE |
| 43. | 007 | 50 | W |
| 44. | 110 | 50 | NE |
| 45. | 110 | 51 | NE |
| 46. | 111 | 51 | NE |
| 47. | 114 | 51 | NE |
| 48. | 117 | 51 | NE |
| 49. | 115 | 52 | NE |
| 50. | 119 | 52 | NE |
| 51. | 122 | 57 | NE |
| 52. | 126 | 59 | NE |
| 53. | 127 | 60 | NE |
| 54. | 130 | 60 | NE |
| 55. | 121 | 62 | NE |
| 56. | 129 | 62 | NE |

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| S. NO | Strike | Dip | Dip Direction |
|-------|--------|-----|---------------|
| 57. | 122 | 63 | NE |
| 58. | 128 | 63 | NE |
| 59. | 124 | 64 | NE |
| 60. | 126 | 65 | NE |
| 61. | 117 | 70 | NE |
| 62. | 117 | 70 | NE |
| 63. | 029 | 71 | SE |
| 64. | 032 | 71 | SE |
| 65. | 026 | 72 | SE |
| 66. | 111 | 72 | NE |
| 67. | 028 | 73 | SE |
| 68. | 030 | 73 | SE |
| 69. | 035 | 73 | SE |
| 70. | 116 | 73 | NE |
| 71. | 119 | 74 | NE |
| 72. | 117 | 75 | NE |
| 73. | 178 | 76 | Е |
| 74. | 030 | 76 | SE |
| 75. | 170 | 77 | E |
| 76. | 174 | 77 | E |
| 77. | 030 | 77 | SE |
| 78. | 110 | 77 | NE |
| 79. | 113 | 77 | NE |
| 80. | 171 | 79 | E |
| 81. | 178 | 79 | E |
| 82. | 179 | 79 | Е |
| 83. | 027 | 79 | SE |
| 84. | 032 | 79 | SE |
| 85. | 174 | 80 | E |
| 86. | 176 | 80 | E |
| 87. | 114 | 80 | NE |
| 88. | 116 | 80 | NE |
| 89. | 040 | 81 | SE |
| 90. | 042 | 81 | SE |
| 91. | 122 | 81 | NE |
| 92. | 171 | 82 | E |
| 93. | 175 | 82 | E |
| 94. | 045 | 82 | SE |
| 95. | 126 | 82 | NE |
| 96. | 039 | 83 | SE |
| 97. | 122 | 83 | NE |

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| S. NO | Strike | Dip | Dip Direction |
|-------|--------|-----|---------------|
| 98. | 125 | 83 | NE |
| 99. | 125 | 83 | NE |
| 100. | 005 | 84 | Е |
| 101. | 038 | 84 | SE |
| 102. | 001 | 85 | Е |
| 103. | 008 | 85 | Е |
| 104. | 129 | 85 | NE |
| 105. | 124 | 86 | NE |
| 106. | 127 | 86 | NE |
| 107. | 002 | 87 | Е |
| 108. | 006 | 87 | Е |
| 109. | 037 | 87 | SE |
| 110. | 042 | 87 | SE |
| 111. | 127 | 87 | NE |
| 112. | 009 | 88 | Е |
| 113. | 002 | 89 | Е |
| 114. | 043 | 89 | SE |
| 115. | 130 | 89 | NE |
| 116. | 001 | 90 | Е |
| 117. | 036 | 90 | SE |
| 118. | 040 | 90 | SE |
| 119. | 006 | 91 | Е |
| 120. | 007 | 93 | Е |
| 121. | 045 | 82 | SE |
| 122. | 126 | 82 | NE |
| 123. | 039 | 83 | SE |
| 124. | 122 | 83 | NE |
| 125. | 130 | 89 | NW |

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Figure 3.6: Rose and contour diagram of the orientation of the 6 sets of joints (no. of samples N=125)

| Joint Set | Average Strike | Average True Dip amount | Average True Dip direction |
|-----------|----------------|----------------------------|-------------------------------|
| J1 | 035 | 80 | SE |
| J2 | 035 | 20 | NW |
| J3 | 000 | 84 | Е |
| J4 | 000 | 40 | W |
| J5 | 300 | 55 | NE |
| J6 | 300 | 80 | NE |

Table 3.2: Details of joint sets.

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A detailed geological map in a scale 1:25000 (Figure 3.7) and in 1:2000 scale (Figure 3.8) showing all structural elements which includes faults, thrusts, shear zones, folds, joints, lithological boundaries along with finalized tunnel alignment, L-Section (Figure 3.9) along the hilly terrain (1:25000 H and 1:2500 V), Graphical representation of the distribution of RQD, Core Recovery, SPT N Values and Soil types along each boreholes intersecting the tunnel (Figure 3.10), magnified parts of the L section showing chainage wise variation in RMR and RQD values in rock portion and C and phi values in soil portion (Figure 3.11 to Figure 3.15) a detailed cross section of the portal face on the mountain front (Figure 3.16),cross-section of the exit end of the NATM structure in soil (Figure 3.17), and the cross section of the portal 2 in the cut and cover region (Figure 3.18) are given below;



Figure 3.7: Geological map of the area at 1:25000 scale.



Figure 3.8: Detailed structural map of the major rocky area at 1:2000 scale. Joint sets are schematically drawn with their actual orientation. Average spacing between the joints are as follows J₁: 300 cm, J₂:252.78cm, J₃:160cm, J₄:80cm, J₅:32cm, J₆:100cm.



Figure 3.9: L-Section along the tunnel alignment (1:25000 H and 1:2500 V). Joint sets are schematically drawn with their actual orientation.



Figure 3.10: Graphical representation of the distribution of RQD, Core Recovery, SPTN Values and Soil types along each boreholes intersecting the tunnel (BH13-BH32). Thick black lines indicate the position of the tunnel.



Figure 3.11: Chainage-wise variation in RQD and RMR (Samples from 2D depth considered only).



Figure 3.12: Chainage-wise variation in C and ϕ . (Samples from 2D depth considered only).

| CAL SECTION HAS BEEN ING GEOLOGICAL MAP OF DEXPLORATORY HOLES INEL ALIGNMENT. DWN IN THE SECTION ARE EIR ACTUAL SPACING, AND HEMATIC. ASSIFICATION INDICATED IN IS TENTATIVE AND MAY XCAVATION. ER CLASSES MAY OCCUR S OCCUPIED STRETCHES. CLASSES MAY OCCUR IN S OF HIGHER ROCK MASS | |
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| ATION QUARTZITE WITH AND ENCOUNTERED AT T AND OTHER CRITICAL LL BE REMOVED AND AIN CEMENT CONCRETE. | |
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| rich | |
| A) Inorganic Silty | |
| HOLA: Clayey Soil (ML-CL) | |
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Figure 3.13: Chainage-wise variation in C and ϕ . (Samples from 2D depth considered only).

| CAL | SECTION | HAS | BEEN |
|------|----------|-------|-------|
| SING | GEOLOGIC | AL M | AP OF |
| ID E | XPLORATO | DRY H | IOLES |
| NNE | ALIGNME | NT. | |



Figure 3.14: Chainage-wise variation in C and ϕ . (Samples from 2D depth considered only).

Name of the Project: Exploring alternate alignments, final location survey, geological mapping, geotechnical investigation, detailed design of tunnel & its approaches including Viaduct if any, and other ancillary work in Sohna-Manesar Section of HORC project.

1. THIS GEOLOGICAL SECTION HAS BEEN DEVELOPED USING GEOLOGICAL MAP OF THE AREA AND EXPLORATORY HOLES DRILLED ON TUNNEL ALIGNMENT.

2. JOINT SETS SHOWN IN THE SECTION ARE NOT AS PER THEIR ACTUAL SPACING, AND

3. ROCK MASS CLASSIFICATION INDICATED IN THE SECTION IS TENTATIVE AND MAY

4. ROCKS OF LOWER CLASSES MAY OCCUR IN WEAK ZONES OCCUPIED STRETCHES. ALSO, LOWER CLASSES MAY OCCUR IN THE STRETCHES OF HIGHER ROCK MASS

5. DURING EXCAVATION QUARTZITE WITH SCHIST INTERBAND ENCOUNTERED AT TUNNEL INVERT AND OTHER CRITICAL LOCATION SHALL BE REMOVED AND REPLACED BY PLAIN CEMENT CONCRETE.

Legends

Clayey Sand (SC) Inorganic Silty Clayey Soil (ML-CL)



Figure 3.15: Chainage-wise variation in C and ϕ values, along the cut & cover region, for the strata below formation level.

| CAL SECTION HAS BEEN ING GEOLOGICAL MAP OF D EXPLORATORY HOLES INEL ALIGNMENT. OWN IN THE SECTION ARE EIR ACTUAL SPACING, AND HEMATIC. LASSIFICATION INDICATED N IS TENTATIVE AND MAY XCAVATION. /ER CLASSES MAY OCCUR S OCCUPIED STRETCHES. CLASSES MAY OCCUR IN S OF HIGHER ROCK MASS /ATION QUARTZITE WITH BAND ENCOUNTERED AT T AND OTHER CRITICAL ALL BE REMOVED AND LAIN CEMENT CONCRETE. |
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Figure 3.16: Detailed cross section of the Portal-I, on the mountain front. Joint sets are schematically drawn maintaining their actual orientation. Average spacing between the joints are as follows J₁: 300 cm, J₂:252.78cm, J₃:160cm, J₄:80cm, J₅:32cm, J₆:100cm.



Figure 3.17: Detailed lithological cross section at the end of NATM Structure in soil (CH 28900).



Figure 3.18: Cut and Cover structure at the end of tunnel – Portal II (CH29600).

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 Table 3.3: Abstract of Safe Bearing Pressure for cut and cover portion (BH-32 & 33).

| Location | Depth from N.G.L in m. | Type of Soil | Field SPT value | Group of sample | Cohesion (C) in KPa | Angle of internal friction (\$)) | E (in MPa) | Net Safe Bearing Capacity in T/m ² | Settlement in mm | Safe Bearing Pressure for 25 mm settlement in T/m ² | Recom mended SBC in T/m ² |
|---------------|---------------------------------|--------------------|-----------------------|-----------------------|----------------------------|---|---------------|--|---------------------|--|---|
| ВН 3 2 | 21.0 | S.P.T | N>50 | МІ | 1 | 26 | 31 | 1100 | 709 | 39.0 | 35 |
| D11-32 | 24.0 | S.P.T | N>50 | IVIL | 4 | 20 | 51 | 1101 | 793 | 35.0 | 35 |
| BH-33 | 20.0 | SPT | N>30 | ML- CL | 8 | 26 | 27.6 | 262 | 245 | 27 | 27 |

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4 GEOTECHNICAL INVESTIGATION OF ROCK MASS:

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Based on the available information from Geotechnical Report, geotechnical investigations have been carried out at different locations along the tunnel alignment and at stations.

4.1 <u>Summary of the Boreholes within ROCK MASS:</u>

The boreholes relevant to this project are mentioned in table below (Table 4.1).

| BH No. | Chainage No. | Chainage No. Ground Elevation, RL Formation Level as (m) Per Alt.2A | | Total depth (m) |
|--------|--------------|--|---------|-----------------|
| BH-13 | 25000 | 276.867 | 226.801 | 60 |
| BH-14 | 25195 | 294.218 | 228.013 | 75 |
| BH-15 | 25380 | 295.532 | 229.225 | 70 |
| BH-15A | 25488 | 276.442 | 229.833 | 50 |
| BH-16 | 25586 | 287.324 | 230.437 | 62 |
| BH-17 | 25785 | 282.461 | 231.650 | 62 |

 Table 4.1: Details of Boreholes drilled for the project along the tunnel line.

4.2 Field Tests for ROCK MASS:

Field tests are conducted in boreholes that are taken along the proposed tunnel alignment and the station locations. The following table shows the summary of field tests conducted in Rock mass

| Table 4.2: Details of test conducted at site |
|--|
|--|

| Field Tests | Type of Test |
|-------------|-----------------------|
| In Rock | Core recovery and RQD |
| | Permeability Test |

4.3 Field Test Result for ROCK MASS:

For the rock masses, during the drilling activity the percentage of core recovery and RQD has been calculated. These on field results has been summarized in Table 4.3.

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| BH No | Chainage | Ground | Donth (m) | | For Ro | ck |
|--------------|----------|---------|--------------|-----------------------|--------|--|
| BH NO. | No. | RL (m) | Deptii (iii) | % of Core recovery | RQD % | Avg. RMR from 2D Depth (*refer to section 5.5.2) |
| BH-13 | 25000 | 276.867 | 0.5-60 | 30.96 | 6.5 | 38 |
| BH-14 | 25195 | 294.218 | 0.5-75 | 28.94 | 5.9 | 37 |
| BH-15 | 25380 | 295.532 | 0.5-70 | 28.91 | 5.91 | 34 |
| BH-15A | 25488 | 276.442 | 0.5-50 | 35.79 | 10.67 | 29 |
| BH-16 | 25586 | 287.324 | 0.5-62 | 36.52 | 16.02 | 41 |
| BH-17 | 25785 | 282.461 | 0.5-62 | 30.02 | 10.98 | 42 |

 Table 4.3: Result for the field tests.

The packer test method was carried out as per IS 5529 (Part 2): 2006 to determine the permeability of the rock strata at site presented in Table 4.4.

| BH No. | Packer test section 1 | | Lugeon | Packer tes | Lugeon | |
|--------|-----------------------|----------------|--------|----------------|----------------|-------|
| | Upper part (m) | Lower part (m) | Value | Upper part (m) | Lower part (m) | Value |
| BH-13 | 36 | 39 | 30.20 | 48 | 51 | 25.62 |
| BH-14 | 54 | 57 | 24.46 | 63 | 66 | 21.88 |
| BG-15 | 55 | 58 | 24.34 | 64 | 67 | 18.42 |
| BH-16 | 44 | 47 | 27.38 | 56 | 59 | 21.14 |

Table 4.4: Result for permeability tests

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4.4 Laboratory Tests:

Laboratory tests were also carried out on rock samples, the details of different laboratory tests conducted as part of the project are given in the table below (Table 4.5)

| | 1. Unconfined Compressive Strength, |
|--------------------------------------|-------------------------------------|
| | 2. Point Load Index Test |
| | 3. Tensile Strength |
| | 4. Specific Gravity |
| Laboratory tasks conducted for reals | 5. Modulus of elasticity |
| Laboratory tests conducted for fock | 6. Water absorption |
| | 7. Poisons' ratio |
| | 8. Triaxial Test |
| | 9. Hardness test |
| | 10. Abrasive test |

Table 4.5: The laboratory tests conducted for rock.

4.5 Laboratory Test Result for Rock Mass:

This section comprises depth wise results of the tests conducted in laboratory for rock masses in accordance with relevant standard codes of practices. Multiple tests in laboratory (Table 4.5) are adopted to ascertain the different essential characteristics of sub-surface using field samples obtained in during field investigations and borehole drilling. The tests as under have been conducted to ascertain the parameters indicated in the test. The findings of these test are required for use in relevant engineering designs and summarized in following tables (Table 6.1).

Representative core samples have been taken from the boreholes along the tunnel alignment. The samples were properly labelled and packed carefully and sent NABL accredited laboratory for determining the physico-mechanical engineering properties as per Indian standardized regulation. Summary of results from the laboratory testing has been graphically presented below.

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4.5.1 Uniaxial Compressive Strength



Figure 4.1: Unconfined Compressive Strength (UCS) of rock mass from entire borehole length vs RL (Refer to Annexure C in Geotechnical Report for detail).

To make recommendation related to the engineering property of the surrounding rock material, which is going to directly influence the tunnel built, samples from 2D has been considered. Pareto chart has been prepared to identify the most frequent and categorically influential data set out of the scattered values. It is based on 80/20 rule, i.e., "Vital few and trivial many" principle. The idea is that the few identified vital values will always statistically dominate over many.

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Figure 4.2: Pareto Chart showing recommended UCS value for the rock mass from 2D depth. As shown in the *Pareto Chart* above, 80% of the total collected samples from 2D depth has the UCS value ranging 60-75 MPa. For safer construction the lower value of the range **60 MPa** is recommended as UCS value for the rock mass.

4.5.2 Assessment of Rock Mass Rating (RMR):

The outcrops encountered along the stretch of the alignment in this project is homogenously Quartzite. The classification of rock types with Rock Mass Rating (RMR) is done based on RQD%, Uniaxial compressive strength of rock material, spacing of discontinuities/joints, Smoothness, Infilling, Alteration/weathering along the discontinuity/joints and ground water condition and borehole wise average index values are tabulated below (For detailed result refer Annexure from Geotechnical Report on this project). Based on the results the rock mass has been broadly classified as **CLASS IV (Poor Rock Mass)**. However, in some of the cases, the RMR value being close to 40, it may be considered as Class III.

Q tunnelling index was also evaluated and the rock mass were found to be in same "POOR ROCK MASS" category. However, accessing Q parameters from boreholes, instead of excavated wall, is considerably subjective and unprecise. Therefore, the Q parameters has not been used for recommending the tunnel support.
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Figure 4.3: Graphical representation of RMR of rock mass from entire borehole length with depth. (Refer to Annexure A in Geotechnical Report for detail).

RMR value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.4: Pareto Chart showing recommended RMR value for the rock mass within 2D depth.

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As shown in the *Pareto Chart* above, 80% of the total collected samples from 2D depth has the RMR value ranging 24-43, only 20% data has RMR value >40. Therefore, the entire rock mass up to 2D height from the formation level statistically belong to **"CLASS IV"**. Hence, as per Bieniawski, 1989, systematic bolts 4-5m long, spaced 1-1.5 m in crown and walls with wire mesh, 100-150 mm shotcrete in crown and 100mm shotcrete in sides, light to medium steel ribs spaced 1.5 m is recommended as tunnel support. However, along some chainage interval the support system of Class III may be used by the discretion of the design engineer.

**For chainage wise variation in RMR value refer to Figure 3.11.

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4.5.3 <u>Point Load Index:</u>



Figure 4.5:Point Load Index (PLI) of rock mass from entire borehole length vs RL. (Refer to Annexure E in Geotechnical Report for detail).

PLI value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.6: Pareto Chart showing recommended PLI value for the rock mass within 2D depth.

As shown in the *Pareto Chart* above, 80% of the total collected samples from 2D depth has the PLI values are ranging 2.5 to 3.0 MPa. For safer construction the lower value of the range **2.5 MPa** is recommended as PLI value for the rock mass.

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4.5.4 <u>Tensile Strength:</u>



Figure 4.7:Tensile Strength of rock mass from entire borehole length vs RL. (Refer to Annexure B in Geotechnical Report for detail).

Tensile strength value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.8: Pareto Chart showing recommended tensile strength value for the rock mass within 2D depth.

As shown in the *Pareto Chart* above, 80% of the total collected samples from 2D depth has the Tensile strength value ranging 15-21 MPa. For safer construction the lower value of the range **15 MPa** is recommended as Tensile Strength value for the rock mass.

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4.5.5 <u>Modulus of Elasticity:</u>



Figure 4.9: Modulus of Elasticity (E) of rock mass from entire borehole length vs RL. (Refer to Annexure F in Geotechnical Report for detail).

Modulus of Elasticity value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.10: Pareto Chart showing recommended Modulus of Elasticity (E) value for the rock mass within 2D depth.

As shown in the *Pareto Chart* above, 80% of the total collected samples from 2D depth has the Modulus of Elasticity value ranging 39-49 GPa. For safer construction the lower value of the range **39 GPa** is recommended as Modulus of Elasticity value for the rock mass.

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4.5.6 <u>Poison's ratio:</u>



Figure 4.11: Poisson's Ratio distribution for the entire rock mass from entire borehole length vs RL. (Refer to Annexure F in Geotechnical Report for detail).

Poison's ratio value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.12: Pareto Chart showing recommended Poisson's Ratio value for the rock mass within 2D depth.

As shown in the *Pareto Chart* above, 80% of the total collected samples from 2D depth has the Tensile strength value ranging 0.11-0.15. For safer construction the higher value of the range **0.15** is recommended as Poisson's Ratio value for the rock mass.

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4.5.7 <u>Hardness:</u>



Figure 4.13: Hardness of rock mass from entire borehole length vs RL. (Refer to Annexure H in Geotechnical Report for detail).

Hardness value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.14: Pareto Chart showing recommended Hardness value for the rock mass within 2D depth.

As shown in the *Pareto Chart* above, 80% of the total collected samples from 2D depth has the Hardness value ranging 55-61. For safer construction the lower value of the range **55** is recommended as Hardness value for the rock mass.

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4.5.8 <u>Abrasive Index:</u>



Figure 4.15:Abrasiveness of rock mass from entire borehole length vs RL. (Refer to Annexure I in Geotechnical Report for detail).

Abrasive Index value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.16: Pareto Chart showing recommended Abrasiveness index value for the rock mass within 2D depth.

As shown in the *Pareto Chart* above, 80% of the total collected samples from 2D depth has the Hardness value ranging 2.50-3.30. For safer construction the higher value of the range **3.30** is recommended as Abrasiveness index value for the rock mass.

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4.5.9 <u>Angle of Internal Friction (ϕ):</u>



Figure 4.17: Angle of internal friction of rock mass from entire borehole length vs RL (Refer to Annexure G in Geotechnical Report for detail).

Angle of Internal Friction (ϕ) value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.18: Pareto Chart showing recommended angle of internal friction value for the rock mass within 2D depth. (The straight cumulative frequency curve, in orange, indicates that all of the classes contribute significantly. Therefore, entire range of the population needs to be considered.)

Laboratory tested angle of internal friction value for the rock mass samples from 2D depth are quite scattered ranges between 55° - 65° . For safer construction the Lower value of the range 55° is recommended as angle of internal friction value for the rock mass.

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4.5.10 Cohesion:



Figure 4.19: Cohesive strength of rock mass from entire borehole length vs RL (Refer to Annexure F in Geotechnical Report for detail).

Cohesion value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.20: Pareto Chart showing recommended Cohesion value for the rock mass within 2D depth. (The straight cumulative frequency curve, in orange, indicates that all of the classes contribute significantly. Therefore, entire range of the population needs to be considered.)

Laboratory tested cohesion value for the rock mass sample from 2D depth are quite scattered ranges between 15-25 MPa. For safer construction the Lower value of the range **15 MPa** is recommended as Cohesion value for the rock mass.

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4.5.11 Lugen Value:

Lugen value has been recommended using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.



Figure 4.21: Pareto Chart showing recommended Lugeon value for the rock mass within 2D depth

As shown in the *Pareto Chart* above, 80% of the total collected samples has the Packer test Lugeon value ranging 18.4-28.4. For safer construction the higher value of the range 28.4 is recommended as Lugeon value for the rock mass.

4.5.12 Wet Density:



Figure 4.22: Wet Density for rock mass from entire bore hole length vs RL. (Refer to Annexure D in Geotechnical Report for detail).

Wet density value being clustered between a maximum of 26.52 kN/m³ and minimum of 24.23 kN/m³, we can safely recommend the average value 25.55 kN/m³ as the representative of the entire rock mass.

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4.6 <u>Petrographic Test:</u>

Petrographic test performed to study the mineralogical, textural and micro-structural property of rock. The rock samples are cut up to 30-micron size and their optical properties are observed. In the present test Grain size analysis is done to study the textural property of rock and the relative abundance of minerals are calculated to study the chemical and mineralogical property of the rock.

Quartz is the most abundant mineral (mostly $94\% \pm 5\%$) found in most of the samples from the drillhole and Feldspar followed by Mica is present as accessory minerals. Borehole BH-16 shows an abrupt compositional change with depth. Abundance of mica raises steeply with depth, from the accessory mineral of 2% volume at 46.5m to second most abundant mineral (after Quartz with volume 55%) with 27% volume at 52m depth. Garnet with volume of 8% is also found at 52m depth of same borehole. Grain size analysis of the samples from all the boreholes exhibit a negatively skewed distribution of mineral grains in the sample mostly with a mean radius of 0.3 mm.

*** All the recommended values for different rock parameters are tabulated in Table 6.1, Chapter-6: Conclusion and Recommendations.

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5 GEOTECHNICAL INVESTIGATION OF SOIL MASS:

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Soil mass encountered along the tunnel alignment has been categorised in two group i.e., 1) Noncohesive Soil comprising Silty Sand (SM) and Inorganic Silt (ML) and 2) Cohesive Soil comprising Inorganic clay (CL). The values for the engineering property of soil have been interpretated categorically from the pareto chart presented below. Based on the available information from Geotechnical Report, geotechnical investigations have been carried out at different locations along the tunnel alignment and at stations.

5.1 <u>Summary of the Boreholes within SOIL:</u>

The boreholes relevant to this project are mentioned in table below Table 5.1.

| BH No. | Chainage No. | Ground Elevation, RL (m) | Formation Level as Per Alt.2A | Total depth (m) |
|--------|--------------|--------------------------|----------------------------------|-----------------|
| BH-18 | 25990 | 280.253 | 232.939 | 55 |
| BH-19 | 26210 | 278.116 | 234.379 | 50 |
| BH-20 | 26387 | 276.795 | 235.522 | 48 |
| BH-21 | 26587 | 274.993 | 236.734 | 45 |
| BH-22 | 26787 | 274.321 | 237.946 | 45 |
| BH-23 | 26980 | 274.85 | 239.158 | 45 |
| BH-24 | 27187 | 274.075 | 240.370 | 40 |
| BH-25 | 27410 | 273.565 | 241.582 | 40 |
| BH-26 | 27550 | 273.112 | 242.588 | 35 |
| BH-27 | 28050 | 272.210 | 245.878 | 30 |
| BH-28 | 28350 | 272.799 | 247.851 | 45 |

Table 5.1: Details of Boreholes drilled for the project along the tunnel line within SOIL.

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| BH No. | Chainage No. | Ground Elevation, RL (m) | Formation Level as Per Alt.2A | Total depth (m) |
|--------|--------------|--------------------------|----------------------------------|-----------------|
| BH-29 | 28550 | 269.964 | 249.134 | 30 |
| BH-30 | 28750 | 270.808 | 250.384 | 45 |
| BH-31 | 29050 | 267.159 | 252.259 | 20 |
| BH-32 | 29550 | 266.684 | 255.384 | 30 |
| BH-33 | 30125 | 265.581 | 258.588 | 20 |

5.2 Field Tests for SOIL:

Field tests are conducted in boreholes that are taken along the proposed tunnel alignment and the station locations. The following table shows the summary of field tests conducted in Soil & Rock as part of the

| Field Tests | Type of Test |
|-------------|---------------------------|
| In Soil | Standard Penetration Test |

5.3 Laboratory Tests for SOIL:

Laboratory tests were also carried out on soil and rock samples, the details of different laboratory tests conducted as part of the project are given in the table below

| Sl. No. | Laboratory tests | IS Codes |
|---------|----------------------------|--|
| 1 | Preparation of soil sample | IS: 2720(part-1)-1983 (Reaffirmed 2015) |
| 2 | Moisture Content | IS: 2720(part-2)-1973 (Reaffirmed 2015) |
| 3 | Specific Gravity | IS: 2720(part-3)(sec-1)-1980 (Reaffirmed 2016) |
| 4 | Grain Size Analysis | IS: 2720(part-4)-1985 (Reaffirmed 2015) |
| 5 | Atterberg's Limits | IS: 2720(part-5)-1985 (Reaffirmed 2015) |
| 6 | Bulk Density | |
| 7 | Triaxial Shear Strength | IS: 2720(part-11)-1993 (Reaffirmed 2016) |
| 8 | Direct Shear Strength | IS: 2720(part-13)-1986 (Reaffirmed 2016) |
| 9 | Consolidation Test | IS: 2720(part-15)-1986 (Reaffirmed 2016) |

Table 5.2: Details of laboratory test conducted for soil.

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5.4 Laboratory Test Result of SOIL:

This section comprises depth wise results of the tests conducted in laboratory for soil masses in accordance with relevant standard codes of practices. Multiple tests in laboratory (Table 5.2)are adopted to ascertain the different essential characteristics of sub-surface using field samples obtained in during field investigations and borehole drilling. The tests as under have been conducted to ascertain the parameters indicated in the test.

Representative core samples have been taken from the boreholes (**BH18-BH33**) along the tunnel alignment. The samples were properly labelled and packed carefully and sent NABL accredited laboratory for determining the physico-mechanical engineering properties as per Indian standardized regulation. Summary of results from the laboratory testing has been graphically presented below.

5.4.1 Cohesion:

Cohesion values from all the all kinds of soil are found to 2 group. As shown in Figure 5.1 CL type soil mass has higher cohesion value (clustered green dots in graph) ranging between 25-35 kPa and other 3 types of soil are comprised of another group with values ranging from 4-12 kPa.



Figure 5.1 Graph showing laboratory tested cohesion for soil from entire borehole length vs RL. (Refer to Annexure J in Geotechnical Report for detail).

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To make recommendation related to the engineering property of the surrounding soil, which is going to directly influence the tunnel built, samples from 2D has been considered. Pareto chart has been prepared to identify the most frequent and categorically influential data set out of the scattered values. It is based on 80/20 rule, i.e., "Vital few and trivial many" principle. The idea is that the few identified vital values will always statistically dominate over many.



Figure 5.2: Pareto Chart showing recommended cohesion value for the non-cohesive soil within 2D depth.

80% of the laboratory tested cohesion value for SM and ML type of soil samples from 2D depth shows a scattered range of values ranging from 3-12 kPa. For safer construction the lower value of the range **3 kPa** is recommended for cohesive strength of the noncohesive soil.



Figure 5.3: Pareto Chart showing recommended cohesion value for the cohesive soil within 2D depth.

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80% of the laboratory tested cohesion value for the CL type of soil sample from 2D depth ranges between 25-31 kPa. For safer construction the lower value of the range **25 kPa** is recommended for cohesive strength of the cohesive soil.

5.4.2 <u>Natural Weight:</u>

Density (Natural Weight) of all kind of soil found to be linearly increasing with depth. The trend of variation with depth is shown below in Figure 5.4.



Figure 5.4: graph for Natural weight of soil from entire borehole length vs RL (Refer to Annexure J in Geotechnical Report for detail).

Natural weight value has been recommended (separately for both group of soil) using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.

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Figure 5.5: Pareto Chart showing recommended density value for the non-cohesive soil within 2D depth.

80% of the laboratory tested Density value for the SM and ML type of soil samples from 2D depth ranges between 1765 - 1942 kgm⁻³. For safer construction the lower value of the range **1765 kgm⁻³** is recommended for density of the noncohesive soil.



Figure 5.6: Pareto Chart for recommended density value for the cohesive soil within 2D depth.

80% of the laboratory tested density value for the CL type of soil samples from 2D depth ranges between 1852 -2018 kgm⁻³. For safer construction the lower value of the range **1852 kgm⁻³** is recommended for density of the cohesive soil.

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5.4.3 Modulus of Elasticity (E):

The drained modulus (E') values are determined based on the corrected SPT N value $-N_{60}$ for granular as well as cohesive soils. For cohesive soil- $\mathbf{E'} = 1.2 \times N_{60}$ (MPa), and for cohesionless soil- $\mathbf{E'} = 1.0 \times N_{60}$ (MPa). Modulus of elasticity was found to be increasing from 10 MPa to 15 MPa with depth up-to first 15 meter from the surface (Figure 5.7), after which it falls within a constant range of value around 30 ± 1 MPa up-to the floor of the tunnel.



Figure 5.7: graph for Modulus of elasticity for soil from entire borehole length vs RL. (Refer to Annexure J in Geotechnical Report for detail).

Natural weight value has been recommended (separately for both group of soil) using the statistical tool namely Pareto chart, selecting samples from 2D depth only. The result is shown below.

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As shown in the *Pareto Chart* above, 80% of the calculated Modulus of Elasticity (based on the

equation $E=N_{60}$) for the noncohesive (SM & ML) soil sample from 2D depth ranges between 30.6-39 MPa. For safer construction, the lower value of the range **30 MPa** is recommended as the E value for the noncohesive soil. No pareto chart has been constructed for Cohesive Soil (CL), because they have consistent E value of 28 MPa for all the samples from 2D depth. Hence, **28 MPa** is the recommended Modulus of Elasticity for the cohesive soil.

5.4.4 <u>Angle of internal friction (ϕ) for non-cohesive soil</u>

Angle of internal friction (ϕ) for non-cohesive soil has been determined depth wise from the corrected field SPT N value as per IS2131. To make a recommendation for the phi value of non-cohesive soil samples (**from BH18-BH33**) were analyzed from 2D elevation from the tunnel formation level. As shown below in the Figure 5.9, 95% of the phi values (2 Sigma) in the 2D lies within a range of 31.53 ± 2.72 . The variation in phi values within the range being absolutely normally distributed, we can safely consider the mean value (rounded up) 32° as the recommended phi value for construction.

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Figure 5.9: Distribution of non-cohesive soil Phi value within 2D overburden depth (Detail distribution of phi values along chainage are graphically shown in the Figure 4.12 to 4.14).

To be even more precise similar statistical analysis were carried out separately for the soil samples along the tunnel alignment and those are form 1D elevation from the crown. Results are graphically shown in the Figure 5.10 and Figure 5.11.



Figure 5.10: Distribution of non-cohesive soil Phi value within 1D overburden depth

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It was found from above two graphs that, 95% of the samples have phi values in the range of 31.68 ± 2.8 for the 1D depth (Figure 5.10), while 31.32 ± 2.64 for the tunnel alignment (Figure 5.11). Therefore, **the recommended phi value of** 32° still remains valid even if tunnel alignment and 1D above it are considered separately.

5.4.5 <u>Angle of internal friction (ϕ) for cohesive soil</u>

Angle of internal friction (ϕ) for cohesive soil has been determined depth wise from laboratory test. To make a recommendation for the phi value of cohesive soil samples (from **BH18-BH33**) were analysed from 2D and 1D elevation from the tunnel formation level. As shown below in the Figure 5.12 & Figure 5.13, 95% of the phi values (2 Sigma) in the 2D and 1D lies within a range of 11.6 ±2.06 and having a modal value of 10. Therefore, as a representative value of phi for the cohesive soil is recommended to be **12°**.

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Figure 5.12: Distribution of cohesive soil Phi value within 2D overburden depth (Detail distribution of phi values along chainage are graphically shown in the Figure 4.12 to 4.14).

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Figure 5.13: Distribution of cohesive soil Phi value within 1D overburden depth (Detail distribution of phi values along chainage are graphically shown in the Figure 4.12 to 4.14).

** for chainage wise variation in C and ϕ values refer Figure 3.12 to Figure 3.15

******* All the recommended values for different soil parameters are tabulated in Table 6.2, Chapter-6: Conclusion and Recommendations.

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6 Conclusion and Recommendations:

The total tunnel length is 4.7 km (CH24900-CH29600), out of which 1.1 km (CH24900-CH25980) km of tunnel will be within the quartzite rock mass of Delhi Supergroup with Portal-I at CH24900. 2.9 km (CH25980-CH28900) km of the tunnel will be through soil and a NATM structure will be built at CH28900. 700m after this structure will be cut & cover in soil and the Portal-II will be built at CH29600.

Based on the available surface information from the geological field investigation and close observation of the drilled cores from the litho-logs, it has been observed that after crossing the soil the tunnel will enter into a folded rock mass where the axis of the tunnel will be perpendicular to the fold axis, thus favorably oriented with respect to the folded bedding planes. However, the folded rock layer has suffered extreme level of later brittle fracturing, which has been testified by the presence of 6 sets of joints of different orientation and a few late brittle discrete shear zones (which is certainly not active in nature). These joints and the fractures have significantly reduced the strength of the otherwise sufficiently cohesive metamorphic rock mass. Presence of the intersecting closely spaced joint sets make the tunnel part within the rock body highly susceptible to wedge failure.

From the results of different on-site and laboratory tests of the rock samples, the recommended values for the different parameters are tabulated below;

| ROCK | | |
|-----------------------------|------------------|--|
| Properties | Values | |
| Lugeon Value | 28.4 | |
| UCS (MPa) | 60 MPa | |
| RMR | 20-40 (CLASS IV) | |
| Tensile Strength (MPa) | 15 MPa | |
| Point Load Strength (MPa) | 2.5 MPa | |
| Modulus of Elasticity (GPa) | 39 GPa | |
| Poisson's Ratio | 0.15 | |
| Hardness | 55 | |
| Abrasion index | 3.30 | |
| Cohesion (MPa) | 15 MPa | |
| Phi (degree) | 55° | |
| Water absorption | 0.54 % | |

Table 6.1: Recommended values for engineering properties of rock

| Consultant: | Geotechnical Investigation Report | | Client : |
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The rock mass as a whole statistically belong to Class-IV. Therefore, as per Bieniawski, 1989, systematic bolts 4-5m long, spaced 1-1.5 m in crown and walls with wire mesh, 100-150 mm shotcrete in crown and 100mm shotcrete in sides, light to medium steel ribs spaced 1.5 m is recommended as tunnel support. However, along some chainage interval the support system of Class III may be used by the discretion of the design engineer. For chainage wise variation in RMR value refer to Figure 3.11.

Almost 2.5 km of tunnel will be running through the soil, which constitutes 44% of Inorganic Clay rich Soil (CL), 33% of Inorganic Silty Soil (ML) and kanker and 23% is Silty Sand (SM). The recommended values for the different parameters for soil are tabulated below;

| | TYPE OF SOIL | MIN. | MAX. | Recommended Values |
|--|---------------------------------|------------------------|------------------------|------------------------|
| FIELD N VALUE | | 11 | 50 | |
| CORRECTED N VALUE | | 5.75 | 29 | |
| | CL | 23.54 kPa | 35.30 kPa | 25 kPa |
| Cohesion (C) | ML | 1.96 kPa | 18.63 kPa | |
| (from Laboratory Test) | ML-CL | 7.85 kPa | 19.61 kPa | 3 kPa |
| | SM | 1.96 kPa | 3.92 kPa | |
| Φ for cohesive soil (from Laboratory Test) | CL | 9° | 16° | 12° |
| Φ for non ochoging goil | ML | 28° | 36° | |
| Ψ for non-conesive soli (from corrected N Value) | ML-CL | 29° | 34° | 32° |
| (If our corrected it value) | SM | 29° | 32° | |
| | Cohesive (CL) | 28 MPa | 28 MPa | 28 MPa |
| Modulus of Elasticity (E) | Non-Cohesive (ML, SM, ML-CL) | 25 MPa | 39 MPa | 30 MPa |
| | Cohesive (CL) | 1604 kg/m^3 | 2018 kg/m ³ | 1852 kg/m^3 |
| Density | Non-Cohesive (ML, SM, ML-CL) | 1752 kg/m ³ | 2009 kg/m ³ | 1765 kg/m ³ |

Table 6.2: Recommended values for engineering properties of soil.

| Consultant: | Geotechnical Investigation Report | | Client : |
|------------------|-----------------------------------|------------|-----------------------------|
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None of the boreholes reached the ground water table. Therefore, based on the preliminary survey, it can be predicted that the tunnel will not face any difficulty due to encounter of ground water table during the construction. However, the overlying rock strata having significant nos. of joint set is quite capable of percolating rain waters during the rainy seasons. There is also a ditch around CH 25500, which is situated almost 31.87m above the roof of the tunnel. This ditch may be connected to a perched water table with a limited water resource. The joint sets and the ditch may act as efficient path ways of rainwater recharge into the tunnel during the rainy season. Therefore, it may be recommended that suitable drainage system should be designed along with the tunnel to drain out that percolated water to avoid water logging during and after the construction of the tunnel. However, such kind of ingress of water is purely seasonal and temporary. Therefore, the water-proofing membrane may also be dispensed with.

Geotechnical Investigation Report

Old Ch. 27+620 to Old Ch. 28+900 km (New CH: 28+287 to 29+567) km

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

JUNE - 2022

| SR. No. | Report No. | Revision No. | Date |
|-----------|--|---------------------|------------|
| 544_21-22 | CEGTH/HRIDCL/SR-544/2022-23/938_(18 BHs) | 00 | 03.10.2022 |



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-544/2022-23/938

Date:- 03.10.2022

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 18 borehole carried out at Old Ch. 27+620 to Old Ch. 28+900 (New CH: 28+287 to 29+567) 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.

Njor

Nehal Jain General Manager - Geotechnical Authorized Signatory

Prepared By:-

Broth

Ankur Mudgal Sr. Manager

| SR. No. | Report Ref. No. | Revision No. | Date |
|-----------|--|--------------|------------|
| 544_21-22 | CEGTH/HRIDCL/SR-544/2022-23/938_(18 BHs) | 00 | 03.10.2022 |



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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 of soil, field test results, laboratory test results, analysis of results and recommendations for proposed structure carried out at Old Ch. 27+620 to Old Ch. 28+900 (New CH: 28+287 to 29+567). based on soil sample collected from the locations of 18 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:-

<u>Panipat</u>: 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.

<u>Rohtak</u>: 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.

<u>Rewari:</u> 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.

<u>Mewat:</u> 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.

On soil Samples

- Dry density test
- o Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- o Liquid Limit and Plastic Limit
- Specific gravity
- $\circ~$ Shrinkage Limit





- Free Swell Index
- Direct Shear Test
- o Triaxial Shear Test
- o 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

On Rock Samples

- 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 three 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. 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 18 boreholes carried out at Old Ch. 27+620 to Old Ch. 28+900 (New CH: 28+287 to 29+567) were marked at site at specified locations. These locations are shown in Appendix A-1 attached subsequently.

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The details of various boreholes along with their coordinates are provided herein below:

| . No. | iage Old km) | lage New km) | (km) Structure | L.No. | H.No. of Water e below L (m) | pth of ole below L (m) | Co-ordinates (m) | | (+) R.L. (m) | |
|-------|-----------------|-----------------|-------------------|---|---------------------------------------|------------------------------|------------------|-------------|-----------------|---------|
| Ś | Chain (J | Chain (J | | BF Depth Tabl EG | Dej Boreho EG | Е | Ν | | | |
| 1. | | 29+297 | | BH-A1 | 33.10 | 40.00 | 697786.663 | 3123079.115 | 270.946 | |
| 2. | | | | BH-P1 | 32.90 | 40.00 | 697786.520 | 3123062.116 | 271.001 | |
| 3. | 27. (20 | | | BH-P2 | 33.00 | 60.00 | 697786.377 | 3123047.116 | 271.080 | |
| 4. | 27-020 | 207207 | | BH-P3 | 33.13 | 60.00 | 697786.129 | 3123021.117 | 270.749 | |
| 5. | | | | BH-P4 | 33.14 | 50.00 | 697785.986 | 3123006.118 | 271.774 | |
| 6. | | | | BH-A2 | 33.12 | 40.00 | 697785.825 | 3122989.119 | 271.929 | |
| 7. | | 28+743 | | BH-A1 | 32.67 | 55.00 | 697330.702 | 3123086.726 | 269.806 | |
| 8. | 28+075 | | 28+742 | de la | BH-P1 | 32.68 | 55.00 | 697330.717 | 3123064.726 | 270.070 |
| 9. | | | Brid | BH-P2 | 33.20 | 55.00 | 697330.724 | 3123026.726 | 270.499 | |
| 10. | | | jor | BH-A2 | 33.21 | 55.00 | 697330.724 | 3123004.726 | 270.616 | |
| 11. | 28+360 | | | Ma | BH-A1 | 34.78 | 40.00 | 697053.722 | 3123109.166 | 268.602 |
| 12. | | 260 20+020 | | BH-P1 | 34.10 | 50.00 | 697050.915 | 3123091.386 | 267.861 | |
| 13. | | 29+028 | | BH-P2 | 33.85 | 50.00 | 697046.700 | 3123064.680 | 267.285 | |
| 14. | | | | BH-A2 | 34.20 | 40.00 | 697043.901 | 3123046.953 | 267.528 | |
| 15. | 28+900 | 0 29+567 | +567 | BH-A1 | 36.90 | 40.00 | 696531.197 | 3123223.834 | 262.678 | |
| 16. | | | | BH-P1 | 38.10 | 50.00 | 696528.146 | 3123214.311 | 263.022 | |
| 17. | | | | BH-P2 | 34.55 | 50.00 | 696520.214 | 3123189.550 | 263.955 | |
| 18. | | | | BH-A2 | 34.50 | 40.00 | 696517.163 | 3123180.027 | 263.847 | |

Table 1.1: Details of Borehole Locations

*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.
- The Ground Water Table was met at depths of from 32.67m to 38.10 m 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 bookof V.N.S. Murthy)

| Correlation for Cla | y / 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 +
$$\frac{1}{2}$$
 (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.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

| Description of Test | Reference | Undisturbed (UDS) Soil Samples | Disturbed (DS/SPT) Soil Samples |
|--|---------------------------|--------------------------------------|---------------------------------------|
| Grain Size Analysis / Hydrometer | IS: 2720 (Part - 4) | \checkmark | \checkmark |
| Natural Moisture Content / Bulk / Dry density | IS : 2720 (Part – 2) | \checkmark | - |
| Atterberg Limits | | | |
| Liquid Limit | IS: 2720 (Part - 5) | \checkmark | \checkmark |
| Plastic Limit | IS: 2720 (Part - 5) | | \checkmark |
| Specific Gravity | IS : 2720 (Part – 3) | | |
| Direct Shear Test | IS : 2720 (Part – 13) | \checkmark | \checkmark |
| Triaxial compressive shear test | IS : 2720 | | |
| | (Part – 11 & 12) | , | , |
| Chemical Analysis of Soil Samples | IS : 2720 (Part – 26, 27) | \checkmark | - |

 Table 1.3: Description of Tests

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 $(\gamma_b) = W/V$

Dry density $(\gamma_d) = \gamma_b / (1+Wn)$

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 75 micron. 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):





$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = \sqrt[M]{\frac{H_R}{t}}$$

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 :

 $G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$



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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 $30^{\circ} \pm 1/2^{\circ}$. The weight of the cone, together with its associated shaft is $80g \pm 0.5g$. 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 (\pm 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 $(30 \pm 0.1g)$ 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 borehole carried out at Old Ch. 27+620 to Old Ch. 28+900 (New CH: 28+287 to 29+567).

At location of O.C. 27+620 (N.C. 28+287) :-

The sub strata of BH-A1 mainly consist of Silty Clay of low plasticity (CL) and sandy silt of low plasticity (ML-CL).

The sub strata of BH-A2 mainly consist of sandy silt of low plasticity (ML-CL) followed by Silty Clay of low plasticity (CL).

The sub strata of BH-P1 mainly consist of Silty Clay of low plasticity (CL).

The sub strata of BH-P2 mainly consist of sandy silt of low plasticity (ML-CL) followed by Silty Clay of low plasticity (CL).

The sub strata of BH-P3 mainly consist of Silty Clay of low plasticity (CL).

The sub strata of BH-P4 mainly consist of sandy silt of low plasticity (ML-CL) followed by Silty Clay of low plasticity (CL).

At location of O.C. 28+075 (N.C. 28+743) :-

The sub strata of BH-A1 mainly consist of Sandy silt of low plasticity (ML-CL) and Silty Clay of low plasticity (CL).

The sub strata of BH-A2 mainly consist of Sandy silt of low plasticity (ML-CL) and Silty Clay of low plasticity (CL).

The sub strata of BH- P1 mainly consist of Silty Clay of low plasticity (CL), Sandy silt of low plasticity (ML-CL) and Silty sand (SM).

The sub strata of BH-P2 mainly consist of sandy silt of low plasticity (ML-CL) and Silty sand with clay (SM-SC).

At location of O.C. 28+360 (N.C. 29+028):-

The sub strata of BH-A1 mainly consist of Sandy silt of low plasticity (ML-CL) Silty sand with clay (SM-SC) and Silty sand (SM).

The sub strata of BH-A2 mainly consist of Silty sand (SM) and Sandy silt of low plasticity (ML-CL).

The sub strata of BH-P1 mainly consist of Silty sand (SM) and Sandy silt of low plasticity (ML-CL) Silty sand with clay (SM-SC).

The sub strata of BH-P2 mainly consist of Sandy silt of low plasticity (ML-CL) Silty sand with clay (SM-SC).



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At location of O.C. 28+900 (N.C. 29+567):-

From the study of the borehole logs of 04 BHs, it is revealed that the sub strata from EGL to 40.0-50.0m depth mostly consist of fine grained soil i.e. silty clay of low plasticity (CL) with some layers of coarse grained soil i.e. sandy silt of low plasticity (ML-CL) embedded in between.

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table was met at depths of from 32.67m to 38.10 m below EGL as given in Table 2.1, 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 2 to 3.0m at the locations of boreholes.

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 :-

| Chemical Property | Findings (Min. to Max.) | Remarks (Required limits as per IS 456-2000) |
|----------------------------------|--------------------------|--|
| pН | 6.85 to 8.61 | > 6.0 |
| Sulphite as SO_3^{2-} (%) | 0.0022 (%) to 0.0035 (%) | < 0.2% (Class I) |
| Chlorides as Cl ⁻ (%) | 0.047 (%) to 0.078 (%) | No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31) |

Summary of chemical analysis of soil samples

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

6.3 INTERPRETATION OF LAB TEST RESULTS

Grain Size Analysis

- Clay content: It generally varies from 4 to 14%.
- Silt content: It generally varies from 22 to 68%.
- Sand content: It generally varies from 23 to 86%.
- **Gravel content:** It generally varies from 2 to 10%.

Atterberg's Limit

• Liquid limit: The test results of liquid limit of the soil samples reveal that it generally varies from 27 to 29% in ML-CL type of soil, 30 to 35% in CL type of soil.



- **Plastic Limit:** The plastic limit of the soil sample varies from 20 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 12% 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 1.64gm/cc to 1.98gm/cc whereas natural moisture content varies from 9.22% 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/cm² to 0.11 kg/cm².

For Silty strata (ML-CL), the value of angle of internal friction varies from 22° to 27° , whereas cohesion varies from 0.19 kg/cm² to 0.22 kg/cm².

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 .



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Abbreviations

| Borehole |
|-----------------------------|
| Electrical Resistivity Test |
| Existing Ground Level |
| Ground Water Table |
| Indian Standards |
| Standard Penetration Test |
| Disturbed Soil |
| Reduced Level |
| Metre |
| Specific Gravity |
| Percentage |
| Milligram per litre |
| 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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| C | JANI NET ANA AN | | | | FIE | ELD | BOREHOLE L | OG | | | | | |
|--------------|-----------------------------|----------------|------------------|------------|------------|------------|--|-----------------|------------------|-------------------------------|-------------------|--|---|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | Client :HRIDCL | | | | |
| BH Loc | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123079.115 m | Eas | ting :697786.6 | 663 m | | | |
| Reduced | d Level (i | n):(+)270 | 0.946 | | | | BH. No. :BH-A1 | BH | Termination L | Depth (m):40 | | | |
| Propose | ed / Exist | ing Struci | <i>ture</i> :Maj | or Bridge | ; | | Water Table (m):33.10 | Incl | ination : Verti | cal | | | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing (i | m) :Not Used | | | |
| Date of | Start :11 | -10-2021 | | | .4 | | Date of Completion :12-10-2021 | | | | | | |
| | л ө Ê | | | per 15cm | 1 | OPT | | ation | | (De sette | al | | |
| Depth (m) | In-Situ Sampl Depth (| Sample Type | N1 | N2 | N3 | N Value | Strata Description | IS lassifica | Graphic Log | (Depth v/s SPT N Value) | Specia bservat | | |
| 0.0 | | DS | | | | | | 0 | 0 10 | 0 20 30 40 50 60 70 80 9010 | <u>, 0</u> | | |
| 0.5 | . 1 | UDS-1 | | | | | | | | | - | | |
| 1.5 | | | | | | | | | | | _ | | |
| 2.0 | 2.5 | SPT-1 | 2 | 7 | 8 | 15 | | | | • | | | |
| 3.0 | | | | | | | | | | | _ | | |
| 3.5 | | | | | | | Brown, Very stiff, Silty clay of low plasticity | CL | | | _ | | |
| 4.0 | . 4 | UDS-2 | | | | | | | | | - | | |
| 5.0 | . 5.5 | SPT-2 | SPT-2 | SPT-2 | 7 | 7 | 9 | 16 | | | | | _ |
| 6.0 | | | | | | | | | | | _ | | |
| 6.5 | . 7 | UDS-3 | | | | | | | | | _ | | |
| 7.5 | | | | | | | | | | | _ | | |
| 8.0 | 8.5 | SPT-3 | 12 | 17 | 24 | 41 | Brown, Dense, Sandy silt of low | | | | | | |
| 9.0 | | | | | | | plasticity with gravel | WIL-UL | | | | | |
| 9.5 | 10 | | | | | | | | | | - | | |

| Ca | ATT CARLON | | | | FIE | CLD | BOREHOLE L | OG | | | | |
|--|-------------------------------|-------------------------|-------------------|----------------------|------------|-------------------|---|---|----------------|---|--|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | alan in the state of Haryana. <i>Client</i> :HRIDCL | | | | |
| BH Loca | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123079.115 m | 6.663 m | | | | |
| Reduced | l Level (r | n):(+)270 | .946 | | | | BH. No. :BH-A1 | BH T | Fermination | n Depth (m):40 | | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):33.10 | Inclin | nation : Ve | ertical | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casing | g (m) :Not Used | | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :12-10-2021 | | | | | |
| | Ê | | В | low coun per 15cm | its າ | | | ion | | su | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opepth (Depth v/s special SPT N Value) Operation (Depted to a transmission of the transmission of transmission of the transmission of | | |
| 10.5 11.0 11.5 12.0 12.5 12.5 13.0 13.5 13.5 14.0 14.5 15.0 15.5 | 11.5 | SPT-4 UDS-5 SPT-5 | 9 | 14 | 16 | 30 | Brown, Dense, Sandy silt of low plasticity with gravel | ML-CL | | | | |
| 16.0 16.5 17.0 | 16 | UDS-6 | | | | | | | | | | |
| _17.5_ | 17.5 | SPT-6 | 22 | 40 | 43 | 83 | | | | | | |
| 18.0 18.5 | | | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | | |
| 19.0 | 19 | UDS-7 | | | | | | | | | | |
| 19.5 20.0 | | | | | | | | | | | | |

| Can a second | JANI ITTANI N | | | | FIE | CLD | BOREHOLE L | OG | | | | | |
|--|-----------------------------------|---------------------------------|----------------|----------------------|-----------------------------------|-------------------|---|------------------|-----------------------------|---|--|--|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | | | |
| BH Loc | ation/Ch | ainage :2' | 7+620 kn | n | | | Northing :3123079.115 m | East | ting :69778 | 6.663 m | | | |
| Reduced | d Level (r | n):(+)270 | .946 | | | | BH. No. :BH-A1 | BH | BH Termination Depth (m):40 | | | | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):33.10 | Incl | ination : Ve | ertical | | | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used | | | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :12-10-2021 | · | | | | | |
| | _ @ Û | | В | low cour per 15cn | nts n | | | tion | | l I ons | | | |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classifica | Graphic Log | OpsetA (Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 00 00 00 00 00 00 00 00 00 00 00 00 | | | |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _23.0_ _23.5_ _24.0_ _24.5_ _25.0_ _25.5_ _26.0_ _26.5_ _26.5_ _27.0_ | 20.5 222 23.5 25 26.5 | SPT-7 UDS-8 SPT-8 UDS* | 14 32 27 | 19 69 40 | 22 31 (3cm) 60 (12cm) | 41 >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | B 10 20 30 40 50 60 70 60 90100 | | | |
| _27.5_ _28.0_ | 28 | SPT-10 | 36 | 74 | 26 (5cm) | >100 | | | | | | | |
| _28.5_ _29.0_ _29.5_ _30.0 | 29.5 | SPT-11 | 38 | 68 | 32 (9cm) | >100 | | | | | | | |

UDS*-UDS not recovered

| Ca | (APRIL 100 C ANNA ME | | | | FIE | CLD | BOREHOLE L | OG | | | | |
|--|----------------------------------|------------------------------------|----------------------|--|--------------------|-----------------------|---|-------------------|-----------------------------|-------------------------------|-----------------------|--|
| Project | Name :G | TI for (H | ORC) pr | oject from | n Palwal to | o Harsana | Calan in the state of Haryana. Client :HRIDCL | | | | | |
| BH Loce | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123079.115 m | 5.663 m | | | | |
| Reduced | d Level (r | n):(+)270 | .946 | | | | BH. No. :BH-A1 | BH | BH Termination Depth (m):40 | | | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):33.10 | Incl | ination : Ve | rtical | | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used | | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :12-10-2021 | | | | | |
| | Ê | | В | low coun | its า | | | ion | | | suc | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatic | |
| _30.0_ _30.5_ _31.0_ _31.5_ _32.0_ _32.5_ _32.5_ _33.0_ _33.5_ _34.0_ _34.5_ _34.5_ _34.5_ _35.0_ _35.5_ _35.5_ _36.0_ _36.5_ _37.0_ _37.5_ | 3 1 32.5 34 35.5 | SPT-12 UDS* SPT-13 SPT-14 | 40 32 30 46 | 100 (15cm) 36 39 100 (13cm) | - - 48 52 | value >100 84 91 >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | | |
| 38.0_ 38.5_ 39.0_ | 38.5 | SPT-16 | 30 | 82 | 18 (3cm) | >100 | | | | | | |
| _39.5_ | 40 | _SPT-17 | 25 | 40 | 48 | 88 | | | | | | |

| Ca | APPE - | | | | FIE | ELD | BOREHOLE L | OG | | | | | | |
|--------------|-------------------------------|----------------|----------|----------------------|----------|-------------------|--|-------------------|----------------|--------------------------------|--|--|--|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | Client :HRIDCL | | | | | |
| BH Loca | ation/Cha | ainage :2' | 7+620 kr | n | | | Northing :3123062.116 m Easting :697786.52 m | | | | | | | |
| Reduced | l Level (n | n):(+)271 | .001 | | | | BH. No. :BH-P1 | BH | Terminatic | on Depth (m):40 | | | | |
| Propose | d / Existi | ing Struct | ure :Maj | or Bridge | | | Water Table (m):32.90 | Incl | ination : V | 'ertical | | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casir | ıg (m) :Not Used | | | | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :12-10-2021 | I | | | | | | |
| | ê | | В | low coun per 15cm | its 1 | | | ion | | suc | | | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth (Depth v/s SPT N Value) | | | | |
| | | DS | | | | | | - | | | | | | |
| 0.5 | 1 | SPT-1 | 2 | 3 | 3 | 6 | | | | | | | | |
| 1.5 | | | | | | | Brown, Medium stiff, Silty clay of | CL | | | | | | |
| 2.5 | 2.5 | UDS-1 | | | | | low plasucity | | | | | | | |
| 3.0 | | | | | | | | | | | | | | |
| 4.0 | 4 | SPT-2 | 9 | 16 | 18 | 34 | | | | | | | | |
| 4.5 5.0 | | | | | | | Brown, Dense, Silty sand | SM | | | | | | |
| 5.5 | 5.5 | UDS-2 | | | | | | | | | | | | |
| 6.5 | | | | | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 7 | 12 | 14 | 26 | | | | | | | | |
| 7.5 | | | | | | | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | CL | | | | | | |
| 8.5 | 8.5 | UDS-3 | | | | | | | | | | | | |
| 9.0 | | | | | | | | | | | | | | |
| 9.5 | 10 | SPT-4 | Q | 11 | 15 | 26 | | | | | | | | |

| Ca | STATIC CONTRACTOR | | | | FIE | ELD | BOREHOLE L | OG | | | | |
|--|----------------------------------|---|-----------------|----------------------|------------|-------------------|--|------------------------------|-----------------------------|--|--|--|
| Project | <i>Name</i> :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | a Kalan in the state of Haryana. | e of Haryana. Client :HRIDCL | | | | |
| BH Loce | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123062.116 m | East | <i>Easting</i> :697786.52 m | | | |
| Reduced | d Level (r | n):(+)271 | .001 | | | | BH. No. :BH-P1 | BH | Terminatio | n Depth (m):40 | | |
| Propose | ed / Exist | ing Struct | <i>ure</i> :Maj | or Bridge | | | Water Table (m):32.90 | Incl | ination : Ve | ertical | | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | <i>g (m)</i> :Not Used | | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :12-10-2021 | | | | | |
| | (| | В | low cour per 15cm | its າ | | | ion | | suc | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opsectiant V/s SPT N Value Opsectiant | | |
| _10.0_ _10.5_ _11.0_ _11.5_ _12.0_ _12.5_ _12.5_ _13.0_ _13.5_ _14.0_ _14.5_ _14.0_ _14.5_ _15.5_ _15.0_ _15.5_ _16.0_ _15.5_ _16.0_ _16.5_ _17.0_ _17.5_ _18.0_ _18.5_ _19.0_ | 11.5 13 14.5 16 17.5 | UDS-4 SPT-5 UDS-5 SPT-6 UDS-6 | 18 | 24 | 26 | 50 | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | CL | | 10 20 30 40 50 60 70 80 90 100 1 | | |
| 19.5 | | | | | | | | | | | | |

| C | JANI ITT CARACTER | | | | FIE | CLD | BOREHOLE L | OG | | | |
|--|-------------------------------|----------------|----------|----------------------|-------------|-------------------|---------------------------------------|-------------------|------------------|-------------------------------|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL | | |
| BH Loce | ation/Ch | ainage :2' | 7+620 kn | n | | | Northing :3123062.116 m | East | ing :697786.52 | 2 m | |
| Reduced | l Level (i | n):(+)271 | .001 | | | | BH. No. :BH-P1 | BH | Termination De | epth (m):40 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):32.90 | Incli | ination : Vertic | al | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing (m |) :Not Used | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :12-10-2021 | I | | | |
| | Ê | | В | low cour per 15cn | nts n | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatic |
| 20.0 | | | | | | | | 0 | 0 10 | 20 30 40 50 60 70 80 90 100 | |
| _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ | 20.5 | UDS-7 SPT-8 | 24 | 38 | 43 | 81 | | | | | |
| _23.0_ _23.5_ _24.0_ | 23.5 | UDS-8 | | | | | Brown, Very stiff to hard, Silty clay | CL | | | |
| _24.5_ _25.0_ _25.5_ _26.0_ _26.5_ | 25 | SPT-9 UDS-9 | 13 | 20 | 24 | 44 | of low plasticity with gravel | | | | |
| _27.0_ | 20 | 007.40 | 20 | 50 | 48 | > 100 | | | | | |
| 28.5 29.0 | 20 | Sr' 1- 10 | 32 | υÜ | | - 100 | Brown, Very dense, Sandy silt of | ML-CL | | | |
| _29.5_ | 29.5 | SPT-11 | 40 | 65 | 35 (8cm) | >100 | low plasticity with gravel | WIL-OL | | | , |

| Ca | ATT CONTRACTOR | | | | FIE | CLD | BOREHOLE L | O | G | | |
|--------------------------------------|-------------------------------|----------------|----------|------------|--------------|-------------------|--|---------|-------------|----------------|-------------------------------|
| Project | Name :G | TI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | | Clier | t :HRIDO | Ľ |
| BH Loca | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123062.116 m | | Easti | ng :69778 | 36.52 m |
| Reduced | l Level (1 | n):(+)271 | .001 | | | | BH. No. :BH-P1 | | BH 1 | erminatio | n Depth (m):40 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | 2 | | Water Table (m):32.90 | | Incli | nation : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | | Dept | h of Casir | g (m) :Not Used |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :12-10-2021 | | | | |
| | - | | В | low cour | nts n | | | | ion | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | <u></u> | Classificat | Graphic Log | (Depth v/s SPT N Value) |
| _30.5_ _31.0_ _31.5_ _32.0_ | 31 | SPT-12 | 53 | 75 | 25 (2cm) | >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML | CL | | |
| _32.5_ | 32.5 | SPT-13 | 21 | 34 | 46 | 80 | | | Ţ | - 32.90m | |
| _33.5_ _34.0_ _34.5_ | 34 | SPT-14 | 26 | 38 | 52 | 90 | | | | | |
| _35.0_ _35.5_ _36.0_ | 35.5 | SPT-15 | 30 | 42 | 56 | 98 | | | | | |
| _36.5_ _37.0_ _37.5 | 37 | SPT-16 | 25 | 46 | 54 (10cm) | >100 | Brown, Hard, Silty clay of low plasticity with gravel | C | CL | | |
| _38.0_ | 38.5 | SPT-17 | 30 | 52 | 48 (8cm) | >100 | | | | | |
| 39.5 | 40 | SPT-18 | 24 | 42 | 49 | 91 | | | | | |

| Ca | ANI I CARANA | | | | FIE | ELD | BOREHOLE L | OG | | | |
|-------------------|--------------------------------|----------------|-------------|------------|-------------|-------------------|--|---------------------|----------------|---------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal te | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDC | L | |
| BH Loca | ation/Cha | ainage :2 | 7+620 kn | n | | | Northing :3123047.116 m | East | ting :69778 | 6.377 m | |
| Reduced | l Level (n | n):(+)271 | .080 | | | | BH. No. :BH-P2 | BH | Terminatio | n Depth (m):60 | |
| Propose | d / Exist | ing Struct | ture : Maj | or Bridge | | | Water Table (m):33.00 | Incli | ination : V | ertical | |
| Boring t | <i>ype</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casin | g (m) :Not Used | |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :21-11-2021 | 1 | 5 | | |
| | | - | В | low coun | its | | | E E | | | s |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificatio | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| 0.0 | | DS | | | | | | 0 | | 0 10 20 30 40 50 60 70 80 90100 | |
| 0.5 1.0 1.5 | 1 | UDS-1 | | | | | | | | | |
| 2.0 | | | | | | | Brown, Medium dense, Sandy silt of low plasticity | ML-CL | | | |
| 2.5 | 2.5 | SPT-1 | 3 | 5 | 6 | 11 | | | | | |
| 3.5 | | | | | | | | | | | |
| 4.0 | 4 | UDS-2 | | | | | | | | | |
| 4.5 5.0 | | | | | | | | | | | |
| 5.5 | 5.5 | SPT-2 | 10 | 15 | 18 | 33 | | | | | |
| 6.0 | | | | | | | | | | | |
| 6.5 7.0 | 7 | UDS-3 | | | | | Brown, Hard, Silty clay of low | CI | | | |
| 7.5 | | | | | | | plasticity with gravel | | | | |
| 8.0 | | | | | | 31 | | | | | |
| <u>8.5</u> | 8.5 | SPT-3 | -3 12 13 18 | 31 | | | | | | | |
| 9.5 | | | | | | | | | | | |
| _10.0_ | 10 | UDS-4 | | | | | | | | | |

UDS*-UDS not recovered

| Car estat | JAHI NI LANAN | | | | FIE | ELD | BOREHOLE I | COG | | | |
|--------------|---------------------------|----------------|------------------|------------|------------|------------|--|-----------------|----------------|---|-------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDC | L | |
| BH Loc | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123047.116 m | East | ing :69778 | 6.377 m | |
| Reduced | d Level (r | n):(+)271 | .080 | | | | <i>BH. No.</i> :BH-P2 | BH | Terminatio | n Depth (m):60 | |
| Propose | ed / Exist | ing Struct | <i>ture</i> :Maj | or Bridge | : | | Water Table (m):33.00 | Incli | nation : Ve | ertical | |
| Boring | <i>type :</i> Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casin | g (m) :Not Used | |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :21-11-2021 | | | | |
| | n e Ê | | В | per 15cm | 1ts 1 | SDT | | ation | | (Depth | al tions |
| Depth (m) | In-Sit Samp Depth (| Sample Type | N1 | N2 | N3 | N Value | Strata Description | IS Classific | Graphic Log | v/s SPT N Value) | Speci |
| 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 | 20 | 35 | | | | | |
| | | | | | | | | | | | |
| _12.0_ | | | | | | | | | | | |
| | | | | | | | | | | | |
| 12.5 | | | | | | | | | | | + |
| 12.0 | 12 | | | | | | | | | | |
| | 13 | 003-5 | | | | | | | | | |
| 13.5 | | | | | | | | | | | |
| | | | | | | | | | | | |
| _14.0_ | | | | | | | | | | | |
| | | | | | | | | | | | |
| _14.5_ | 14.5 | SPT-5 | 15 | 19 | 22 | 41 | | | | | |
| | | | | | | | | | | | |
| _15.0_ | | | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| | | | | | | | | | | | |
| 15.5 | | | | | | | | | | | |
| 16.0 | 16 | | | | | | | | | | |
| _ 10.0_ | 10 | 003-0 | | | | | | | | | |
| 16.5 | | | | | | | | | | | |
| | | | | | | | | | | | |
| _17.0_ | | | | | | | | | | + + + + + + + + + + + + + + + + + + + | |
| | | | | | | | | | | | |
| _17.5_ | 17.5 | SPT-6 | 16 | 19 | 28 | 47 | | | | | |
| | | | | | | | | | | | |
| 18.0 | | | | | | | | | | +++++++++++++++++++++++++++++++++++++++ | + |
| | | | | | | | | | | | |
| 18.5 | | | | | | | | | | | + |
| 10.0 | 10 | | | | | | | | | | |
| L 19.0_ | 19 | 000-7 | | | | | | | | | + |
| 19.5 | | | | | | | | | | | |
| | | | | | | | | | | | |
| _20.0_ | | | | | | | | | | | |

| Ca | JAHI DECIMINE | | | | FIE | CLD | BOREHOLE L | OG | | | |
|--|-------------------------------|-------------------------|------------------|----------------------|-----------|-------------------|--|-------------------|----------------|--|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loce | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123047.116 m | East | ing :697786. | 377 m | |
| Reduced | d Level (i | n):(+)271 | .080 | | | | BH. No. :BH-P2 | BH | Termination . | Depth (m):60 | |
| Propose | ed / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | | | Water Table (m):33.00 | Incli | nation : Vert | tical | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | (m) :Not Used | |
| Date of | Start :18 | 3-11-2021 | | | | | Date of Completion :21-11-2021 | | | | |
| | Ê | | В | low cour per 15cm | its 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 80 90100 | Special Observatic |
| _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _24.0_ _24.5_ | 20.5 22 23.5 | SPT-7 UDS-8 SPT-8 | 18 | 21 | 30 | 51 | | | | | |
| _25.0_ _25.5_ _26.0_ _26.5 | 25 | UDS-9 | 25 | 28 | 34 | 62 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | - |
| 27.0 | 20.0 | | 20 | 20 | 04 | 02 | | | | | _ |
| _27.5_ | 28 | UDS-10 | | | | | | | | | - |
| _28.5_ | | | | | | | | | | | |
| _29.0_ _29.5_ | 29.5 | SPT-10 | 25 | 29 | 35 | 64 | | | | | - |
| 30.0 | | | | | | | | | | | |

| Ca | JAPIT I | | | | FIE | CLD | BOREHOLE L | OG | | |
|--------------|-------------------------------|----------------|----------|----------------------|--------------|-------------------|--|------------------|----------------|---|
| Project | Name :C | GTI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDO | CL |
| BH Loce | ation/Ch | ainage :2' | 7+620 kr | n | | | Northing :3123047.116 m | East | ing :69778 | 36.377 m |
| Reduced | l Level (i | m):(+)271 | .080 | | | | BH. No. :BH-P2 | BH | Terminatio | on Depth (m):60 |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | e | | Water Table (m):33.00 | Incli | ination : V | ertical |
| Boring i | ype :Rot | tary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | ng (m) :Not Used |
| Date of | Start :18 | 8-11-2021 | | | | | Date of Completion :21-11-2021 | | | |
| | - e (u | | В | low cour per 15cn | nts n | | | tion | | _ ous |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classifica | Graphic Log | A do no |
| | | | | | | | | | | |
| _30.5_ | | | | | | | | | | |
| _31.0_ | 31 | UDS-11 | | | | | | | | |
| _31.5_ | | | | | | | | | | |
| _32.0_ | | | | | | | | | | |
| _32.5_ | 32.5 | SPT-11 | 30 | 35 | 45 | 80 | | | | |
| | | | | | | | | . | | |
| 33.0 | | | | | | | | - | ¥33.00m | |
| _33.5_ | | | | | | | | | | |
| _34.0_ | 34 | UDS-12 | | | | | | | | |
| _34.5_ | 34.5 | SPT-12 | 39 | 51 | 49 (10cm) | >100 | | | | |
| _35.0_ | | | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _35.5_ | | | | | | | | | | |
| _36.0_ | | | | | | | | | | |
| _36.5_ | 36.5 | SPT-13 | 44 | 59 | 41 (7cm) | >100 | | | | |
| _37.0_ | 37 | SPT-14 | 25 | 32 | 40 | 72 | | | | |
| _37.5_ | | | | | | | | | | |
| _38.0_ | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-15 | 32 | 40 | 48 | 88 | | | | |
| _39.0_ | | | | | | | | | | |
| _39.5_ | | | | | | | | | | |
| | | | | | | | | | | |
| 40.0_ | 40 | LSPT-16 | 39 | 45 | 54 | 99 | | | | |

| C | JAHI NI CANANA | | | | FIE | CLD | BOREHOLE L | OG | | | |
|--------------|-------------------------------|----------------|-------------------|----------------------|-------------|-------------------|--------------------------------|-------------------|----------------|---|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCI | | |
| BH Loc | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123047.116 m | East | ing :69778 | 6.377 m | |
| Reduced | d Level (r | n):(+)271 | .080 | | | | <i>BH. No.</i> :BH-P2 | BH | Terminatior | n Depth (m):60 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):33.00 | Incl | ination : Ve | rtical | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used | |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :21-11-2021 | · | | | |
| | e (e | | В | low cour per 15cm | nts า | | | tion | | | ons |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | opecial Observatio |
| _40.0_ | | | | | | | | | | | |
| _40.5_ | | | | | | | | | | | |
| _41.0_ | | | | | | | | | | | |
| _41.5_ | 41.5 | SPT-17 | 44 | 61 | 39 (8cm) | >100 | | | | | |
| | | | | | | | | | | | |
| _42.0_ | | | | | | | | | | | |
| _42.5_ | | | | | | | | | | | |
| _43.0_ | 43 | SPT-18 | 40 | 69 | 31 (8cm) | >100 | | | | _ | |
| 13.5 | | | | | | | | | | | |
| _40.0_ | | | | | | | | | | | |
| _44.0_ | | | | | | | | | | | |
| _44.5_ | 44.5 | SPT-19 | 48 | 75 | 25 (5cm) | >100 | | | | +++++++++++++++++++++++++++++++++++++++ | |
| _45.0_ | | | | | | | Brown, Hard, Silty clay of low | CL | | | |
| 15.5 | | | | | | | plasticity with graver | | | | |
| _43.3_ | | | | 100 | | | | | | | |
| _46.0_ | 46 | SPT-20 | 60 | (6cm) | - | >100 | | | | •••••••••••••••••••••••••••••••••••••• | |
| _46.5_ | | | | | | | | | | | |
| _47.0_ | | | | | | | | | | | |
| 47.5 | 47.5 | SPT-21 | 41 | 57 | 43 (9cm) | >100 | | | | | |
| | . 47.5 | 01 1-21 | 71 | 01 | (0011) | - 100 | | | | | |
| _48.0_ | | | | | | | | | | | |
| _48.5_ | | | | | | | | | | | |
| _49.0_ | 49 | SPT-22 | 51 | 100 (7cm) | - | >100 | | | | | |
| 49.5 | | | | | | | | | | | |
| | | | | | | | | | | | |
| _50.0_ | | | | | | | | | | | |

| Ca | JAHI DECAMINE | | | | FIE | CLD | BOREHOLE L | OG | | | |
|--|-------------------------------|----------------------------|----------------|---------------------------|----------------------------|----------------------|--|-------------------|----------------|-------------------------------|------------|
| Project | Name :G | TI for (H | ORC) pr | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCI | _ | |
| BH Loce | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123047.116 m | East | ing :697786 | 5.377 m | |
| Reduced | d Level (r | n):(+)271 | .080 | | | | BH. No. :BH-P2 | BH | Termination | <i>Depth (m)</i> :60 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):33.00 | Incli | ination : Ve | rtical | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | (m) :Not Used | |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :21-11-2021 | I | | | |
| | Ê | | В | low coun | its 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | 0bservatio |
| _50.5_ _51.0_ _51.5_ _52.0_ _52.5_ _53.0_ _53.5_ | 50.5 | SPT-23 SPT-24 SPT-25 | 43 40 47 | 55 61 100 (11cm) | 45 (7cm) 39 (6cm) | >100 >100 >100 | | | | | |
| _54.0_ _54.5_ _55.0_ _55.5_ _56.0_ | . 55 | SPT-26 | 52 | 100 (7cm) | - | >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| _56.5_ _57.0_ | 56.5 | SPT-27 | 32 | 37 | 48 | 85 | | | | | |
| _57.5_ _58.0_ _58.5_ | 58 | SPT-28 | 27 | 33 | 47 | 80 | | | | | |
| _59.0_ _59.5_ _60.0_ | 59.5 60 | SPT-29 | 39 | 45 | 50 | 95 | | | | | |

| Can and a | JAHI NI LANAN | | | | FIE | ELD | BOREHOLE L | ,OG | | | |
|-------------------|-------------------------------|----------------|-------------------|----------------------|------------|-------------------|--|------------------|----------------|-------------------------------|---------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | ent :HRIDO | L | |
| BH Loc | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123021.117 m | Eas | ting :6977 | 86.129 m | |
| Reduced | d Level (i | n):(+)270 | .749 | | | | <i>BH. No.</i> :BH-P3 | BH | Terminatio | on Depth (m):60 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | ; | | Water Table (m):33.13 | Inc | ination : V | ^v ertical | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casi | ng (m) :Not Used | |
| Date of | Start :18 | 8-11-2021 | | | | | Date of Completion :20-11-2021 | | | | |
| | | | В | low cour per 15cn | nts n | | | tion | | | l ons |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classifica | Graphic Log | (Depth v/s SPT N Value) | Specia Observati |
| 0.0 | | DS-1 | | | | | | | | | |
| 0.5 | . 1 | SPT-1 | 1 | 2 | 2 | 4 | | | | | |
| 1.5 | | | | | | | | | | | |
| 3.0 3.5 | 2.5 | UDS-1 | | | | | Brown, Medium stiff to very stiff, Silty clay of low plasticity | CL | | | |
| 4.0 4.5 | . 4 | SPT-2 | 5 | 7 | 9 | 16 | | | | | |
| 5.0 | 5.5 | UDS-2 | | | | | | | | | |
| 6.0 6.5 7.0 | 7 | SPT-3 | 10 | 13 | 18 | 31 | | | | | |
| 7.5 | | | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| 8.5 | 8.5 | UDS-3 | | | | | | | | | |
| | 10 | _SPT-4_ | 9 | 12 | | 27 | | | | | |

| C | LANII U CARANA | | | | FIE | ELD | BOREHOLE I | LOG | | |
|--|----------------------------------|---|------------------|----------------------|------------|-------------------|--|-------------------|----------------|---|
| Project 1 | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loca | ation/Ch | ainage :2' | 7+620 kr | n | | | Northing :3123021.117 m | East | ing :69778 | 6.129 m |
| Reduced | l Level (r | n):(+)270 | .749 | | | | BH. No. :BH-P3 | BH | Terminatio | n Depth (m):60 |
| Propose | d / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | | | Water Table (m):33.13 | Incl | ination : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | <i>g (m)</i> :Not Used |
| Date of S | Start :18 | -11-2021 | | | | | Date of Completion :20-11-2021 | | | |
| | (| | В | low cour per 15cm | nts า | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opeth v/s SPT N Value) Opersatic |
| 10.0 10.5 11.0 11.5 12.0 12.5 12.5 13.0 13.5 13.5 14.0 14.5 14.0 14.5 15.5 15.5 16.0 16.5 16.5 17.0 17.5 18.0 18.5 19.0 19.5 | 11.5 13 14.5 16 17.5 | UDS-4 SPT-5 UDS-5 SPT-6 UDS-6 | 10 | 15 | 18 | 33 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |

| Can epsil | JAHI NI CANANA | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--|----------------------------------|---|------------------|------------|------------|-------------------|---|-------------------|----------------|--|------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | |
| BH Loc | ation/Ch | ainage :2' | 7+620 kr | n | | | Northing :3123021.117 m | East | ting :69778 | 6.129 m | |
| Reduced | d Level (i | n):(+)270 | .749 | | | | BH. No. :BH-P3 | BH | Termination | n Depth (m):60 | |
| Propose | ed / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | : | | Water Table (m):33.13 | Incl | ination : Ve | ertical | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used | |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :20-11-2021 | | | | |
| | - | | В | low cour | its 1 | | | ion | | | su |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 80 90100 | Observatic |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _24.0_ _24.5_ _24.0_ _24.5_ _25.0_ _25.5_ _26.0_ _26.5_ _26.5_ _27.0_ _27.5_ | 20.5 22 23.5 25 26.5 | UDS-7 SPT-8 UDS-8 SPT-9 UDS-9 | 16 | 22 | 26 | 48 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | Obs |
| _28.0_ | 28 | SPT-10 | 21 | 29 | 33 | 62 | | | | | |
| 29.0 29.5 30.0 | 29.5 | UDS-10 | | | | | | | | | |

| Can and | ANI ITTERNA | | | | FIE | CLD | BOREHOLE L | OG | | |
|--|---|--|----------------------------|----------------------------|--|--------------------|---|-------------------|----------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject fron | n Palwal to |) Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loc | ation/Ch | ainage :2' | 7+620 kn | n | | | Northing :3123021.117 m | East | ting :69778 | 6.129 m |
| Reduced | l Level (r | n):(+)270 | .749 | | | | BH. No. :BH-P3 | BH | Terminatio | n Depth (m):60 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | e | | Water Table (m):33.13 | Incl | ination : V | ertical |
| Boring | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :20-11-2021 | | | |
| | ê | | В | low cour per 15cm | nts n | | | ion | | SUC |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth Instruction of the second seco |
| _30.0_ _30.5_ _31.0_ _31.5_ _32.0_ _32.5_ _32.5_ _33.0_ _33.5_ _34.0_ _34.5_ _34.5_ _35.5_ _35.0_ _35.5_ _36.0_ _36.5_ _37.0_ _37.5_ _38.0_ _38.5_ _39.0_ _39.5_ | □ 31 32.5 33 34 35.5 37 38.5 | SPT-11 UDS* SPT-12 SPT-13 SPT-14 SPT-14 UDS-11 | 27 35 48 44 22 | 38 58 69 75 28 | 42 42 (5cm) 31 (5cm) 25 (11cm) 34 | 80 >100 >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| 40.0_ | _40 | SPT-16 | 29 | 32 | 37 | 69 | | | | |

| Ca | JANI UTE AND AND | | | | FIE | ĽD | BOREHOLE L | COG | | | |
|--|----------------------------------|--|----------------------|--------------------------------|---|----------------------|--|-------------------|----------------|-------------------------------|------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal to | Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDO | Ľ | |
| BH Loce | ation/Ch | ainage :2' | 7+620 kr | n | | | Northing :3123021.117 m | East | ing :69778 | 36.129 m | |
| Reduced | l Level (i | n):(+)270 | .749 | | | | BH. No. :BH-P3 | BH | Terminatio | on Depth (m):60 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):33.13 | Incl | ination : V | ertical | |
| Boring | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casir | ng (m) :Not Used | |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :20-11-2021 | | | | |
| | 2 | | В | low cour per 15cn | nts n | | | ion | | | suo |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Observatic |
| _40.0_ _40.5_ _41.5_ _41.5_ _42.0_ _42.5_ _42.5_ _43.0_ _43.5_ _43.5_ _44.0_ _44.5_ _44.5_ _45.0_ _45.5_ _45.0_ _45.5_ _46.0_ _46.5_ _46.0_ _46.5_ _47.0_ _47.5_ _48.0_ | 41.5 43 44.5 46 47.5 | UDS-12 SPT-17 SPT-18 SPT-19 SPT-20 | 46 40 58 43 | 73 68 100 (5cm) 63 | 27 (12cm) 32 (8cm) - 37 (5cm) | >100 >100 >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | Obs |
| _48.5_ _49.0_ _49.5_ | 49 | SPT-21 | 55 | 100 (7cm) | - | >100 | | | | | |
| _50.0_ | | | | | | | | | | | |

| FIELD BOREHOLE LOG | | | | | | | | | | | | |
|--|-------------------------------|----------------|----------|---------------|-------------|-------------------|--|-------------------|-------------------------------|---|--|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | Client :HRIDCL | | | |
| BH Location/Chainage :27+620 km | | | | | | | Northing :3123021.117 m | East | <i>Easting</i> :697786.129 m | | | |
| Reduced Level (m):(+)270.749 | | | | | | | <i>BH. No.</i> :BH-P3 | BH | BH Termination Depth (m):60 | | | |
| Proposed / Existing Structure : Major Bridge | | | | | | | Water Table (m):33.13 | Incli | Inclination : Vertical | | | |
| Boring type :Rotary | | | | | | | Dia. of Boring :150 mm | Dep | Depth of Casing (m) :Not Used | | | |
| Date of Start :18-11-2021 Date of Completion :20-11-2021 | | | | | | | | | | | | |
| Blow counts | | | | | | | | ion | ioi | | | |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | OpsetA difference of the second difference of | | |
| 50.5 51.0 51.5 | 50.5 | SPT-22 | 43 | 60 | 40 (6cm) | >100 | | | | | | |
| _52.0_ _52.5_ | 52 | SPT-23 | 35 | 66 | 34 (5cm) | >100 | | | | | | |
| _53.0_ _53.5_ _54.0_ | 53.5 | SPT-24 | 47 | 100 (10cm) | - | >100 | | | | | | |
| 54.5 55.0 55.5 | 55 | SPT-25 | 55 | 100 (8cm) | _ | >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | | |
| _56.0_ _56.5_ _57.0_ | 56.5 | SPT-26 | 34 | 39 | 45 | 84 | | | | | | |
| _57.5_ | | | | | | | | | | | | |
| _58.0_ _58.5_ _59.0_ | 58 | SPT-27 | 28 | 35 | 43 | 78 | | | | | | |
| _59.5_ | 59.5 60 | SPT-28 | 36 | 45 | 52 | 97 | | | | | | |

UDS*-UDS not recovered
| | TUTIONAL | | | | | | BOREHOLE I | | | | |
|--|--------------------------------|----------------------|-------------------|----------------|------------|-------------------|--|--------------------|----------------|-------------------------------|------------------------|
| Project | Name :C | fTI for (H | ORC) pr | oject fron | n Palwal t | to Harsana | Kalan in the state of Haryana. | Clie | ent :HRIDC | | |
| BH Loc | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123006.118 m | Eas | ting :69778 | 5.986 m | |
| Reduce | d Level (i | n):(+)271 | .774 | | | | BH. No. :BH-P4 | BH | Termination | n Depth (m):50 | |
| Propos | ed / Exist | ing Struct | <i>ture :</i> Maj | jor Bridge | : | | Water Table (m):33.14 | Inc | lination : Ve | rtical | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing | g (m) :Not Used | |
| Date of | <i>Start</i> :18 | 3-11-2021 | | | ato . | | Date of Completion :20-11-2021 | | | | |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | per 15cn N2 | N3 | SPT N Value | Strata Description | IS assification | Graphic Log | (Depth v/s SPT N Value) | Special bservations |
| _0.0_ | | | | | | | | Ū | 0 | 10 20 30 40 50 60 70 80 90 1 | <u>o</u> |
| 0.5_ 1.0_ 1.5_ 2.0_ 2.5_ 3.0_ 3.5_ | 2.5 | DS UDS-1 SPT-1 | 3 | 4 | 6 | 10 | Brown, Stiff, Silty clay of low plasticity | CL | | | |
| 4.0_ 4.5_ 5.0_ 5.5_ 6.0_ 6.5_ | 5.5 | UDS-2 SPT-2 | 10 | 14 | 17 | 31 | | | | | |
| 6.5_ 7.0_ 7.5_ 8.0_ 8.5_ 9.0_ 9.5_ | 8.5 | UDS-3 SPT-3 | 11 | 19 | 24 | 43 | Brown, Medium dense to dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| 10.0 | 10 | | | | | | | | | | |

| Ca | ATT CONTRACTOR | | | | FIE | ELD | BOREHOLE L | ,OG | | |
|--|-------------------------------|-------------------------|-------------------|----------------------|----------|-------------------|--|-------------------|----------------|-----------------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | t :HRIDC | XL |
| BH Loc | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3123006.118 m | Easti | ing :69778 | 35.986 m |
| Reduced | l Level (r | n):(+)271 | .774 | | | | <i>BH. No.</i> :BH-P4 | BH T | "erminatio | on Depth (m):50 |
| Propose | ed / Exist | ing Struci | <i>ture :</i> Maj | or Bridge | | | Water Table (m):33.14 | Inclin | nation : V | ertical |
| Boring i | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casin | ng (m) :Not Used |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :20-11-2021 | | | |
| | <u>،</u> وَ | | В | low coun per 15cm | its 1 | | | tion | | _ uo |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s v/s SPT N Value) |
| 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 13.5 14.0 14.5 15.5 | 11.5 13 14.5 | SPT-4 UDS-5 SPT-5 | 8 | 14 | 19 | 25 | Brown, Medium dense to dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| 16.0 16.5 17.0 | 16 | UDS-6 | | | | | | | | |
| _17.5_ | 17.5 | SPT-6 | 23 | 39 | 51 | 90 | | | | |
| 18.0 18.5 19.0 19.5 | 19 | UDS-7 | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _20.0_ | | | | | | | | | | |

| Ca | APRIL TELEVISION | | | | FIE | CLD | BOREHOLE L | OG | | |
|--|--|---|----------------------|----------------------|---|--------------------------|--|-------------------|----------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loce | ation/Ch | ainage :2' | 7+620 kn | n | | | Northing :3123006.118 m | East | ting :69778 | 5.986 m |
| Reduced | l Level (1 | n):(+)271 | .774 | | | | <i>BH. No.</i> :BH-P4 | BH | Terminatio | n Depth (m):50 |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):33.14 | Incl | ination : V | ertical |
| Boring | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :20-11-2021 | | | |
| | ê | | В | low cour per 15cn | nts n | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | OpsetA v/s SPT N Value) Opsecraatic |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _24.0_ _24.5_ _24.5_ _25.0_ _25.5_ _26.0_ _25.5_ _26.0_ _26.5_ _27.0_ _27.5_ _28.0_ _28.0_ _28.5_ _29.0_ _29.5_ | 20.5 22 23.5 25 25.5 26.5 28 28 | SPT-7 UDS-8 UDS-8 UDS* SPT-9 SPT-10 UDS-9 | 24 16 17 22 | 32 21 50 57 | 34 27 50 (10cm) 43 (8cm) | 66 48 >100 >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | 10 20 30 40 50 60 70 60 90 10 1 < |
| 30.0 | 20.0 | 511-11 | 10 | 27 | | | | | | |

| Ca | APRIL TELEVISION | | | | FIE | CLD | BOREHOLE L | LOG | | |
|--------------------------------------|-------------------------------|----------------|----------|----------------------|--------------|-------------------|--|-------------------|-----------------|---|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loca | ation/Ch | ainage :2' | 7+620 kr | n | | | Northing :3123006.118 m | East | ing :69778 | 5.986 m |
| Reduced | l Level (1 | n):(+)271 | .774 | | | | <i>BH. No.</i> :BH-P4 | BH | Terminatio | n Depth (m):50 |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | e | | Water Table (m):33.14 | Incl | ination : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :20-11-2021 | | | |
| | Ê | | В | low cour per 15cm | nts n | | | ion | | su |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | O Do 20 00 00 00 00 00 00 00 00 00 00 00 00 |
| _30.5_ _31.0_ _31.5_ | 31 | UDS-10 | | | | | | | | |
| _32.0_ | 32.5 | SPT-12 | 27 | 43 | 57 (13cm) | >100 | | | | |
| 33.5_ 34.0_ 34.5_ | 34 | SPT-13 | 30 | 47 | 53 (11cm) | >100 | | | 2 33.14m | |
| _35.0_ _35.5_ _36.0_ | 35.5 | SPT-14 | 37 | 54 | 46 (9cm) | >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _36.5_ _37.0_ _37.5_ | 37 | SPT-15 | 22 | 45 | 55 (15cm) | >100 | | | | |
| _38.0_ _38.5_ _39.0_ _39.5_ | 38.5 | SPT-16 | 25 | 43 | 55 | 98 | | | | |
| 40.0_ | 40 | SPT-17 | 22 | 37 | 45 | 82 | | | | |

| Ca | APRIL TELEVISION | | | | FIE | CLD | BOREHOLE I | OG | | | |
|--------------|-------------------------------|----------------|----------|------------|-------------|---|--|--------------------|----------------|---|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | |
| BH Loce | ation/Ch | ainage :2' | 7+620 kr | n | | | Northing :3123006.118 m | East | ing :69778 | 5.986 m | |
| Reduced | l Level (i | n):(+)271 | .774 | | | | BH. No. :BH-P4 | BH | Terminatio | n Depth (m):50 | |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):33.14 | Incli | nation : V | ertical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used | |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :20-11-2021 | | | | |
| | <u> </u> | | В | low cour | nts | | | u | | | su |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificati | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| 40.0 | | | | | | | | | | | |
| _40.5_ | | | | | | | | | | | |
| _41.0_ | 41 5 | SPT-18 | 21 | 35 | 43 | 78 | | | | | |
| | 11.0 | 01 1 10 | - · | | 10 | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | | | | | |
| _42.0_ | | | | | | | | | | | |
| | | | | | | | | | | | |
| _42.5_ | | | | | | | | | | | |
| | | | | | | | | | | | |
| _43.0_ | 43 | UDS-11 | | | | | | | | | _ |
| | | | | | | | | | | | |
| _43.5_ | | | | | | | | | | | \downarrow |
| | | | | | | | | | | | |
| _44.0_ | | | | | | | | | | | + |
| | | | | | 57 | | | | | | |
| _44.5_ | 44.5 | SPT-19 | 22 | 43 | (11cm) | >100 | | | | | _ |
| | | | | | | | | | | | |
| _45.0_ | | | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| | | | | | | | . , , | | | | |
| _45.5_ | | | | | | | | | | | _ |
| | | | | | 53 | | | | | | |
| _46.0_ | 46 | SPT-20 | 31 | 47 | (8cm) | >100 | | | | | -• |
| | | | | | | | | | | | |
| 46.5 | | | | | | | | | | | _ |
| 47.0 | | | | | | | | | | | |
| _47.0_ | | | | | | | | | | +++++++++++++++++++++++++++++++++++++++ | |
| _47.5_ | 47.5 | SPT-21 | 35 | 54 | 46 (7cm) | >100 | | | | | _ • |
| 18.0 | | | | | | | | | | | |
| _40.0_ | | | | | | | | | | | |
| 185 | | | | | | | | | | | |
| 40.0 | | | | | | | | | | | - |
| _49.0_ | 49 | SPT-22 | 28 | 60 | 40 (7cm) | >100 | | | | | _ • |
| 105 | | | | | | | | | | | |
| | | | | | | | | | | | |
| 50.0 | 50 | SPT-23 | 25 | 65 | 35 (6cm) | _>100_ | | | | | |

| Can and a | JAHI NI CANANA | | | | FIE | ELD | BOREHOLE L | OG | , r | | |
|-------------------|-------------------------------|----------------|-------------------|----------------------|------------|-------------------|--|------------------|----------------|--------------------------------|---------------------|
| Project | Name :C | ïTI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Cl | lient :HRIDC | L | |
| BH Loc | ation/Ch | ainage :2 | 7+620 kr | n | | | Northing :3122989.119 m | Ea | asting :69778 | 5.825 m | |
| Reduced | d Level (i | n):(+)271 | .929 | | | | BH. No. :BH-A2 | BI | H Terminatio | n Depth (m):40 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | : | | Water Table (m):33.12 | In | clination : Ve | ertical | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | De | epth of Casin | g (m) :Not Used | |
| Date of | Start :18 | 8-11-2021 | | | | | Date of Completion :19-11-2021 | · | | | |
| | | | В | low cour per 15cn | nts 1 | | | tion | | | l ons |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classifica | Graphic Log | (Depth v/s SPT N Value) | Specia Dbservati |
| 0.0 | | DS | | | | | | 0 | | 10 20 30 40 50 60 70 80 90 100 | 0 |
| 0.5 1.0 1.5 | . 1 | SPT-1 | 4 | 5 | 7 | 12 | | | | | |
| 2.0 | 2.5 | | | | | | | | | | |
| 3.0 | 2.5 | 003-1 | | | | | Brown, Medium dense, Sandy silt of low plasticity | ML-CI | | | |
| 3.5 | | | | | | | | | | | |
| 4.0 | 4 | SPT-2 | 6 | 7 | 10 | 17 | | | | | |
| 5.0 | | | | | | | | | | | |
| 5.5 | 5.5 | UDS-2 | | | | | | | | | |
| 6.06.5 | | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 10 | 16 | 22 | 38 | | | | | |
| 7.5 | | | | | | | Brown, Hard, Silty clay of low | CI | | | |
| 8.0 | | | | | | | plasticity with gravel | UL | | | |
| 8.5 9.0 | 8.5 | UDS-3 | | | | | | | | | |
| 9.5 | | | | | | | | | | | |
| _10.0_ | 10 | _SPT-4_ | 12 | | 25 | 43 | | | | | |

| Ca | APRIL TELEVISION | | | | FIE | ELD | BOREHOLE L | OG | | |
|--|----------------------------------|---|------------------|----------------------|------------|-------------------|--|-------------------|----------------|---|
| Project . | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loca | ation/Ch | ainage :2' | 7+620 kr | n | | | Northing :3122989.119 m | East | ing :69778 | 5.825 m |
| Reduced | l Level (r | n):(+)271 | .929 | | | | BH. No. :BH-A2 | BH | Termination | n Depth (m):40 |
| Propose | d / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | | | Water Table (m):33.12 | Incl | ination : Ve | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :19-11-2021 | | | |
| | (| | В | low cour per 15cm | nts า | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opeth v/s SPT N Value) Ops so Ops so Option of the solution of |
| 10.0 10.5 11.5 11.5 12.0 12.5 13.0 13.5 13.5 14.0 14.5 14.5 15.5 15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0 19.5 | 11.5 13 14.5 16 17.5 | UDS-4 SPT-5 UDS-5 UDS-6 UDS-6 | 11 | 20 | 26 | 40 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |

| Car epsil | INTERNAL INC. | | | | FIE | ELD | BOREHOLE L | UOG | | |
|--|-----------------------------------|---|----------|----------------------|------------|-------------------|---|-------------------|----------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loc | ation/Ch | ainage :2 | 7+620 kn | n | | | Northing : 3122989.119 m | East | ting :69778 | 5.825 m |
| Reduced | d Level (r | n):(+)271 | .929 | | | | BH. No. :BH-A2 | BH | Terminatio | n Depth (m):40 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):33.12 | Incl | ination : V | ertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :19-11-2021 | | | |
| | Ê | | В | low cour per 15cm | its າ | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90100 |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _23.0_ _23.5_ _24.0_ _24.5_ _25.0_ _25.0_ _25.5_ _26.0_ _26.0_ _26.5_ _27.0_ _27.5_ _28.0_ _28.5_ _29.0_ | 20.5 222 23.5 25 26.5 | UDS-7 SPT-8 UDS-8 SPT-9 UDS-9 SPT-10 | 22 | 28 | 35 | 63 56 86 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| 29.5 | 29.5 | UDS-10 | | | | | | | | |

| Ca | APRIL TELEVISION | | | | FIE | CLD | BOREHOLE L | ,OG | | |
|--------------|-------------------------------|----------------|----------|----------------------|-------------|-------------------|--|-------------------|----------------|--------------------------------|
| Project | Name :G | TI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loce | ation/Ch | ainage :2' | 7+620 kn | n | | | Northing :3122989.119 m | East | ing :69778 | 5.825 m |
| Reduced | l Level (r | n):(+)271 | .929 | | | | BH. No. :BH-A2 | BH | Terminatio | n Depth (m):40 |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):33.12 | Incli | ination : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :18 | -11-2021 | | | | | Date of Completion :19-11-2021 | | | |
| | . (| | В | low cour per 15cn | nts n | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth (Depth v/s SPT N Value) |
| _30.0_ | | | | | | | | | | |
| _30.5_ | | | | | 48 | | | | | |
| _31.0_ | 31 | SPT-11 | 33 | 52 | (10cm) | >100 | | | | |
| _31.5_ | | | | | | | | | | |
| _32.0_ | | | | | | | | | | |
| _32.5_ | 32.5 | SPT-12 | 32 | 59 | 41 (7cm) | >100 | | | | |
| 33.0 | | | | | | | | | | |
| | | | | | | | | <u> </u> | - 33.12m | |
| _33.5_ | | | | | | | | | | |
| _34.0_ | 34 | SPT-13 | 36 | 62 | 38 (5cm) | >100 | | | | |
| _34.5_ | | | | | | | | | | |
| _35.0_ | | | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _35.5_ | 35.5 | SPT-14 | 54 | 56 | 44 (7cm) | >100 | | | | |
| _36.0_ | | | | | | | | | | |
| _36.5_ | | | | | | | | | | |
| _37.0_ | 37 | SPT-15 | 20 | 34 | 45 | 79 | | | | |
| _37.5_ | | | | | | | | | | |
| _38.0_ | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-16 | 22 | 38 | 50 | 88 | | | | |
| _39.0_ | | | | | | | | | | |
| _39.5_ | | | | | | | | | | |
| _40.0_ | 40 | SPT-17 | 29 | | | 86 | | | | |

| C | JAHI NETANA M | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--------------|-------------------------------|----------------|----------|----------------------|------------|-------------------|--|-------------------|----------------|-------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | t :HRIDC | L | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123086.726 m | East | ng :69733 | 0.702 m | |
| Reduced | d Level (r | n):(+)269 | .806 | | | | BH. No. :BH-A1 | BHT | erminatio | n Depth (m):55 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):32.67 | Incli | nation : V | ertical | |
| Boring | <i>type</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casin | g (m) :Not Used | |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | I | | | |
| | Ê | | В | low cour per 15cm | its າ | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| 0.0 | | DS | | | | | | | | | |
| 0.5 | . 1 | SPT-1 | 7 | 9 | 10 | 19 | | | | | |
| | | | | | | | | | | | |
| 2.0 | | | | | | | | | | | |
| 25 | 25 | | | | | | | | | | |
| | 2.0 | 000 1 | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| | | | | | | | | | | | |
| 3.5 | | | | | | | | | | | |
| | | | | | | | | | | | |
| _4.0_ | 4 | SPT-2 | 7 | 12 | 14 | 26 | | | | | |
| | | | | | | | | | | | |
| 4.5 | | | | | | | | | | | ļ |
| | | | | | | | Darram Mariliana darram ta darram | | | | |
| 5.0 | | | | | | | Brown, Medium dense to dense, Sandy silt of low plasticity with | ML-CL | | | ļ |
| | | | | | | | gravel | | | | |
| 5.5 | 5.5 | UDS-2 | | | | | | | | | <u>+-</u> |
| | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |
| | | | | | | | | | | | |
| 0.5 | | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 10 | 14 | 15 | 20 | | | | | |
| | | 0110 | 10 | 14 | | 20 | | | | | |
| 7.5 | | | | | | | | | | | |
| | | | | | | | | | | | |
| 8.0 | | | | | | | | | | | |
| | | | | | | | | | | | |
| 8.5 | 8.5 | UDS-3 | | | | | | | | | |
| | | | | | | | | | | | |
| 9.0 | | | | | | | | | | | |
| | | | | | | | | | | | |
| 9.5 | | | | | | | | | | | + |
| | | | | | | | | | | | |
| _10.0_ | 10 | SPT-4 | 8 | 12 | <u> </u> | 29 | | | | | |

| C | DANI DE CARANA | | | | FIE | ELD | BOREHOLE L | ,OG | | | |
|---|-------------------------------|----------------------------------|-------------------|----------------------|------------|-------------------|--|-------------------|----------------|--|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCI | | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kr | n | | | Northing :3123086.726 m | East | ing :69733(| 0.702 m | |
| Reduced | d Level (r | n):(+)269 | .806 | | | | BH. No. :BH-A1 | BH | Termination | Depth (m):55 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):32.67 | Incli | nation : Ve | rtical | |
| Boring | <i>type</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used | |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | I | | | |
| | Ê | | В | low cour per 15cm | its າ | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 80 90100 | Special Observatic |
| 10.0_ 10.5_ 11.0_ 11.5_ 12.0_ 12.5_ 13.0_ 13.5_ 14.0_ | . 11.5 | UDS-4 | 10 | 13 | 18 | 31 | Brown, Medium dense to dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| 14.5_ 15.0_ 15.5_ 16.0_ 16.5_ 17.0_ 17.5_ 18.0_ 18.5_ 19.0_ 19.5_ | 14.5 | UDS-5 SPT-6 UDS-6 SPT-7 | 13 | 18 | 24 | 42 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | |

| Ca | APRIL 10 E Lacis, No. | | | | FIE | CLD | BOREHOLE L | ,OG | | |
|------------------|-------------------------------|----------------|----------|----------------------|-------------|-------------------|--|-------------------|----------------|---|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDC | Ľ |
| BH Loca | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123086.726 m | East | ing :69733 | 30.702 m |
| Reduced | l Level (1 | n):(+)269 | .806 | | | | BH. No. :BH-A1 | BH | Terminatio | n Depth (m):55 |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | : | | Water Table (m):32.67 | Incli | nation : V | ertical |
| Boring t | ype :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | th of Casin | ng (m) :Not Used |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | I | | |
| | _ د (| | В | low cour per 15cm | nts 1 | | | ion | | |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | o المربع مه |
| _20.5_ | 20.5 | UDS-7 | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _21.0_ | | | | | | | | | | |
| _22.0_ | 22 | SPT-8 | 14 | 31 | 37 | 68 | | | | |
| _23.0_ | | | | | | | | | | |
| _23.5_ | 23.5 | UDS-8 | | | | | | | | |
| 24.5 25.0 | 25 | SPT-9 | 18 | 30 | 45 | 75 | Brown Vonudonco Sandy silt of | | | |
| 25.5 | | | | | | | low plasticity with gravel | ML-CL | | |
| _26.5_ | 26.5 | UDS-9 | | | | | | | | |
| _27.0_ _27.5_ | | | | | | | | | | |
| 28.0 | 28 | SPT-10 | 37 | 62 | 38 (5cm) | >100 | | | | |
| 28.5 29.0 | | | | | | | | | | |
| _29.5_ | 29.5 | SPT-11 | 19 | 34 | 46 | 80 | | | | |

| Ca | SAME | | | | FIE | CLD | BOREHOLE L | OG | | |
|------------------|-------------------------------|----------------|----------|----------------------|---------------|-------------------|--|-------------------|-------------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | <i>t :</i> HRIDC | L |
| BH Loce | ation/Ch | ainage :28 | 8+075 kn | n | | | Northing :3123086.726 m | East | ing :69733 | 0.702 m |
| Reduced | l Level (r | n):(+)269 | .806 | | | | BH. No. :BH-A1 | BHT | <i>Terminatio</i> | n Depth (m):55 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):32.67 | Incli | nation : Ve | ertical |
| Boring i | ype :She | ll & Auge | r | | | | Dia. of Boring :150 mm | Dept | h of Casin | g (m) :Not Used |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | |
| | . 6 | | В | low cour per 15cn | nts n | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Depth (Depth v/s v/s SPT N Value) Opsection |
| _30.0_ | | | | | | | | | | |
| _30.5_ _31.0_ | 31 | SPT-12 | 31 | 50 | 50 (10cm) | >100 | | | | |
| _31.5_ | | | | | | | | | | |
| _32.5_ | 32.5 | SPT-13 | 18 | 35 | 42 | 77 | | <u> </u> | 432 67m | |
| _33.0_ | | | | | | | | | | |
| 33.5 34.0 | 34 | SPT-14 | 20 | 41 | 48 | 89 | | | | |
| _34.5_ _35.0_ | | | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| 35.5 36.0 | 35.5 | SPT-15 | 19 | 38 | 40 | 78 | | | | |
| _36.5_ | | | | | | | | | | |
| _37.0_ _37.5_ | 37 | SPT-16 | 19 | 35 | 50 | 85 | | | | |
| _38.0_ | | | | | | | | | | |
| _38.5_ _39.0_ | 38.5 | SPT-17 | 21 | 37 | 48 | 85 | | | | |
| _39.5_ | | | | | | | | | | |
| 40.0_ | 40 | SPT-18 | 18 | | 52 (14cm)_ | | | | | |

| CRITICI . | CARACTER | | | | $\Gamma I L$ | LD | BOREHOLE L | UG | | | | |
|--|----------------------------------|--|----------------------------------|---|---|----------------------------|---|-------------------|--------------------|------------------------------|-------------------------|-----------------------|
| Project N | <i>lame</i> :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | <i>it :</i> HRIDCI | | | |
| BH Locat | tion/Ch | ainage :28 | 8+075 kr | n | | | Northing :3123086.726 m | East | ing :69733 | 0.702 m | | |
| Reduced | Level (n | n):(+)269 | .806 | | | | BH. No. :BH-A1 | BHT | Ferminatior | Depth (m):55 | | |
| Proposed | d / Existi | ing Struct | <i>ure :</i> Maj | or Bridge | 1 | | Water Table (m):32.67 | Incli | nation : Ve | rtical | | |
| Boring ty | pe :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casing | g (m) :Not Used | | |
| Date of S | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | | |
| | (| | В | low coun per 15cm | nts า | | | ion | | | | suo |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value |) 0 80 90 100 | Special Observatio |
| _40.0_ _40.5_ _41.0_ _41.5_ _42.0_ _42.5_ _43.0_ _43.5_ _43.5_ _43.0_ _43.5_ _44.0_ _44.5_ _45.0_ _45.5_ _46.0_ _45.5_ _46.0_ _45.5_ _46.0_ _45.5_ _48.0_ _48.0_ _48.5_ _49.0_ _49.5_ | 41.5 43 44.5 46 47.5 | SPT-20 SPT-21 SPT-22 SPT-23 SPT-23 | 17 22 25 27 37 36 | 40 43 59 51 53 100 (14cm) | 48 57 (12cm) 38 (10cm) 49 (13cm) 47 (8cm) | 88 >100 >100 >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | | |

| Project | Name .C | TI for (H | ORC) mr | niect from | 1 Palwal +/ | Harson | Kalan in the state of Harvana | Clia | nt ·HRIDCI | | | |
|--|--------------------------------|--------------------|----------------|----------------|--|-------------------|--|---------------------|------------------|--|------------------------|------------------------|
| | nume .C | | 2+075 lm | | i r aiwai u | 114184114 | Nowhing 2122086 726 m | East | ting :607330.7 | 02 m | | |
| БП LOC Reduce | d Level (i | $n) \cdot (+) 269$ | 806 | n | | | RH No ·BH A1 | BH | Tormination D | $\frac{1}{2}$ $\frac{1}$ | | |
| Propos | d / Frist | ing Struct | ura Mai | or Bridge | | | Water Table (m):32.67 | Inch | ination · Vertic | ral | | |
| Roring | wne ·She | | r | of Diluge | , | | Dia of Boring :150 mm | Den | th of Casing (r | n) ·Not Used | | |
| Doring Date of | Start .16 | -10-2021 | | | | | Date of Completion :18-10-2021 | Dep | in of cusing (n | | | |
| Duie of | 51477.10 | 10 2021 | В | low cour | nts | | Due of completion . 10 10 2021 | L. | | | | s |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | per 15cn N2 | n N3 | SPT N Value | Strata Description | IS Classificatic | Graphic Log | (Depth v/s SPT N Value |) 70 80 9010 | Special Observatior |
| _50.0_ _50.5_ _51.0_ _51.5_ _52.0_ _52.5_ _53.0_ _53.5_ _54.0_ _54.5_ | 50.5 | SPT-25 SPT-26 | 30 39 38 | 80 | 20 (13cm) 25 (7cm) 27 (8cm) 30 | >100 >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | | |
| | | -37 1-20. | 4U | | (/ CIII) | > 100 | | | | | | • |

| Ca | SAMI TELEVISION | | | | FIE | ELD | BOREHOLE L | ,OG | | |
|-------------------|-------------------------------|----------------|----------|----------------------|------------|-------------------|--|-------------------|----------------|---|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCI | |
| BH Loce | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123064.726 m | East | ing :697330 |).717 m |
| Reduced | l Level (n | n):(+)270 | .070 | | | | BH. No. :BH-P1 | BH | Termination | Depth (m):55 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):32.68 | Incli | ination : Ve | rtical |
| Boring | ype :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :15-10-2021 | | | |
| | (c | | В | low cour per 15cm | its າ | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | att dial v/s SPT N Value) کې SPT N Value |
| 0.0 | | DS | | | | | | | | |
| 0.5 1.0 1.5 | 1 | UDS-1 | | | | | | | | |
| 2.0 | | | | | | | Brown, Medium dense, Silty sand | SM | | |
| 2.5 | 2.5 | SPT-1 | 8 | 11 | 13 | 24 | | | | |
| 3.0 | | | | | | | | | | |
| 3.5 | 4 | UDS-2 | | | | | | | | |
| 4.5 | | | | | | | | | | |
| 5.0 | | | | | | | | | | |
| 5.5 | 5.5 | SPT-2 | 14 | 20 | 24 | 44 | Brown, Dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| 6.0 | | | | | | | | | | |
| | 7 | UDS-3 | | | | | | | | |
| 7.5 | | | | | | | | | | |
| 8.0 | | | | | | | | | | |
| 8.5 | 8.5 | SPT-3 | 8 | 10 | 14 | 24 | Brown, Very stiff to hard, Silty clay of low plasticity | CL | | |
| 9.0 | | | | | | | | | | |
| 9.5 | 10 | | | | | | | | | |

UDS*-UDS not recovered

| Ca | (APRIL THE EAST AND | | | | FIE | ELD | BOREHOLE L | OG | | | |
|----------------|-------------------------------|----------------|-------------------|----------------------|------------|-------------------|--|------------------|------------------|-------------------------------|---------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | a Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kr | n | | | Northing :3123064.726 m | East | ting :697330.7 | 17 m | |
| Reduced | d Level (i | n):(+)270 | 0.070 | | | | BH. No. :BH-P1 | BH | Termination D | <i>epth (m):</i> 55 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | ; | | Water Table (m):32.68 | Incl | ination : Vertic | cal | |
| Boring | <i>type</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dep | th of Casing (n | n) :Not Used | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :15-10-2021 | | | | |
| | _ a Ê | | В | low cour per 15cn | nts n | | | tion | | | l |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classifica | Graphic Log | (Depth v/s SPT N Value) | Specia Dbservati |
| 10.0 | | | | | | | | 0 | | 20 30 40 50 60 70 80 9010 | |
| _10.5_ | | | | | | | | | | | _ |
| 11.0 | 11.5 | SPT-4 | 7 | 10 | 11 | 21 | | | | • | _ |
| _12.0_ | | | | | | | | | | | - |
| 12.5 | | | | | | | | | | | _ |
| 13.0 13.5 | . 13 | UDS-5 | | | | | | | | | |
| 14.0 | | | | | | | | | | | _ |
| 14.5 | . 14.5 | SPT-5 | 5 | 9 | 10 | 19 | Brown, Very stiff to hard, Silty clay of low plasticity | CL | | | _ |
| 15.0 | | | | | | | | | | | |
| 16.0 | . 16 | UDS-6 | | | | | | | | | _ |
| 16.5 | | | | | | | | | | | - |
| _17.0_ | | 0.57.0 | | | | | | | | | _ |
| 17.5_ 18.0_ | 17.5 | SPT-6 | 10 | 15 | 22 | 37 | | | | | |
| _18.5_ | | | | | | | | | | | _ |
| _19.0_ | . 19 | UDS-7 | | | | | | | | | _ |
| 19.5 | | | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | - |

| Ca | JAHI NI LANAN | | | | FIE | ELD | BOREHOLE L | ,OG | | | |
|--|-----------------------------------|---|----------------------|----------------------|----------------------|----------------------|--|-------------------|--------------------|--|--|
| Project | Name :C | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | <i>t</i> :HRIDCL | | |
| BH Loca | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123064.726 m | East | ing :697330 | .717 m | |
| Reduced | d Level (i | n):(+)270 | .070 | | | | BH. No. :BH-P1 | BHT | <i>Fermination</i> | Depth (m):55 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):32.68 | Incli | nation : Ver | tical | |
| Boring t | <i>type :</i> She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casing | (m) :Not Used | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :15-10-2021 | | | | |
| | <u> </u> | | В | low cour per 15cm | its 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 80 | 00 00 00 00 00 00 00 00 00 00 00 00 00 |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _23.0_ _23.5_ _24.0_ _24.5_ _25.5_ _25.0_ _25.5_ _26.0_ _26.5_ _26.0_ _26.5_ _27.0_ _27.5_ _28.0_ _28.0_ _28.5_ _29.0_ | 20.5 222 23.5 25 26.5 | SPT-7 UDS-8 UDS-9 UDS-9 SPT-9 | 15 21 17 18 | 22 30 28 30 | 33 36 38 41 | 55 66 66 71 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| 29.5 | 29.5 | SPT-11 | 20 | 35 | 45 | 80 | | | | | |

| Ca | ALANI ITTE CARGO AND | | | | FIE | ELD | BOREHOLE L | ,OG | | | |
|--|-------------------------------|----------------------------|----------------|----------------------|----------------|-------------------|--|-------------------|----------------|-----------------|------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | t :HRIDC | L | |
| BH Loce | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123064.726 m | East | ng :69733 | 0.717 m | |
| Reduced | l Level (r | n):(+)270 | .070 | | | | BH. No. :BH-P1 | BH T | ermination | n Depth (m):55 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):32.68 | Incli | nation : Ve | ertical | |
| Boring | ype :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casing | g (m) :Not Used | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :15-10-2021 | I | | | |
| | Ê | | В | low cour per 15cm | its າ | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth | Observatio |
| 30.0_ 30.5_ 31.0_ 31.5_ 32.0_ 32.5_ 33.0_ 33.5_ 34.0_ 34.5_ | 31 32.5 34 | SPT-12 SPT-13 SPT-14 | 27 29 18 | 42 45 40 | 50 52 50 | 92 97 90 | | Ţ | -32.68m | | |
| _35.0_ _35.5_ _36.0_ _36.5_ _37.0_ | 35.5 | SPT-15 SPT-16 | 14 | 33 35 | 44 | 77 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| _37.5_ | | | | | | | | | | | |
| _38.5_ _39.0_ _39.5_ | 38.5 | SPT-17 | 20 | 36 | 47 | 83 | | | | | |
| | | | | | | | | | | | |
| _40.0_ | 40 | SPT-18 | 22 | 40 | 52 | 92 | | | | | |

| CHINE CHINE | CAUNTRAL STREET, STREE | | | | $\Gamma I L$ | LD | BOREHOLE L | UG | | | |
|---|--|--|----------------------------------|----------------------------------|--------------------------------------|------------------------------------|--|-------------------|------------------|-------------------------------|-----------------------|
| Project N | <i>lame</i> :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | <i>t :</i> HRIDC | L | |
| BH Locat | tion/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123064.726 m | East | ing :69733 | 0.717 m | |
| Reduced 1 | Level (n | n):(+)270 | .070 | | | | BH. No. :BH-P1 | BHT | Ferminatio | n Depth (m):55 | |
| Proposed | l / Existi | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):32.68 | Incli | nation : V | ertical | |
| Boring typ | pe :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casin | g (m) :Not Used | |
| Date of St | tart :11 | -10-2021 | | | | | Date of Completion :15-10-2021 | I | | | |
| | (| | В | low cour per 15cm | nts n | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| _40.0 _40.5 _41.0 _41.5 _42.0 _42.5 _43.0 _43.5 _43.0 _43.5 _43.0 _43.5 _44.0 _45.5 _46.0 _45.5 _46.0 _45.5 _46.0 _45.5 _46.0 _45.5 _46.0 _45.5 _46.0 _45.5 _46.0 _45.5 _46.0 | 41.5 43 44.5 46 47.5 49 | SPT-19 SPT-20 SPT-21 SPT-22 SPT-22 SPT-23 | 17 16 15 17 18 34 | 42 40 31 35 36 54 | 48 42 39 45 46 (10cm) | 90 82 70 80 82 >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |

| Proiect | Nama ·C | TI for (U | | niect from | Palmal + | Harcono | Kalan in the state of Harvana | Clia | nt HRIDCI | | | |
|--|--------------------------------|--------------------|----------------|----------------|---|-------------------|--|---------------------|------------------|-----------------------------|-------------|------------------------|
| | nume .G | | 2 1075 lm | | I Falwal u | | Nowhing (2122064 726 m | East | fing :607220.7 | 17 m | | |
| БП LOC Reduce | d Level (i | $n) \cdot (+) 270$ | 070 | n | | | RH No ·BH P1 | BH | Tormination D | 17 III | | |
| Propos | nd / Exist | ing Struct | ura Mai | or Bridge | | | Water Table (m):32.68 | Inch | ination · Vertic | ral | | |
| Roring | tvne ·She | | r | of blidge | , | | Dia of Boring :150 mm | Den | th of Casing (n | n) ·Not Used | | |
| Doring Date of | Start .11 | -10-2021 | | | | | Date of Completion :15-10-2021 | Dep | in of Casing (ii | <i>ii)</i> .1101 Osed | | |
| Duie of | Start | 10 2021 | В | low cour | nts | | Due of completion . 10 10 2021 | L. | | | | s |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | per 15cn N2 | n N3 | SPT N Value | Strata Description | IS Classificatic | Graphic Log | (Depth v/s SPT N Valu | 1 e) | Special Observatior |
| 50.0_ 50.5_ 51.0_ 51.5_ 52.0_ 52.5_ 53.0_ 53.5_ 54.0_ 54.5_ | 50.5 | SPT-25 SPT-26 | 36 38 33 | 61 68 | 39 (7cm) 32 (5cm) 39 (8cm) | >100 >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | | |
| _55.0_ | 55 | _SPT-28_ | 41 | 78 | (3cm) | _>100_ | | | | | | |

| Ca | ALANI UTTE SACIALIS | | | | FIE | ELD | BOREHOLE L | ,OG | | |
|-------------------|-------------------------------|----------------|----------|----------------------|----------|-------------------|--|-------------------|-------------------|---|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | <i>ıt :</i> HRIDO | CL |
| BH Loce | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123026.726 m | East | ing :69733 | 30.724 m |
| Reduced | l Level (r | n):(+)270 | .499 | | | | BH. No. :BH-P2 | BHT | Ferminatio | on Depth (m):55 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):33.20 | Incli | nation : V | ertical |
| Boring t | ype :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casir | ng (m) :Not Used |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :14-10-2021 | I | | |
| | (| | В | low coun per 15cm | its 1 | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opersatic v/s SPT N Value) Opersatic |
| 0.0 | | DS | | | | | | | | |
| 0.5 1.0 1.5 | 1 | SPT-1 | 3 | 4 | 5 | 9 | | | | |
| 2.0 | | | | | | | Brown, Loose, Sandy silt of low plasticity | ML-CL | | |
| 2.5 | 2.5 | UDS-1 | | | | | | | | |
| 3.5 | | | | | | | | | | |
| 4.0 | 4 | SPT-2 | 9 | 10 | 12 | 22 | | | | |
| 4.5 | | | | | | | | | | |
| 5.0 | 5.5 | UDS-2 | | | | | | | | |
| 6.0 | | | | | | | | | | |
| 6.5 | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 12 | 17 | 21 | 38 | Brown, Medium dense to dense, Silty sand with clay & gravel | SM-SC | | |
| 7.5 8.0 | | | | | | | | | | |
| 8.5 | 8.5 | UDS-3 | | | | | | | | |
| 9.0 | | | | | | | | | | |
| 9.5 | | | | | | | | | | |
| _10.0_ | 10 | SPT-4 | 10 | 16 | 25 | 41 | | | | |

| C | JANI DECISION | | | | FIE | ELD | BOREHOLE L | ,OG | | | |
|--|-------------------------------|----------------------------------|-----------------|----------------------|------------|-------------------|--|-------------------|----------------|--|----------------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | t :HRIDCI | L | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123026.726 m | East | ng :69733 | 0.724 m | |
| Reduced | d Level (r | n):(+)270 | .499 | | | | BH. No. :BH-P2 | BH T | erminatior | 1 Depth (m):55 | |
| Propose | ed / Exist | ing Struct | <i>ure</i> :Maj | or Bridge | | | Water Table (m):33.20 | Incli | nation : Ve | rtical | |
| Boring | <i>type</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casing | g (m) :Not Used | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | | |
| | Ê | | В | low cour per 15cm | its າ | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 60 90100 | ° Special Observatio |
| 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 | 11.5 | UDS-4 SPT-5 | 10 | 20 | 22 | 42 | Brown, Medium dense to dense, Silty sand with clay & gravel | SM-SC | | | - |
| 14.5_ 15.0_ 15.5_ 16.0_ 16.5_ 17.0_ 17.5_ 17.5_ 18.0_ 18.5_ 19.0_ 19.5_ | 14.5 | UDS-5 SPT-6 UDS-6 SPT-7 | 14 | 21 | 30 | 51 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | - |

| Cas | JAHI NI CANANA | | | | FIE | CLD | BOREHOLE L | ,OG | | |
|--|-----------------------|----------------|----------|----------------------|-------------|------------|--|---------------|----------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | |
| BH Loce | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123026.726 m | East | ting :697330.7 | 724 m |
| Reduced | d Level (r | n):(+)270 | .499 | | | | BH. No. :BH-P2 | BH | Termination I | Depth (m):55 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | : | | Water Table (m):33.20 | Incl | ination : Vert | ical |
| Boring | <i>type</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dep | th of Casing (| (m) :Not Used |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | |
| Depth | situ nple h (m) | Sample | В | low cour per 15cn | nts n | SPT | Strata | S ication | Graphic | Cial Cial |
| (m) | San San Depti | Туре | N1 | N2 | N3 | N Value | Description | l(Classif | Lòg | V/S SPT N Value) ⁰ 20 30 40 50 60 70 80 90100 |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ | 20.5 | UDS-7 SPT-8 | 18 | 27 | 36 | 63 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _24.0_ _24.5_ | 05 | | 24 | 50 | 48 | > 100 | | | | |
| 25.5_ 26.0_ | . 23 | 5r 1-9 | 51 | 52 | (9011) | - 100 | | | | |
| _26.5_ _27.0_ | 26.5 | SPT-10 | 29 | 50 | 50 (9cm) | >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| _27.5_ _28.0_ _28.5_ | 28 | SPT-11 | 22 | 31 | 46 | 77 | | | | |
| 29.0 29.5 30.0 | 29.5 | SPT-12 | 24 | 34 | 50 | 84 | | | | |

| Cas | ATT CONTRACTOR | | | - | FIE | ELD | BOREHOLE L | ,OG | | | |
|--------------|------------------------------|----------------|----------|------------|----------|------------|----------------------------------|------------------|----------------|--------------------------------|---------------------|
| Project | Name :G | TI for (H | ORC) pr | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCI | _ | |
| BH Loce | ation/Ch | ainage :28 | 8+075 kr | n | | | Northing :3123026.726 m | East | ing :697330 |).724 m | |
| Reduced | l Level (r | n):(+)270 | .499 | | | | <i>BH. No.</i> :BH-P2 | BH | Termination | Depth (m):55 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):33.20 | Incli | nation : Ve | rtical | |
| Boring | <i>ype</i> :She | ll & Auge | r | | | | Dia. of Boring :150 mm | Dep | th of Casing | (m) :Not Used | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | | |
| | - e Ê | | В | per 15cm | ts I | ODT | | ation | | (De with | al ions |
| Depth (m) | In-Situ Sampl Depth (I | Sample Type | N1 | N2 | N3 | N Value | Strata Description | IS Classifica | Graphic Log | (Depth v/s SPT N Value) | Specia Observati |
| 30.0 | | | | | | | | 0 | 0 | 10 20 30 40 50 60 70 80 90 100 | |
| 30.5 31.0 | 31 | SPT-13 | 40 | 44 | 54 | 98 | | | | | |
| _31.5_ | | | | | | | | | | | |
| _32.0_ | | | | 100 | | | | | | | |
| _32.5_ | 32.5 | SPT-14 | 25 | (12cm) | - | >100 | | | | | • |
| _33.0_ | | | | | | | | 2 | 33.20m | | |
| _33.5_ | | | 40 | 0.5 | 44 | 70 | | | | | |
| 34.0 | . 34 | 571-15 | 10 | 35 | 41 | 70 | | | | | |
| | | | | | | | Brown, Very dense, Sandy silt of | ML-CL | | | |
| _35.5_ | 35.5 | SPT-16 | 18 | 38 | 50 | 88 | low plasticity with gravel | MIL-OL | | | |
| _36.0_ | | | | | | | | | | | |
| _36.5_ | | | | | | | | | | | |
| _37.0_ | 37 | SPT-17 | 19 | 40 | 48 | 88 | | | | | |
| _37.5_ | | | | | | | | | | | |
| _38.0_ | | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-18 | 18 | 36 | 45 | 81 | | | | | |
| _39.0_ | | | | | | | | | | | |
| _39.5_ | | | | | | | | | | | |
| _40.0_ | 40 | SPT-19 | 15 | 34 | 43 | <u> </u> | | | | | |

| C | JANI DECIMINA | | | | FIE | CLD | BOREHOLE L | OG | | | |
|--|-------------------------------|---|----------------------------|----------------------------|--|--------------------------|--|-------------------|--------------------|---|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCI | | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kr | n | | | Northing :3123026.726 m | East | ing :69733(| 0.724 m | |
| Reduce | d Level (i | n):(+)270 | .499 | | | | BH. No. :BH-P2 | BHT | <i>Termination</i> | Depth (m):55 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | • | | Water Table (m):33.20 | Incli | nation : Ve | rtical | |
| Boring | <i>type</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casing | (m) :Not Used | |
| Date of | Start :11 | -10-2021 | | | | | Date of Completion :14-10-2021 | I | | | |
| | Ê | | В | low cour per 15cm | nts n | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 _80 90100 | Special Observatic |
| _40.0_ _40.5_ _41.0_ _41.5_ _42.0_ _42.5_ _42.5_ _43.0_ _43.5_ _44.0_ _44.5_ _44.5_ _45.5_ _45.5_ _46.0_ _45.5_ _46.0_ _47.0_ _47.5_ _48.0_ _48.5_ _48.0_ _49.0_ _49.5_ | 41.5 | SPT-20 SPT-21 UDS-9 SPT-22 SPT-23 | 22 24 40 32 36 | 31 32 40 62 73 | 45 45 60 (11cm) 38 (7cm) 27 (3cm) | 76 77 >100 >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |

| CPI 1 | Distant and the | | | | ΓΙΕ | LD | BUREHULE L | | | | |
|------------------|--------------------------------|----------------|----------|------------|----------------|-------------------|--|---------------------|------------------|-------------------------------|---------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123026.726 m | East | ting :697330.72 | 24 m | |
| Reduced | d Level (i | n):(+)270 | .499 | | | | <i>BH. No.</i> :BH-P2 | BH | Termination D | epth (m):55 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | : | | Water Table (m):33.20 | Incl | ination : Vertic | cal | |
| Boring | <i>type</i> :She | ell & Auge | r | | | | Dia. of Boring :150 mm | Dep | th of Casing (n | n) :Not Used | |
| Date of | Start :11 | -10-2021 | В | | nts | | Date of Completion :14-10-2021 | | | | |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS lassificatior | Graphic Log | (Depth v/s SPT N Value) | Special |
| _50.0_ | | | | | | | | U | 0 10 | 20 30 40 50 60 70 80 90 | 100 |
| 50.5_ 51.0_ | 50.5 | SPT-25 | 34 | 66 | 34 (6cm) | >100 | | | | | - |
| 51.5_ 52.0_ | . 52 | SPT-26 | 39 | 58 | 42 (8cm) | >100 | | | | | - |
| _52.5_ _53.0_ | | | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| _53.5_ _54.0_ | 53.5 | SPT-27 | 43 | 75 | 25 (4cm) | >100 | | | | | • |
| _54.5_ _55.0_ | 55 | _SPT-28_ | 33 | 51 | 49 _(12cm)_ | _>100_ | | | | | |
| | | | | | | | | | | | |

| Physical Name - GTI Inc (HORC) project From Palwa to Hansam Kalm in the same of Hanyma. Citeer: HRIDCL BIL Location-Claiming: 28-073 km Monthing: 12000.726 km Rading: 497303.0724 km Makeel Level of (L-2706.16) BIL Location-Claiming: 12000.726 km Dataget (H-2706.16) Dataget (H-2706.16) Proposal / Faiting: Structure: 'Monthing: 12000.726 km Dataget (H-2706.16) Dataget (H-2706.16) Dataget (H-2706.16) Proposal / Faiting: Structure: 'Monthing: 120 mm Dataget (H-2706.16) Dataget (H-2706.16) Dataget (H-2706.16) Dataget (H-2706.16) Image: Structure: 'Monthing: 120 mm Dataget (H-2706.16) Dataget (H-2706.16) Dataget (H-2706.16) Image: Structure: 'Monthing: 120 mm Dataget (H-2706.16) Dataget (H-2706.16) Dataget (H-2706.16) Image: Structure: 'Monthing: 120 mm Dataget (H-2706.16) Imaget (H-2706.16) Dataget (H-2706.16) Image: Structure: 'Monthing: 120 mm Dataget (H-2706.16) Imaget (H-2706.16) 1.1 Image: Structure: 'Monthing: 120 mm Dataget (H-2706.16) Imaget (H-2706.16) 2.3. Dataget (H-2706.16) Imaget (H-2706.16) Imaget (H-2706.16) 2.3. Structure: 'Monthing: Structure: 'Monthing: Structure: 'Month | Ca | JANI ITE SAGAME | | | | FIE | ELD | BOREHOLE L | ,OG | | |
|---|--------------|-------------------------------|----------------|----------|----------------------|------------|-------------------|---|-------------------|----------------|---|
| Diff Location Chanage 284075 km Monthing 3123004 726 m Exating: 697330 724 m Reflect Quert (00) (-1)270.016 III. No. 384-A2 BH Termination Days (op. 55 Propeod (Estimation Surplish Change) Units No. 384-A2 BH Termination Days (op. 55 Propeod (Estimation Surplish Change) Days (f)25004 (f)25004 Days (f)25004 (f)25004 Date of Borng (150 ma) Days (f)25004 (f)25004 (f)25004 Date of Borng (150 ma) Days (f)25004 (f)25 | Project | <i>Name</i> :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDC | Ľ |
| Induced log(1):120:06 li BH No. 181-A2 BH Termination Depth (m):55 Proposed I (1):20:06 li Water Table (m):33.21 Induced (m): Vertical Descriptions Depth of Casure (m): Not Used Depth of Casure (m): Not Used Date of Start: 10-10:201 Date of Completion: 18:10:201 Date of Campletion: 18:10:201 Depth of Casure (m): Not Used Date of Campletion: 18:10:201 Depth of Casure (m): Not Used 0.0 DS DS Strata Depth of Casure (m): Not Used 1.0 1 UDS-1 Strata Depth of Casure (m): Not Used 1.1 UDS-1 Strata Depth of Casure (m): Not Used Depth of Casure (m): Not Used 2.0 DS Strata Strata Depth of Casure (m): Not Used Depth of Casure (m): Not Used 2.0 DS Strata Strata Depth of Casure (m): Not Used Depth of Casure (m): Not Used 2.0 DS Strata Strata Depth of Casure (m): Not Used Depth of Casure (m): Not Used 3.0 DS Strata Strata Depth of Casure (m): Not Used Depth of Casure (m): Not Used | BH Loc | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123004.726 m | East | ing :69733 | 30.724 m |
| Proposed / Existing Structure: Major Bridge Witer Table (m3.3.21) Industator: Vertical Nonic type: Shift & Auger Disc of Borrig: 150 mm Dappin (gr ge | Reduced | d Level (r | n):(+)270 | .616 | | | | BH. No. :BH-A2 | BH | Terminatio | n Depth (m):55 |
| Benerg type: Statil: Auge: Disk of Rondy: 190 mm Depth of Casting (m): Not Used Date of Start: 10-10-2021 Date of Start: Date of Completion: 18-10-2021 Date of Completion: 18-10-2021 Date of Start: Date of Completion: Not of Completio: Not of Completio: No | Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | : | | Water Table (m):33.21 | Incli | ination : V | ertical |
| Description Bit of Completion: 18-10-2021 Description Description <thdescription< th=""> Description <thd< td=""><td>Boring</td><td><i>type</i> :She</td><td>ll & Auge</td><td>er</td><td></td><td></td><td></td><td>Dia. of Boring :150 mm</td><td>Depi</td><td>th of Casin</td><td>ng (m) :Not Used</td></thd<></thdescription<> | Boring | <i>type</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Depi | th of Casin | ng (m) :Not Used |
| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$ | Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | |
| Depth Respective Service NM NZ NS SPT Value Strata Description Respective Service Corport SPT N value) Orgon SPT N value) Orgon Value Value Value Value Value Val | | (| | В | low coun per 15cm | its າ | | | ion | | suc |
| 00 DS DS< | Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opeth v/s SPT N Value) Ope scall |
| .0.5. .10. 1 UDS-1 .15. .20. | | | DS | | | | | | | | |
| 1.5 1.5 000-11 5 6 6 12 Brown, Stiff, Sity clay of low plasticity CL 0 0 0 3.0 3.5 0 0 0 0 0 3.5 0 0 0 0 0 0 0 4.0 4 UDS-2 0 0 0 0 0 0 0 4.5 5.5 SPT-2 12 18 22 40 Brown, Danse, Sardy sill of low plasticity with gravel ML-CL 0 </td <td>0.5</td> <td>1</td> <td>UDS-1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> | 0.5 | 1 | UDS-1 | | | | | | | | |
| 2.0 2.5 SPT-1 5 6 6 12 3.0 3.5 3.5 3.5 3.6 3.6 12 4.0 4 UDS-2 4.7 1.2 18 22 4.0 5.5 5.5 SPT-2 12 18 22 4.0 Brown, Dense, Sandy silt of low plasticity with gravel ML-CL 4.0 6.0 1.2 18 22 4.0 Brown, Dense, Sandy silt of low plasticity with gravel ML-CL 4.0 4.0 6.0 1.2 18 22 4.0 Brown, Dense, Sandy silt of low plasticity with gravel ML-CL 4.0 1.0 1.0 6.5 1.2 18 22 4.0 Brown, Dense, Sandy silt of low plasticity with gravel ML-CL 4.0 1.0 1.0 6.5 1.7.5 1.1 1.4 2.5 Brown, Very stiff to hard, Silty clay of Low plasticity with gravel CL 4.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 </td <td>1.5</td> <td></td> <td>0001</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> | 1.5 | | 0001 | | | | | | | | |
| 2.5 2.5 SPT-1 5 6 6 12 .3.0_ | 2.0 | | | | | | | Brown, Stiff, Silty clay of low plasticity | CL | | |
| _3.5 4.0 4 UDS-2 _4.5 5.0 _5.0 5.5 SPT-2 12 18 22 40 Brown, Dense, Sandy silt of low plasticity with gravel ML-CL | 2.5 | 2.5 | SPT-1 | 5 | 6 | 6 | 12 | | | | |
| _4.0_ 4 UDS-2 _4.5_ | 3.5 | | | | | | | | | | |
| -4.5. -5.0 -5.0 -5.5 5.5 SPT-2 12 18 22 40 Brown, Dense, Sandy silt of low plasticity with gravel -6.0. -6.5. - | 4.0 | 4 | UDS-2 | | | | | | | | |
| -5.0 5.5 SPT-2 12 18 22 40 Brown, Dense, Sandy silt of low plasticity with gravel -6.0 -6.5 | 4.5 | | | | | | | | | | |
| | 5.0 | 5.5 | SPT-2 | 12 | 18 | 22 | 40 | Brown, Dense, Sandy silt of low | ML-CL | | |
| _6.5_ | 6.0 | | | | | | | | | | |
| -7.0 7 UDS-3 -7.5 | 6.5 | | | | | | | | | | |
| -7.5 -8.0 -8.0 -8.5 -8.5 8.5 9.0 -9.0 9.5 -9.5 | 7.0 | 7 | UDS-3 | | | | | | | | |
| 8.5 SPT-3 7 11 14 25 Brown, Very stiff to hard, Silty clay of low plasticity with gravel CL Image: CL Ima | 7.5 8.0 | | | | | | | | | | |
| | 8.5 | 8.5 | SPT-3 | 7 | 11 | 14 | 25 | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | ay CL | | |
| 9.5 | 9.0 | | | | | | | | | | |
| | 9.5 | | | | | | | | | | |

UDS*-UDS not recovered

| Cas | LANIT DECISION | | | | FIE | ELD | BOREHOLE L | OG | | |
|----------------|-------------------------------|----------------|------------------|----------------------|------------|-------------------|--|------------------|----------------|---|
| Project | Name :G | iTI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123004.726 m | East | ting :697330. | .724 m |
| Reduced | l Level (1 | n):(+)270 | .616 | | | | BH. No. :BH-A2 | BH | Termination | Depth (m):55 |
| Propose | ed / Exist | ing Struct | <i>ture</i> :Maj | or Bridge | ; | | Water Table (m):33.21 | Incl | ination : Ver | tical |
| Boring | <i>ype</i> :She | ell & Augo | er | | | | Dia. of Boring :150 mm | Dep | th of Casing | (m) :Not Used |
| Date of | Start :16 | -10-2021 | | _ | - | | Date of Completion :18-10-2021 | | | |
| | _ @ Ê | | В | low cour per 15cm | nts n | | | tion | | |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classifica | Graphic Log | Gepth (Depth) v/s SPT N Value) SPT N Value |
| 10.0 | | | | | | | | | | |
| _10.5_ | | | | | | | | | | |
| 11.0 11.5 | 11.5 | SPT-4 | 11 | 14 | 17 | 31 | | | | |
| _12.0_ | | | | | | | | | | |
| 12.5 | 10 | | | | | | | | | |
| 13.0_ 13.5_ | 13 | 008-5 | | | | | | | | |
| 14.0 | | | | | | | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | CL | | |
| 14.5 | 14.5 | SPT-5 | 10 | 13 | 18 | 31 | | | | |
| 15.5_ | | | | | | | | | | |
| _16.0_ | 16 | UDS-6 | | | | | | | | |
| 16.5 | | | | | | | | | | |
| _17.5_ | 17.5 | SPT-6 | 100 (13cm) | - | - | >100 | | | | |
| _18.0_ | | | | | | | | | | |
| 18.5_ 19.0_ | 19 | UDS-7 | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| 19.5_ | | | | | | | | | | |

| Ca | JANI I | | | | FIE | CLD | BOREHOLE L | ,OG | | | |
|--|----------------------------------|---|-----------|----------------------|--------------------|-----------|--|----------------|--------------|---------------|------------------|
| Project | Name :G | TI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL | | |
| BH Loce | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123004.726 m | East | ing :697330 | .724 m | |
| Reduced | l Level (r | n):(+)270 | .616 | | | | BH. No. :BH-A2 | BH | Termination | Depth (m):55 | |
| Propose | ed / Exist | ing Struct | ture :Maj | or Bridge | | | Water Table (m):33.21 | Incli | nation : Ver | tical | |
| Boring i | ype :She | ell & Auge | er | | | | Dia. of Boring :150 mm | Depi | th of Casing | (m) :Not Used | |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | |
| Depth | Situ nple th (m) | Sample | В | low cour per 15cn | nts n | SPT N | Strata | IS fication | Graphic | (Depth v/s | ecial vations |
| (m) 20.0 | Sal Depi | Туре | N1 | N2 | N3 | Value | Description | Classi | Log | SPT N Value) | ° Sp(Obser |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _23.0_ _23.5_ _24.0_ _24.5_ _25.0_ _25.5_ _26.0_ _26.5_ _26.0_ _27.0_ _27.5_ | 20.5 22 23.5 25 26.5 | SPT-7 UDS-8 SPT-8 UDS-9 SPT-9 | 15 | 21 | 29 35 (14cm) | 50 | Brown, Very dense, Sandy silt of low plasticity with gravel | O ML-CL | | | |
| _28.0_ _28.5_ _29.0_ | 28 | SPT-10 | 32 | 40 | 48 | 88 | | | | | _ |
| 29.5 | 29.5 | SPT-11 | 21 | 32 | 43 | 75 | | | | | |

| Ca | ATT CONTRACTOR | | | | FIE | CLD | BOREHOLE L | OG | | |
|----------------------------|--------------------------------|----------------|----------|----------------|--------------|-------------------|--|--------------------|------------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | <i>t :</i> HRIDC | Ľ |
| BH Loc | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123004.726 m | East | ing :69733 | 30.724 m |
| Reduced | l Level (r | n):(+)270 | .616 | | | | BH. No. :BH-A2 | BHT | Ferminatio | n Depth (m):55 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | e | | Water Table (m):33.21 | Incli | nation : V | ertical |
| Boring | <i>ype</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dept | h of Casin | g (m) :Not Used |
| Date of | Start :16 | -10-2021 | | | -4- | 1 | Date of Completion :18-10-2021 | | | |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | ы N1 | per 15cn N2 | N3 | SPT N Value | Strata Description | IS assification | Graphic Log | bectal SPT N Value) SPT N Value SPT N Value |
| _30.0_ | | | | | | | | <u></u> | | 0 10 20 30 40 50 60 70 80 90 100 O |
| _30.5_ | 31 | SPT-12 | 20 | 42 | 58 (14cm) | >100 | | | | |
| 32.0 | 32 5 | SPT-13 | 19 | 34 | 45 | 79 | | | | |
| _33.0_ | 02.0 | | 10 | 04 | | | | <u>_</u> | 433.21m | |
| _33.5_ _34.0_ _34.5_ | 34 | SPT-14 | 20 | 35 | 42 | 77 | | | | |
| _35.0_ _35.5_ _36.0_ | 35.5 | SPT-15 | 28 | 40 | 52 | 92 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| _36.5_ | 37 | SPT-16 | 42 | 64 | 36 (7cm) | >100 | | | | |
| 38.038.5 | 38.5 | SPT-17 | 38 | 61 | 39 (8cm) | >100 | | | | |
| _39.0_ | | | | | | | | | | |
| | | | | | | | | | | |
| _40.0_ | 40 | SPT-18 | 20 | 40 | 42 | 82 | | | | |

| Ch | JANI I | | | | FIE | LD | BOREHOLE L | OG | | | |
|----------------------------|-------------------------------|----------------|----------|----------------------|--------------|-------------------|--|-------------------|-------------------|-------------------------------|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal to |) Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kn | n | | | Northing :3123004.726 m | East | ting :697330.72 | 4 m | |
| Reduced | l Level (i | n):(+)270 | .616 | | | | BH. No. :BH-A2 | BH | Termination De | epth (m):55 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):33.21 | Incli | ination : Vertica | al | |
| Boring | ype :She | ll & Auge | r | | | | Dia. of Boring :150 mm | Dep | th of Casing (m |) :Not Used | |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | |
| | - | | В | low cour per 15cn | nts n | | | ion | | | sue |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Dbservatic |
| _40.0_ | | | | | | | | | | | 0 100 |
| _40.5_ _41.0_ | | | | | | | | | | | |
| _41.5_ | 41.5 | SPT-19 | 19 | 42 | 48 | 90 | | | | | |
| _42.5_ | | | | | | | | | | | |
| 43.0 43.5 | 43 | SPT-20 | 22 | 41 | 47 | 88 | | | | | |
| _44.0_ _44.5_ _45.0_ | 44.5 | SPT-21 | 24 | 40 | 46 | 86 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | • | |
| _45.5_ _46.0_ _46.5_ | 46 | SPT-22 | 21 | 38 | 45 | 83 | | | | | |
| _47.0_ _47.5_ _48.0 | 47.5 | SPT-23 | 28 | 42 | 50 | 92 | | | | | • |
| 48.5 | 49 | SPT-24 | 30 | 70 | 30 (10cm) | >100 | | | | | |
| _49.5_ | | · £7 | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |

| Ca | GARTI DE ENGLAND | | | | FIE | LD | BOREHOLE L | OG | | | |
|------------------|-------------------------------|----------------|------------------|----------------|-------------|-------------------|--|-------------------|----------------|-------------------------------|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal te | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loc | ation/Ch | ainage :2 | 8+075 kr | n | | | Northing :3123004.726 m | Eas | ting :697330. | 724 m | |
| Reduced | d Level (i | n):(+)270 | .616 | | | | BH. No. :BH-A2 | BH | Termination 1 | Depth (m):55 | |
| Propose | ed / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | | | Water Table (m):33.21 | Incl | ination : Vert | ical | |
| Boring | <i>type</i> :She | ll & Auge | er | | | | Dia. of Boring :150 mm | Dep | th of Casing (| (m) :Not Used | |
| Date of | Start :16 | -10-2021 | B | | te | | Date of Completion :18-10-2021 | | | | |
| Depth (m) | In-Situ Sample epth (m) | Sample Type | ы N1 | per 15cn N2 | n N3 | SPT N Value | Strata Description | IS ssification | Graphic Log | (Depth v/s SPT N Value) | Special servations |
| _50.0_ | | | | | | | | Cla | 0 1 | 0 20 30 40 50 60 70 80 90 10 | ₀ ^{°°} äÖ |
| _50.5_ _51.0_ | 50.5 | SPT-25 | 33 | 68 | 32 (9cm) | >100 | | | | | • |
| _51.5_ _52.0_ | 52 | SPT-26 | 36 | 72 | 26 (7cm) | >100 | | | | | |
| _52.5_ _53.0_ | | | | | 05 | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | - |
| _53.5_ _54.0_ | 53.5 | SPT-27 | 35 | 75 | 25 (8cm) | >100 | | | | | • |
| _54.5_ _55.0_ | 55 | _SPT-28_ | 39 | 74 | 26 (8cm) | >100 | | | | | • |
| | | | | | | | | | | | |

| Project | Nama :C | TI for (H | OPC) pr | oject from | I'IL | | A Kalan in the state of Harvana | | ant HRIDCI | | |
|--------------|--------------------------------|----------------|------------|------------|---------|-------------------|--|--------------------|----------------|-------------------------------|-----------------------|
| RHLoc | nume .C | ainago ·? | 8+360 kr | n | | 0 114154116 | Northing :2122100 166 m | Fas | ting :607053 | | |
| Reduced | l Level (i | $\frac{1}{2}$ | 602 | 11 | | | RH No -: BH-A1 | BH | Termination | $\frac{722 \text{ m}}{2}$ | |
| Propose | d / Frist | ing Struct | ure Mai | or Bridge | | | Water Table (m):34 78 | Incl | ination · Vert | ical | |
| Roring | wne ·Rot | arv | ure . wiaj | of Diluge | | | Dia. of Boring :150 mm | Der | oth of Casing | (m) :Not Used | |
| Date of | Start ·13 | -10-2021 | | | | | Date of Completion :14-10-2021 | | in of cusing (| <i>my</i> .1101 0300 | |
| 2 are of | | 10 2021 | В | low cour | nts | | | 5 | | | s |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | N2 | n N3 | SPT N Value | Strata Description | IS lassificatio | Graphic Log | (Depth v/s SPT N Value) | Special bservatior |
| 0.0 | | DS | | | | | | 0 | 0 1 | 0 20 30 40 50 60 70 80 | 90 100 O |
| 0.5 | 1 | SPT-1 | 2 | 2 | 3 | 5 | | | | | |
| 2.0 | | | | | | | | | | | |
| 2.5 | 2.5 | UDS-1 | | | | | Brown, Loose, Silty sand | SM | | | |
| 3.5 | 4 | SPT-2 | 3 | 4 | 6 | 10 | | | | | |
| 4.5 | | | | | | | | | | | |
| 5.0 | 5.5 | UDS-2 | | | | | | | | | |
| 6.0 6.5 | | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 8 | 12 | 17 | 29 | | | | | |
| 8.0 | | | | | | | Brown, Medium dense, Silty sand with clay | SM-SC | | | |
| 8.5 | 8.5 | UDS-3 | | | | | | | | | |
| 9.5 | | | | | | | | | | | |
| 10.0 | 10 | SDT 4 | 7 | 12 | 15 | 27 | | | | | |

| Ca | JAHI NI LANAN | | | | FIE | ELD | BOREHOLE L | OG | | |
|--------------|-------------------------------|----------------|----------|------------|------------|-------------------|--|------------------|----------------|---|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCI | L |
| BH Loc | ation/Ch | ainage :2 | 8+360 kn | n | | | Northing :3123109.166 m | East | ing :69705. | 3.722 m |
| Reduced | d Level (i | n):(+)268 | .602 | | | | BH. No. :BH-A1 | BHT | Termination | n Depth (m):40 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):34.78 | Incli | nation : Ve | rtical |
| Boring i | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing | g (m) :Not Used |
| Date of | Start :13 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | |
| | - | | В | low cour | nts n | | | ion | | su |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS lassificat | Graphic Log | tic construction v/s محمد SPT N Value) محمد |
| _10.0_ | | | | | | | | C | 0 | 10 20 30 40 50 60 70 80 90 100 O |
| 10.5 | | | | | | | Brown, Medium dense, Silty sand with clay | SM-SC | | |
| 11.5 | 11.5 | UDS-4 | | | | | | | | |
| _12.0_ | | | | | | | | | | |
| _12.5_ | | | | | | | | | | |
| _13.0_ | . 13 | SPT-5 | 12 | 18 | 24 | 42 | | | | |
| _13.5_ | | | | | | | | | | |
| _14.0_ | | | | | | | | | | |
| 14.5 | 14.5 | UDS-5 | | | | | Brown, Dense, Silty sand with gravel | SM | | |
| _15.0_ | | | | | | | | | | |
| _15.5_ | | | | | | | | | | |
| 16.0 | 16 | SPT-6 | 10 | 16 | 27 | 43 | | | | |
| 16.5 | | | | | | | | | | |
| 17.0 | 17.5 | UDS-6 | | | | | | | | |
| | | 000-0 | | | | | | | | |
| 18.5 | | | | | | | | | | |
| _19.0_ | . 19 | SPT-7 | 20 | 27 | 33 | 60 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| _19.5_ | | | | | | | | | | |
| 20.0 | | | | | | | | | | |

| Ca | JAHI NETANA M | | | | FIE | LD | BOREHOLE L | ,OG | | |
|--|-------------------------------|----------------------------------|----------|----------------------|----------------------------|-------------------|--|-------------------|------------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject fron | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | <i>t :</i> HRIDC | Ľ |
| BH Loce | ation/Ch | ainage :2 | 8+360 kn | n | | | Northing :3123109.166 m | East | ing :69705 | 53.722 m |
| Reduced | d Level (r | n):(+)268 | .602 | | | | BH. No. :BH-A1 | BHT | Ferminatio | n Depth (m):40 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):34.78 | Incli | nation : V | ertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casin | ng (m) :Not Used |
| Date of | Start :13 | -10-2021 | | | | | Date of Completion :14-10-2021 | I | | |
| | Ê | | В | low cour per 15cn | nts n | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opservatic Opservation Opserv |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _24.0_ _24.5_ _25.0_ | 20.5 22 23.5 25 | UDS-7 SPT-8 UDS-8 SPT-9 | 24 | 33 | 45 58 (13cm) | 78 | Brown, Very dense, Sandy silt of low plasticity with gravel | U ML-CL | | |
| _25.5_ _26.0_ _26.5_ _27.0_ _27.5_ _28.0_ | 26.5 | SPT-10 SPT-11 | 31 28 | 49 | 52 (9cm) 42 (6cm) | >100 | | | | |
| _28.5_ _29.0_ _29.5_ _30 0 | 29.5 | SPT-12 | 16 | 47 | 53 (8cm) | >100 | | | | |

UDS*-UDS not recovered
| Ch | JANI ITT CARD, NO | | | | FIE | CLD | BOREHOLE L | OG | | | | | | | | |
|------------------|-------------------------------|----------------|----------|----------------------|-------------|-------------------|---------------------------------|-------------------|-------------|--------------------|----------|----------|----------------------|-----------|--------|----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | ent :H | IRIDC | L | | | | | |
| BH Loce | ation/Ch | ainage :28 | 8+360 kn | n | | | Northing :3123109.166 m | Eas | ting | :69705 | 3.722 n | n | | | | |
| Reduced | l Level (i | n):(+)268 | .602 | | | | BH. No. :BH-A1 | BH | Tern | inatio | n Depth | (m):4 | 40 | | | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):34.78 | Incl | linati | on : V | ertical | | | | | |
| Boring i | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth oj | ^c Casin | g (m) :N | Not U | sed | | | |
| Date of | Start :13 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | | | | | | | |
| | <u>ہ</u> و | | В | low cour per 15cn | nts n | | | tion | | | | | | | | ons |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Gr I | aphic ₋og | | (SPT | Deptł v/s N Va | n lue) | | Special Dbservati |
| 30.0 | | | | | | | | | | | 0 10 20 | 30 40 | 50 | 30 70 | 80 901 | |
| _30.5_ _31.0_ | 31 | SPT-13 | 31 | 49 | 51 (7cm) | >100 | | | | | | | | | | - |
| _31.5_ | | | | | | | | | | | | | _ | | | _ |
| | | | | | | | | | | | | | | | | |
| _32.0_ | | | | | | | | | | | | | | | | _ |
| | | | | | 46 | | | | | | | | | | | |
| _32.5_ | 32.5 | SPT-14 | 23 | 54 | (8cm) | >100 | | | | | | | | | | ┥ |
| | | | | | | | | | | | | | | | | |
| 33.0 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| _33.5_ | | | | | | | | | | | | | | | | |
| | ~ ~ ~ | 0.07 15 | | | 26 | | | | | | | | | | | |
| 34.0 | 34 | SP1-15 | 38 | 74 | (6CM) | >100 | | | | | | | | | | ┥ |
| 245 | | | | | | | | | | | | | | | | |
| 34.5 | | | | | | | | | | | | | | | | |
| 35.0 | | | | | | | Brown Very dense, Sandy silt of | | ¥ 34 | .78m | | | | | | |
| | | | | | | | low plasticity with gravel | ML-CL | | | | | | | | |
| 35.5 | 35.5 | SPT-16 | 24 | 55 | 46 (7cm) | >100 | | | | | | | | | | |
| | 00.0 | | 2. | | | 100 | | | | | | | | | | |
| 36.0 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| _36.5_ | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| _37.0_ | 37 | SPT-17 | 27 | 64 | (5cm) | >100 | | | | | | | | | | . |
| | | | | | | | | | | | | | | | | |
| _37.5_ | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| _38.0_ | | | | | | | | | | | | | | | | _ |
| | | | | | 28 | | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-18 | 25 | 72 | (8cm) | >100 | | | | | ++ | | | | | - ↓ |
| | | | | | | | | | | | | | | | | |
| _39.0_ | | | | | | | | | | | ++ | | | | | |
| | | | | | | | | | | | | | | | | |
| _39.5_ | | | | | | | | | | | ++ | + | _ | | ++ | |
| | | | | | 55 | | | | | | | | | | | |
| _40.0_ | 40 | SPT-19 | 29 | 45 | (13cm) | _>100_ | | | | | | | | | | |

| | THE CONTRACTOR | | | | | | BOREHOLE L | $\frac{OG}{G}$ | | | |
|-------------------|--------------------------------|----------------|----------------------------------|----------------|------------|-------------------|---|-------------------|-------------------|-------------------------------|----------------------|
| Project | Name :G | fII for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | | ent :HRIDCL | | |
| BH Loc | ation/Ch | ainage :2 | $\frac{8+360 \text{ kr}}{2.841}$ | n | | | <i>Northing</i> :3123091.386 m | Eas | ting :69/050.915 | m | |
| Reduced | a Level (I | n):(+)207 | | D.1. | | | BH. No. :BH-PI | BH | Termination Dep | <i>th (m)</i> :50 | |
| Propose | tung Pot | ing Struct | ture : Maj | or Bridge | ; | | Dia of Boring :150 mm | Dar | th of Casing (m) | Not Used | |
| Data of | Stant 12 | ary | | | | | Date of Completion :15 10 2021 | Dep | oin of Casing (m) | .not Used | |
| Dale 0j | Siari . 15 | -10-2021 | В | low cour | nts | | Dule of Completion .15-10-2021 | Ę | | | s |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | per 15cn N2 | n N3 | SPT N Value | Strata Description | IS assificatic | Graphic Log | (Depth v/s SPT N Value) | Special servation |
| 0.0 | | DS | | | | | | ū | 0 10 2 | 0 30 40 50 60 70 80 90 100 | ō |
| 0.5 | . 1 | UDS-1 | | | | | | | | | _ |
| 2.0 | 2.5 | SPT-1 | 3 | 5 | 7 | 12 | Brown, Medium dense, Silty sand with clay | SM-SC | | | - |
| 3.0 3.5 | - | | | | | | | | | | - |
| 4.0 4.5 5.0 | . 4 | UDS-2 | | | | | | | | | - |
| 5.5 6.0 | 5.5 | SPT-2 | 13 | 15 | 19 | 34 | | | | | - |
| 7.0 | . 7 | UDS-3 | | | | | Brown, Dense, Sandy silt of low plasticity with gravel | ML-CL | | | _ |
| 8.0 | . 8.5 | SPT-3 | 16 | 20 | 25 | 45 | | | | | - |
| 9.0 | - | | | | | | | | | | _ |

| G | JANI I | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--------------|-------------------------|----------------|-------------------|----------------------|------------|------------|---|-----------------|----------------|---------------------|---------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL | , | |
| BH Loca | ation/Ch | ainage :2 | 8+360 kr | n | | | Northing :3123091.386 m | East | ing :697050 | .915 m | |
| Reduced | l Level (r | n):(+)267 | .861 | | | | BH. No. :BH-P1 | BH | Termination | Depth (m):50 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):34.10 | Incli | nation : Ver | tical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing | (m) :Not Used | |
| Date of | Start :13 | -10-2021 | | | | | Date of Completion :15-10-2021 | | | | |
| | tu ele (m) | | В | low coun per 15cm | nts n | SPT | | ation | | (Depth | tions |
| (m) | In-Sil Samp Depth | Sample Type | N1 | N2 | N3 | N Value | Strata Description | IS Classific | Graphic Log | v/s SPT N Value) | Dbserva |
| 10.5 | | | | | | | | | | | |
| 11.0 | | | | | | | | | | | |
| _11.5_ | 11.5 | SPT-4 | 10 | 13 | 16 | 29 | Brown, Very stiff, Silty clay of low plasticity with gravel | CL | | | |
| 12.0 | | | | | | | | | | | |
| 12.5 13.0 | 13 | UDS-5 | | | | | | | | | |
| 13.5 | | | | | | | | | | | |
| 14.0 | | | | | | | | | | | |
| 14.5 15.0 | 14.5 | SPT-5 | 15 | 21 | 23 | 44 | | | | | |
| 15.5 | | | | | | | | | | | |
| 16.0 | 16 | UDS-6 | | | | | | | | | |
| 16.5 | | | | | | | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| _17.0_ | 17.5 | SPT-6 | 18 | 25 | 28 | 53 | | | | | |
| 18.0 | | | | | | | | | | | |
| 18.5 | | | | | | | | | | | |
| 19.0 | 19 | UDS-7 | | | | | | | | | |
| | | | | | | | | | | | |

| Ca | LAN IT | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--------------|-------------------------------|----------------|----------|----------------------|------------|-------------------|---|-------------------|--------------------|-------------------------------|----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | a Kalan in the state of Haryana. | Clie | ent :HRIDCL | | |
| BH Loca | ation/Ch | ainage :28 | 8+360 kn | n | | | Northing :3123091.386 m | Eas | ting :697050.915 | 5 m | |
| Reduced | l Level (r | n):(+)267 | .861 | | | | BH. No. :BH-P1 | BH | Termination Dep | oth (m):50 | |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):34.10 | Incl | ination : Vertical | l | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing (m) | :Not Used | |
| Date of | Start :13 | -10-2021 | | | | | Date of Completion :15-10-2021 | | | | |
| | _ د (| | В | low cour per 15cm | nts n | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS :lassificat | Graphic Log | (Depth v/s SPT N Value) | Special bservatio |
| 20.0 | | | | | | | | 0 | 0 10 2 | 20 30 40 50 60 70 80 90 100 | 0 |
| _20.5_ | 20.5 | SPT-7 | 28 | 33 | 36 | 69 | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| _21.5_ | 22 | 8 פחוו | | | | | | | | | |
| _22.5_ | 22 | 003-0 | | | | | | | | | |
| _23.0_ | | | | | | | | | | | |
| _23.5_ | 23.5 | SPT-8 | 16 | 18 | 21 | 39 | Brown, Hard, Silty clay of low | CL | | | |
| 24.0 | | | | | | | | | | | |
| 24.5 | 25 | UDS* | | | | | | | | | |
| 25.5 | 25.5 | SPT-9 | 32 | 43 | 50 | 93 | | | | | |
| _26.0_ | | | | | | | | | | | |
| 26.5 27.0 | 26.5 | SPT-10 | 31 | 45 | 53 | 98 | | | | | |
| _27.5_ | | | | | | | Brown, Very dense. Sandy silt of | | | | |
| _28.0_ | 28 | SPT-11 | 14 | 22 | 32 | 54 | low plasticity with gravel | ML-CL | | | |
| 28.5 29.0 | | | | | | | | | | | |
| 29.5 | 29.5 | SPT-12 | 18 | 26 | 37 | 63 | | | | | |

| Ca | JANI ITTE AND AND | | | | FIE | CLD | BOREHOLE L | ,OG | | |
|----------------------------|-------------------------------|----------------|----------|------------|-------------|-------------------|--|--------------------|----------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDO | CL |
| BH Loce | ation/Ch | ainage :2 | 8+360 kn | n | | | Northing :3123091.386 m | East | ing :6970: | 50.915 m |
| Reduced | l Level (1 | n):(+)267 | .861 | | | | BH. No. :BH-P1 | BH | Terminatio | on Depth (m):50 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):34.10 | Incli | nation : V | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casir | ng (m) :Not Used |
| Date of | Start :13 | -10-2021 | | | | | Date of Completion :15-10-2021 | | | |
| | | | В | low cour | nts | | | uo | | St |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificati | Graphic Log | O 000000000000000000000000000000000000 |
| 30.5 | | | | | | | | | | |
| _30.5_ _31.0_ _31.5_ | 31 | UDS-9 | | | | | | | | |
| _32.0_ | | | | | | | | | | |
| _32.5_ | 32.5 | SPT-13 | 21 | 27 | 35 | 62 | | | | |
| _33.0_ | | | | | | | | | | |
| _33.5_ | | | | | | | | | | |
| _34.0_ | 34 | UDS-10 | | | | | | <u>-</u> | 34.10m | |
| _34.5_ | | | | | | | | | | |
| _35.0_ | | | | | 47 | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| _35.5_ | 35.5 | SPT-14 | 40 | 53 | (7cm) | >100 | | | | |
| 36.5 | | | | | | | | | | |
| _37.0_ | 37 | SPT-15 | 45 | 57 | 43 (5cm) | >100 | | | | |
| _37.5_ | | | | | | | | | | |
| _38.0_ | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-16 | 44 | 65 | 35 (7cm) | >100 | | | | |
| _39.0_ | | | | | | | | | | |
| _39.5_ | | | | | 24 | | | | | |
| 40.0_ | 40 | SPT-17 | 48 | 69 | (6cm) | | | | | |

| Ca | JANI UTE LANA ME | | | | FIE | CLD | BOREHOLE L | ,OG | | | | | | | |
|--------------|-------------------------------|----------------|----------|----------------------|-------------|-------------------|----------------------------------|-------------------|-----------|------------|------------|------------------------|---------|--------|----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Cli | ent :HI | RIDCL | | | | | |
| BH Loca | ation/Ch | ainage :2 | 8+360 kr | n | | | Northing :3123091.386 m | Ea | sting :6 | 597050.9 | 915 m | | | | |
| Reduced | l Level (r | n):(+)267 | .861 | | | | BH. No. :BH-P1 | BH | I Termi | nation L | Depth (m): | 50 | | | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):34.10 | Inc | linatio | n : Verti | cal | | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | De | pth of (| Casing (i | m) :Not U | sed | | | |
| Date of | Start :13 | -10-2021 | | | | | Date of Completion :15-10-2021 | | | | | | | | |
| | <u>،</u> وَ | | В | low coun per 15cm | its 1 | | | tion | | | | | | | l |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Gra Lo | phic og | SPT | (Depth v/s ſN Va | lue) | | Special Observati |
| _40.0_ | | | | | | | | | | 0 10 | 20 30 4 | 0 50 6 | 0 70 80 | 90 100 | |
| _40.5_ | | | | | | | | | | | | | | | - |
| _41.0_ | 41.5 | SPT-18 | 35 | 53 | 47 (5cm) | >100 | | | | | | | | | • |
| _42.0_ | | | | | | | | | | | | | | | |
| _42.5_ | | | | | | | | | | | | | | | - |
| _43.0_ | 43 | SPT-19 | 37 | 60 | 40 (5cm) | >100 | | | | | | | | | • |
| _43.5_ | | | | | | | | | | | | | | | |
| _44.0_ | | | | | 36 | | | | | | | | | | - |
| _44.5_ | 44.5 | SPT-20 | 40 | 64 | (7cm) | >100 | Brown. Verv dense. Sandv silt of | | | | | | | | • |
| _45.5_ | | | | | | | low plasticity with gravel | ML-CL | | | | | | | |
| _46.0_ | 46 | SPT-21 | 50 | 80 | 20 (4cm) | >100 | | | | | | | | | • |
| _46.5_ | | | | | | | | | | | | | | | |
| _47.0_ | | | | | | | | | | | | | | | |
| _47.5_ | 47.5 | SPT-22 | 40 | 70 | 30 (6cm) | >100 | | | | | | | | | • |
| _48.0_ | | | | | | | | | | | | | | | |
| 48.5 | 40 | е рт оо | 40 | 100 | | N100 | | | | | | | | | |
| 49.0 49.5 | 49 49.25 | SPT-23 | 40 | | - | >100 | | | | | | | | | |
| | | | | | | | | | | | | | | | |

UDS*-UDS not recovered

| Ch | LANT CONTRACTOR | | | | FIE | ELD | BOREHOLE L | OG | | | |
|-------------------|-------------------------------|----------------|----------|----------------------|----------|-------------------|--|-------------------|----------------|-------------------------------|-----------------------|
| Project . | Name :G | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL | , | |
| BH Loca | ation/Ch | ainage :28 | 8+360 kn | n | | | Northing :3123064.68 m | East | ing :697046 | .7 m | |
| Reduced | l Level (n | n):(+)267 | .285 | | | | BH. No. :BH-P2 | BHT | Termination | Depth (m):50 | |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):33.85 | Incli | nation : Ver | tical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing | (m) :Not Used | |
| Date of | Start :12 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | | |
| | (c | | В | low coun per 15cm | its 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | special Observatic |
| 0.0 | | DS | | | | | | | | | _ |
| 0.5 1.0 1.5 | 1 | SPT-1 | 2 | 4 | 6 | 10 | | | | | |
| 2.0 | | | | | | | Brown, Loose, Sandy silt of low plasticity | ML-CL | | | |
| 2.5 | 2.5 | UDS-1 | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 3.5 | | | | | | | | | | | |
| 4.0 | 4 | SPT-2 | 7 | 9 | 11 | 20 | | | | | |
| 4.5 | | | | | | | | | | | |
| 5.5 | 5.5 | UDS-2 | | | | | Brown, Medium dense, Silty sand | SM-SC | | | |
| 6.0 | | | | | | | inter only | | | | |
| 6.5 | | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 11 | 15 | 19 | 34 | | | | | |
| 7.5 | | | | | | | | | | | |
| 8.0 | | | | | | | | | | | |
| 8.5 | 8.5 | UDS-3 | | | | | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| 9.0 | | | | | | | | | | | |
| 9.5 | 40 | ODT (| 40 | 47 | 00 | 40 | | | | | |

| Ca | CANE OF CASE O | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--|--|---|-------------------|----------------------|-------------------------|-------------------|---|-------------------|------------------|-------------------------------|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal te | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loc | ation/Ch | ainage :2 | 8+360 kr | n | | | Northing :3123064.68 m | East | ting :697046.7 | m | |
| Reduced | d Level (i | n):(+)267 | .285 | | | | BH. No. :BH-P2 | BH | Termination De | epth (m):50 | |
| Propose | ed / Exist | ing Struci | <i>ture :</i> Maj | or Bridge | ; | | Water Table (m):33.85 | Incli | ination : Vertic | cal | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing (n | ı) :Not Used | |
| Date of | Start :12 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | | |
| | Ê | | В | low cour per 15cn | nts n | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| - 10.0- - 10.5- - 11.5- - 11.5- - 12.0- - 12.5- - 13.0- - 13.5- - 13.5- - 13.5- - 14.0- - 14.5- - 14.5- - 15.5- - 16.0- - 15.5- - 16.0- - 15.5- - 16.0- - 15.5- - 16.0- - 15.5- - 16.0- - 11.5- - 11.0- - 11.5- - 1 | 11.5 11.5 13 14.5 16 17.5 | UDS-4 SPT-5 UDS-5 SPT-6 UDS-6 | 16 | 26 | 29 31 40 (5cm) | 55 | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | O ML-CL | | | |
| 19.0 19.5 20.0 | . 19 | SPT-7 | 31 | 60 | 40 (5cm) | >100 | | | | | - |

| Ca | APRIL TELEVISION | | | | FIE | CLD | BOREHOLE L | 00 | \widetilde{J} | | | | |
|--|-------------------------------|-----------------------|------------------|----------------------|-------------|-------------------|---|------|-----------------|----------------|---------------------------|------|---------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | a Kalan in the state of Haryana. | | Client | :HRIDC | L | | |
| BH Loca | ation/Ch | ainage :2 | 8+360 kn | n | | | Northing :3123064.68 m | | Eastir | ng :69704 | 6.7 m | | |
| Reduced | l Level (r | n):(+)267 | .285 | | | | BH. No. :BH-P2 | | BH Te | erminatio | n Depth (m):50 | | |
| Propose | d / Exist | ing Struct | <i>ture</i> :Maj | or Bridge | | | Water Table (m):33.85 | | Inclin | ation : V | ertical | | |
| Boring t | <i>ype</i> :Rot | ary | | | | | Dia. of Boring :150 mm | | Depth | of Casin | g <i>(m)</i> :Not Used | | |
| Date of | Start :12 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | | | | |
| | - @Ê | | В | low coun per 15cm | nts 1 | | | | tion | | | | _ u |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | SI | classifica | Graphic Log | (Depth v/s SPT N Va | lue) | Specia Dbservati |
| _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ | 20.5 22 23.5 | UDS* SPT-8 UDS* | 39 | 55 | 45 (5cm) | >100 | | | _ | | | | |
| _24.0_ _24.5_ _25.0_ _25.5_ _26.0_ | 25 | SPT-9 | 45 | 79 | 21 (4cm) | >100 | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-(| CL | | | | - |
| _26.5_ _27.0_ _27.5_ | 26.5 | UDS* | | | | | | | | | | | _ |
| _28.0_ _28.5_ _29.0_ | 28 | SPT-10 | 43 | 65 | 35 (7cm) | >100 | | | | | | | ● |
| 29.5 | 29.5 | UDS* | | | | | | | | | | | |

UDS*-UDS not recovered

| Ca | SAPIT TE E SACIN MA | | | | FIE | ĽD | BOREHOLE L | OG | | | | | | | |
|----------------------------|-------------------------------|----------------|----------|----------------------|---------------|-------------------|---|-------------------|---------------|-----------|-----------|------------------------|-----------|---------|-----------------------|
| Project . | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | Harsana | Kalan in the state of Haryana. | Clier | <i>t :</i> HR | IDCL | | | | | |
| BH Loca | ation/Ch | ainage :28 | 8+360 kn | n | | | Northing :3123064.68 m | Easti | ing :69 | 97046.7 r | n | | | | |
| Reduced | l Level (1 | n):(+)267 | .285 | | | | BH. No. :BH-P2 | BH 1 | Fermin | ation De | pth (m): | 50 | | | |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):33.85 | Incli | nation | : Vertica | ıl | | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of C | asing (m |) :Not U | sed | | | |
| Date of | Start :12 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | | | | | | |
| | ء َ َ | | В | low cour per 15cn | nts า | | | tion | | | | | | | l |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Grapi Log | hic 9 | SP | (Depth v/s 「N Va | 1 Iue) | 0 90.10 | Special Observatio |
| _30.5_ | 31 | SPT-11 | 38 | 63 | 37 (4cm) | >100 | | | | | | | | | - |
| _31.5_ _32.0_ _32.5_ | 32.5 | UDS* | | | | | | | | | | | | | - |
| _33.0_ _33.5_ | | | | | | | | | | | | | | | - |
| _34.0_ _34.5_ | 34 | SPT-12 | 49 | 53 | 47 (6cm) | >100 | | Ţ | 33.85 | | | | | | • |
| _35.0_ _35.5_ | 35.5 | UDS* | | | | | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-CL | | | | | | | - |
| _36.0_ _36.5_ | | | | | 27 | | | | | | | | | | - |
| _37.0_ _37.5_ | 37 | SPT-13 | 39 | 63 | (5cm) | >100 | | | | | | | | | • |
| _38.0_ | 38.5 | SPT-14 | 48 | 69 | 31 (8cm) | >100 | | | | | | | | | - |
| _39.0_ | | | | | | | | | | | | | | | - |
| 40.0 | 40 | _SPT-15_ | 45 | 72 | 28 _(5cm)_ | _>100_ | | | | | | | | | |

| Ca | ALANI ITTE CARGO AND | | | | FIE | CLD | BOREHOLE L | 00 | G | | | | |
|--------------|-------------------------------|----------------|------------------|----------------------|-------------|-------------------|---|-----|-------------|----------------|----------------|-------------------------|--------------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | | Clien | t :HRIDC | L | | |
| BH Loce | ation/Ch | ainage :2 | 8+360 kr | n | | | Northing :3123064.68 m | | Eastin | ıg :69704 | 6.7 m | | |
| Reduced | l Level (r | n):(+)267 | .285 | | | | BH. No. :BH-P2 | | BH T | erminatio | n Depth (m):50 |) | |
| Propose | ed / Exist | ing Struci | <i>ture</i> :Maj | or Bridge | | | Water Table (m):33.85 | | Inclin | ation : V | ertical | | |
| Boring i | ype :Rot | ary | | | | | Dia. of Boring :150 mm | | Dept | of Casin | g (m) :Not Use | d | |
| Date of | Start :12 | -10-2021 | | | | | Date of Completion :14-10-2021 | | | | | | |
| | <u>،</u> وَ | | В | low coun per 15cm | its 1 | | | | tion | | | | l |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | ิร | Classificat | Graphic Log | (D SPT N | epth //s I Value) | Special Observati |
| 40.0 | | | | | | | | | | | | | |
| 40.5 41.0 | | | | | | | | | | | | | - |
| _41.5_ | 41.5 | SPT-16 | 42 | 68 | 32 (7cm) | >100 | | | | | | | • |
| _42.0_ | | | | | | | | | | | | | |
| _42.5_ | | | | | | | | | | | | | - |
| _43.0_ | 43 | SPT-17 | 49 | 75 | 25 (9cm) | >100 | | | | | | | • |
| _43.5_ | | | | | | | | | | | | | - |
| _44.0_ | | | | | | | | | | | | | - |
| _44.5_ | 44.5 | SPT-18 | 52 | 100 (10cm) | - | >100 | | | | | | | • |
| _45.0_ | | | | | | | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML- | -CL | | | | - |
| _45.5_ | | | | | | | | | | | | | - |
| _46.0_ | 46 | SPT-19 | 40 | 100 (15cm) | - | >100 | | | | | | | • |
| _46.5_ | | | | | | | | | | | | | $\left \right $ |
| _47.0_ | | | | | | | | | | | | | |
| _47.5_ | 47.5 | SPT-20 | 48 | 100 (3cm) | - | >100 | | | | | | | |
| _48.0_ | | | | | | | | | | | | | $\left \right $ |
| _48.5_ | | | | | | | | | | | | | $\left \right $ |
| _49.0_ | 49 49 23 | SPT-21 | 45 | 100 (8cm) | - | >100 | | | | | | | |
| _49.5_ | 10.20 | | | | | | | | | | | | $\left \right $ |
| _50.0_ | | | | | | | | | | | | | |

| C | LIANT CANADA | | | | FIE | | BOREHOLE L | OG | |
|--------------|-------------------------|----------------|------------------|------------|------------|------------|---|---------------|---|
| Project | Name :C | fTI for (H | ORC) pr | oject fron | n Palwal t | to Harsana | Kalan in the state of Haryana. | Clie | ent :HRIDCL |
| BHLoc | ation/Ch | ainage :2 | 8+360 kr | n | | | <i>Northing</i> :3123046.953 m | Eas | <i>sting</i> :697043.901 m |
| Reduce | d Level (i | n):(+)267 | 7.528 | | | | BH. No. :BH-A2 | BH | Termination Depth (m):40 |
| Propose | ed / Exist | ing Struct | <i>ture</i> :Maj | or Bridge | • | | Water Table (m):34.20 | Incl | lination : Vertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing (m) : Not Used |
| Date of | Start : 12 | 2-10-2021 | B | low cour | nts | | Date of Completion :13-10-2021 | - | |
| | | | | per 15cn | n | SPT | | atio | (Depth |
| Depth (m) | In-Sit Samp Depth | Sample Type | N1 | N2 | N3 | N Value | Strata Description | IS assific | Graphic v/s of the second sec |
| 0.0 | _ | | | | | | | Ü | 0 10 20 30 40 50 60 70 80 90100 Ö |
| 0.5 | . 1 | UDS-1 | | | | | | | |
| 1.5 2.0 | - | | | | | | Brown, Loose, Silty sand | SM | |
| 2.5 | . 2.5 | SPT-1 | 3 | 4 | 5 | 9 | | | |
| 3.0 3.5 | - | | | | | | | | |
| 4.0 | . 4 | UDS-2 | | | | | | | |
| 4.5 | - | | | | | | | | |
| 5.5 | 5.5 | SPT-2 | 12 | 19 | 25 | 44 | | | |
| 6.5 | - | | | | | | | | |
| 7.0 | 7 | UDS-3 | | | | | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-CL | |
| 7.5 | - | | | | | | | | |
| 8.5 | 8.5 | SPT-3 | 14 | 22 | 28 | 50 | | | |
| 9.0 | | | | | | | | | |
| 10.0 | 10 | | | | | | | | |

| C | ATT CONTRACTOR | | | | FIE | ELD | BOREHOLE L | OG | | |
|---|--|---|-----------------|---------------------------|----------|-------------------|---|-------------------|-------------------|---|
| Project | Name :C | TI for (H | ORC) pr | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | <i>ıt :</i> HRIDC | Ľ |
| BH Loc | ation/Ch | ainage :2 | 8+360 kı | m | | | Northing :3123046.953 m | East | ing :69704 | 13.901 m |
| Reduce | d Level (i | n):(+)267 | .528 | | | | BH. No. :BH-A2 | BH | Ferminatio | n Depth (m):40 |
| Propos | ed / Exist | ing Struct | <i>ure</i> :Maj | jor Bridge | | | Water Table (m):34.20 | Incli | nation : V | ertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casin | ng (m) :Not Used |
| Date of | Start :12 | -10-2021 | | | | | Date of Completion :13-10-2021 | | | |
| | Ê | | B | Blow coun | its 1 | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Clepth (Depth v/s SPT N Value) 00 ps 00 00 ps 00 00 ps 00 00 00 00 00 00 00 00 00 00 00 00 00 |
| 10.5_ 11.0_ 11.5_ 12.0_ 12.5_ 12.5_ 13.0_ 13.5_ 14.0_ 14.5_ 14.5_ 15.5_ 15.5_ 16.0_ 15.5_ 16.0_ 16.5_ 17.0_ 17.5_ 18.0_ 18.5_ 19.0_ 19.5_ | - 11.5 - 13 - 14.5 - 16 - 17.5 - 19 | SPT-4 UDS-5 UDS* SPT-6 UDS* | 16 | 27 100 (15cm) 33 | - | 59 >100 | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-CL | | |

| Ca | APRIL 10 E Lacis, No. | | | | FIE | CLD | BOREHOLE L | OG | | | |
|--|-------------------------------|----------------|------------------|----------------------|------------------|-------------------|---|-------------------|----------------|---|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | |
| BH Loca | ation/Ch | ainage :2 | 8+360 kr | n | | | Northing :3123046.953 m | East | ing :69704 | 3.901 m | |
| Reduced | l Level (r | n):(+)267 | .528 | | | | BH. No. :BH-A2 | BH | Termination | n Depth (m):40 | |
| Propose | d / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | | | Water Table (m):34.20 | Incl | nation : Ve | rtical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used | |
| Date of | Start :12 | -10-2021 | | | | | Date of Completion :13-10-2021 | | | | |
| | ر م | | В | low coun per 15cm | its າ | | | tion | | | ons |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 80 6010 | Special Observatio |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _24.0_ _24.5_ | 20.5 22 23.5 | SPT-7 UDS* | 44 | 100 (15cm) | - 48 (6cm) | >100 | | | | | |
| _25.0_ _25.5_ _26.0_ _26.5_ | 25 26.5 | UDS* | 44 | 70 | 30 (5cm) | >100 | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-CL | | | - |
| _27.0_ | | | | | | | | | | | _ |
| _27.5_ _28.0_ _28.5_ _29.0_ | 28 | UDS* | | | | | | | | | |
| 29.5 | 29.5 | SPT-10 | 45 | 100 (10cm) | - | >100 | | | | | • |

| Ca | JANI ITTE AND AND | | | | FIE | CLD | BOREHOLE L | OG | | |
|--------------------------------------|-------------------------------|----------------|------------------|----------------------|--------------|-------------------|---|-------------------|----------------|---|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | a Kalan in the state of Haryana. | Clier | nt :HRIDC | Ľ |
| BH Loca | ation/Ch | ainage :2 | 8+360 kr | n | | | Northing :3123046.953 m | East | ing :69704 | 13.901 m |
| Reduced | l Level (1 | n):(+)267 | .528 | | | | BH. No. :BH-A2 | BH | Terminatio | n Depth (m):40 |
| Propose | ed / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | ; | | Water Table (m):34.20 | Incli | nation : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casin | ng (m) :Not Used |
| Date of | Start :12 | -10-2021 | | | | | Date of Completion :13-10-2021 | | | |
| | . 6 | | В | low cour per 15cn | nts n | | | ion | | |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opeth v/s SPT N Value) 0 10 20 30 40 50 00 70 00 100 00 50 00 100 00 100 00 100 00 100 00 100 00 |
| | | | | | | | | | | |
| _30.5_ _31.0_ _31.5_ _32.0_ | 31 | UDS* | | | | | | | | |
| _32.5_ | 32.5 | SPT-11 | 48 | 75 | 25 (4cm) | >100 | | | | |
| _33.5_ _34.0_ _34.5_ | 34 | UDS* | | | | | | Ţ | 34.20m | |
| _35.0_ _35.5_ _36.0_ | 35.5 | SPT-12 | 38 | 63 | 37 (10cm) | >100 | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| _36.5_ _37.0_ | 37 | UDS* | | | | | | | | |
| 37.5 38.0 | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-13 | 32 | 49 | 51 (13cm) | >100 | | | | |
| _39.5_ | 40 | SPT-14 | 54 | 60 | 31 (10cm) | >100 | | | | |

| Ca | ATT CARLON | | | | FIE | ELD | BOREHOLE L | OG | | | |
|-------------------|-------------------------------|----------------|----------|----------------------|----------|-------------------|---|-------------------|----------------|-------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | t :HRIDC | L | |
| BH Loce | ation/Ch | ainage :2 | 8+900 kn | n | | | Northing :3123223.834 m | East | ng :69653 | 1.197 m | |
| Reduced | l Level (r | n):(+)262 | .678 | | | | BH. No. :BH-A1 | BH T | erminatio | n Depth (m):40 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):36.90 | Incli | nation : V | ertical | |
| Boring | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casin | g (m) :Not Used | |
| Date of | Start :18 | -10-2021 | | | | | Date of Completion :21-10-2021 | I | | | |
| | (c | | В | low cour per 15cm | its 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatic |
| | | DS | | | | | | | | | |
| 0.5 1.0 1.5 | 1 | SPT-1 | 7 | 12 | 15 | 27 | | | | | |
| 2.0 | | | | | | | | | | | - |
| 2.5 | 2.5 | UDS-1 | | | | | | | | | |
| 3.5 | | | | | | | | | | | - |
| 4.0 | 4 | SPT-2 | 7 | 9 | 11 | 20 | | | | | - |
| 4.5 | | | | | | | Brown, Medium dense to dense, | | | | |
| 5.5 | 5.5 | UDS-2 | | | | | Sandy silt of low plasticity with gravel | ML-CL | | | - |
| 6.0 | | | | | | | | | | | - |
| 6.5 | | | | | | | | | | | |
| 7.0 7.5 | 7 | SPT-3 | 9 | 13 | 16 | 29 | | | | | |
| 8.0 | | | | | | | | | | | - |
| 8.5 | 8.5 | UDS-3 | | | | | | | | | |
| 9.0 | | | | | | | | | | | |
| 9.5 | 10 | SPT-4 | 11 | 15 | 17 | 32 | | | | | |

| Ca | STATIC CONTRACTOR | | | | FIE | CLD | BOREHOLE L | 0 | G | | | |
|--|-------------------------------|----------------|------------------|----------------------|-------------|-------------------|--|----------|-------------|----------------|-------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | | Clier | t :HRIDCL | | |
| BH Loc | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123223.834 m | | Easti | ing :696531. | 197 m | |
| Reduced | d Level (r | n):(+)262 | .678 | | | | BH. No. :BH-A1 | | BH T | ermination . | Depth (m):40 | |
| Propose | ed / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | | | Water Table (m):36.90 | | Incli | nation : Vert | ical | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | | Dept | h of Casing | (m) :Not Used | |
| Date of | Start :18 | 3-10-2021 | | | | | Date of Completion :21-10-2021 | | | | | |
| | Ê | | В | low coun per 15cm | its າ | | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | <u>s</u> | Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| _10.0 _10.5 _11.0 _11.5 _12.0 _12.5 _13.0 _13.5 _14.0_ | 11.5 | UDS-4 | 18 | 52 | 48 | 100 | Brown, Medium dense to dense, Sandy silt of low plasticity with gravel | ML | -CL | | | |
| 14.5 15.0 15.5 16.0 16_5 | 14.5 | SPT-6 | 21 | 29 31 | 35 37 | 64 | | | | | | _ |
| 16.5_ 17.0_ 17.5_ 18.0_ 18.5_ 19.0_ 19.5_ | 17.5 | UDS-5 SPT-8 | 35 | 57 | 43 (8cm) | >100 | Brown, Hard, Silty clay of low plasticity with gravel | C | ïL | | | |

| Ca | JANI UT CASA AN | | | | FIE | CLD | BOREHOLE L | OG | | | |
|----------------------------|-------------------------------|----------------|----------|----------------------|--------------|-------------------|--|-------------------|----------------|--|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loca | ation/Ch | ainage :2 | 8+900 kn | n | | | Northing :3123223.834 m | East | ing :696531 | .197 m | |
| Reduced | l Level (1 | n):(+)262 | .678 | | | | BH. No. :BH-A1 | BH | Termination | Depth (m):40 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | ; | | Water Table (m):36.90 | Incli | ination : Ver | tical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | (m) :Not Used | |
| Date of | Start :18 | -10-2021 | | | | | Date of Completion :21-10-2021 | | | | |
| | - | | В | low cour per 15cn | nts n | | | ion | | | su |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 80 90100 | Special Observatic |
| _20.5_ _21.0_ _21.5_ | 20.5 | SPT-9 | 38 | 49 | 51 (6cm) | >100 | | | | | , |
| _22.0_ | 22 | SPT-10 | 35 | 60 | 40 (9cm) | >100 | | | | | , |
| _23.0_ _23.5_ _24.0_ | 23.5 | SPT-11 | 41 | 56 | 46 (6cm) | >100 | | | | | • |
| _24.5_ _25.0_ _25.5_ | 25 | SPT-12 | 37 | 53 | 47 (8cm) | >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | , |
| _26.0_ _26.5_ _27.0_ | 26.5 | SPT-13 | 40 | 51 | 49 (10cm) | >100 | | | | | , |
| _27.5_ | | | | | 47 | | | | | | |
| 28.0 | 28 | SPT-14 | 38 | 53 | (8cm) | >100 | | | | | |
| _29.0_ _29.5_ _30.0 | 29.5 | SPT-15 | 41 | 52 | 48 (7cm) | >100 | | | | | • |

UDS*-UDS not recovered

| Ca | JANI NE CANANA | | | | FIE | LD | BOREHOLE L | JOG | | | |
|--------------|-------------------------------|----------------|---------------|----------------------|--------------|-------------------|--------------------------------|-------------------|-----------------|-------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | |
| BH Loce | ation/Ch | ainage :2 | 8+900 kn | n | | | Northing :3123223.834 m | East | ting :69653 | 1.197 m | |
| Reduced | d Level (r | n):(+)262 | 2.678 | | | | BH. No. :BH-A1 | BH | Terminatio | n Depth (m):40 | |
| Propose | ed / Exist | ing Struct | ture :Majo | or Bridge | ; | | Water Table (m):36.90 | Incl | ination : V | ertical | |
| Boring i | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used | |
| Date of | Start :18 | -10-2021 | | | | | Date of Completion :21-10-2021 | | | | |
| | 2 | | B | low cour per 15cn | nts n | | | ion | | | suo |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatic |
| | | | | | | | | | | | |
| _30.5_ | | | | | 48 | | | | | | - |
| _31.0_ | 31 | SPT-16 | 26 | 52 | (10cm) | >100 | | | | | • |
| _32.0_ | | | | | | | | | | | - |
| _32.5_ | 32.5 | SPT-17 | 34 | 40 | 60 (8cm) | >100 | | | | | • |
| _33.0_ | | | | | | | | | | | |
| 34.0 | . 34 | SPT-18 | 19 | 43 | 57 (15cm) | >100 | | | | | • |
| _34.5_ | | | | | | | Brown, Hard, Silty clay of low | CI | | | |
| _35.5_ | 35.5 | SPT-19 | 23 | 45 | 55 (8cm) | >100 | plasticity with gravel | | | | • |
| 36.0 | | | | | | | | | | | - |
| _36.5_ | 37 | SPT-20 | 19 | 58 | 42 (5cm) | >100 | | - | ⊻ 36.90m | | • |
| _37.5_ | | | | | | | | | | | - |
| _38.0_ | | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-21 | 100 (10cm) | - | - | >100 | | | | | • |
| _39.0_ | | | | | | | | | | | |
| | | | 60 | | | | | | | | |
| _40.0_ | 40 | SPT-22 | (15cm) | 100 | <u> </u> | _>100_ | | | | | |

| Ca | CAPIT. | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--------------------------|-------------------------------|----------------|-------------------|----------------------|------------|-------------------|--|-------------------|----------------|-------------------------------|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | a Kalan in the state of Haryana. | Clie | ent :HRIDCL | | |
| BH Loc | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123214.311 m | Eas | ting :696528 | .146 m | |
| Reduced | d Level (i | n):(+)263 | .022 | | | | BH. No. :BH-P1 | BH | Termination | Depth (m):50 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | : | | Water Table (m):38.10 | Incl | ination : Ver | tical | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing | (m) :Not Used | |
| Date of | Start :19 | -10-2021 | | | | | Date of Completion :22-10-2021 | | | | |
| | Ê | | В | low cour per 15cn | nts 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| 0.0 | | DS | | | | | | | | 10 20 30 40 50 60 70 80 90100 | |
| 0.5 1.0 1.5 2.0 | . 1 | UDS-1 | | | | | Brown, Medium dense, Sandy silt of low plasticity with gravel | ML-CL | | | - |
| 2.5 3.0 3.5 4.0 | 2.5 | SPT-1 | 7 | 9 | 13 | 22 | | | | | - |
| 4.5 5.0 5.5 6.0 | 5.5 | SPT-2 | 15 | 24 | 29 | 53 | | | | | |
| 6.5 7.0 7.5 | . 7 | UDS-3 | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | - |
| 8.0 8.5 9.0 9.5 | 8.5 | SPT-3 | 12 | 19 | 27 | 46 | | | | | - |
| 10.0 | 10 | | | | | | | | | | 1 |

| Ca | JANI I | | | | FIE | ĽD | BOREHOLE L | OG | | |
|--------------------------------------|----------------------|----------------|-------------------|----------------------|-------------|------------|--|----------------|---------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to |) Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL | |
| BH Loce | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123214.311 m | East | ing :696528. | 146 m |
| Reduced | l Level (r | n):(+)263 | .022 | | | | BH. No. :BH-P1 | BH | Termination . | Depth (m):50 |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):38.10 | Incli | nation : Ver | tical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing | (m) :Not Used |
| Date of | Start :19 | -10-2021 | | | | | Date of Completion :22-10-2021 | | | |
| Depth | itu ple (m) | Sample | В | low cour per 15cn | nts n | SPT | Strata | cation | Graphic | Cial (Depth ations |
| (m) | In-S Sam Depth | Туре | N1 | N2 | N3 | N Value | Description | IS Classifi | Log | V/S SPT N Value) 10 20 30 40 50 60 70 80 90100 |
| 10.5 11.0 11.5 12.0 12.5 | 11.5 | SPT-4 | 23 | 34 | 42 | 76 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _13.0_ _13.5_ | 13 13.5 | UDS-5 SPT-5 | 29 | 45 | 55 (7cm) | >100 | | | | |
| 14.0 14.5 15.0 | 14.5 | SPT-6 | 24 | 38 | 44 | 82 | | | | |
| 15.5_ 16.0 16.5 | 16 | UDS-6 | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| 17.0 17.5 | 17.5 | SPT-7 | 28 | 47 | 53 (8cm) | >100 | | | | |
| 18.0 18.5 19.0 | 19 | SPT-8 | 32 | 50 | 50 (6cm) | >100 | | | | |
| 19.5 | | | | | | | | | | |

| Ca | APRIL 1 Constant | | | | FIE | CLD | BOREHOLE L | ,OG | | | |
|--|-------------------------------|----------------|-----------------|---------------------|------------------|-------------------|--|-------------------|-------------------|-------------------------------|------------|
| Project . | Name :G | TI for (H | ORC) pr | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL | | |
| BH Loca | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123214.311 m | East | ing :696528.146 | m | |
| Reduced | l Level (r | n):(+)263 | .022 | | | | BH. No. :BH-P1 | BHT | Termination Dep | oth (m):50 | |
| Propose | d / Exist | ing Struct | <i>ure</i> :Maj | or Bridge | | | Water Table (m):38.10 | Incli | nation : Vertical | l | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing (m) | :Not Used | |
| Date of | Start :19 | -10-2021 | | | | | Date of Completion :22-10-2021 | | | | |
| | ê | | В | Blow coun | its า | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Dbservatic |
| _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ | 20.5 | SPT-9 | 36 | 53 100 (13cm) | 47 (7cm) - | >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| _23.5_ | 23.5 | SPT-11 | 30 | 46 | (10cm) | >100 | | | | | |
| 24.3 25.0 25.5 | 25 | SPT-12 | 25 | 47 | 53 (12cm) | >100 | | | | | |
| _26.0_ _26.5_ _27.0_ | 26.5 | SPT-13 | 28 | 48 | 52 (10cm) | >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | • |
| _27.5_ _28.0_ | 28 | SPT-14 | 34 | 60 | 40 (7cm) | >100 | | | | | |
| _28.5_ | | | | | | | | | | | |
| _29.5_ | 29.5 | SPT-15 | 42 | 56 | 44 (8cm) | >100 | | | | | |

| | | | | · | | | | | | | |
|--|----------------------------|------------------|------------------|------------|-------------------|------------|--|------------------|-------------------|-------------------------|---------------------|
| Project | Name :C | fII for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | | ent :HRIDCL | ~ | |
| BHLoc | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123214.311 m | Eas | sting :696528.14 | ł6 m | |
| Reduced | d Level (1 | n):(+)263 | 3.022 | | | | BH. No. :BH-P1 | BH | Termination De | epth (m):50 | |
| Propose | ed / Exist | ing Struc | <i>ture</i> :Maj | or Bridge | ; | | Water Table (m):38.10 | Inc | lination : Vertic | al | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | pth of Casing (m |) :Not Used | |
| Date of | Start :19 | -10-2021 | | | te | | Date of Completion :22-10-2021 | | | | |
| Depth (m) | n-Situ ample pth (m) | Sample Type | | per 15cn | | SPT N | Strata Description | IS sification | Graphic Log | (Depth v/s | pecial ervations |
| 20.0 | _so= | | | 112 | - NJ | value | | Clas | 0 10 | 20 30 40 50 60 70 80 90 | SqO |
| 30.5_ 31.0_ 31.5_ 32.0_ 32.5_ 33.0_ | 31 | SPT-16 SPT-17 | 19 38 | 36 | 54 45 (9cm) | 90 >100 | | | | | |
| _33.5_ _34.0_ _34.5_ | 34 | SPT-18 | 43 | 57 | 43 (7cm) | >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | - |
| _35.0_ _35.5_ _36.0_ | 35.5 | SPT-19 | 35 | 44 | 56 (8cm) | >100 | | | | | - |
| _36.5_ _37.0_ _37.5_ | 37 | SPT-20 | 41 | 62 | 38 (8cm) | >100 | | | | | |
| _38.0_ | 38.5 | SPT-21 | 100 (15cm) | - | - | >100 | | | 38.10m | | - |
| _39.0_ _39.5_ | | | | 100 | | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | _ |

| Ca | APRIL 1 Constant | | | | FIE | CLD | BOREHOLE L | ,OG | | | |
|--|-------------------------------|----------------|-----------------|----------------------|-----------------|-------------------|--|-------------------|----------------|-------------------------------|------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loca | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123214.311 m | East | ing :696528. | 146 m | |
| Reduced | l Level (1 | n):(+)263 | .022 | | | | BH. No. :BH-P1 | BH | Termination . | Depth (m):50 | |
| Propose | d / Exist | ing Struct | <i>ure</i> :Maj | or Bridge | | | Water Table (m):38.10 | Incli | nation : Vert | ical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | (m) :Not Used | |
| Date of | Start :19 | -10-2021 | | | | | Date of Completion :22-10-2021 | | | | |
| | ê | | В | low coun per 15cm | its 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Observatic |
| _40.0_ _40.5_ _41.0_ _41.5_ _42.0_ _42.5_ _43.0_ | 41.5 | SPT-23 | 51 | 100 (12cm) | - - (9cm) | >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| _43.5_ _44.0_ _44.5_ | 44.5 | SPT-25 | 52 | 65 | 35 (8cm) | >100 | | | | | |
| _45.0_ _45.5_ _46.0_ _46.5_ | 46 | SPT-26 | 55 (10cm) | 100 | - | >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| _47.0_ _47.5_ _48.0_ | 47.5 | SPT-27 | 100 (13cm) | - | - | >100 | | | | | |
| _48.5_ _49.0_ _49.5_ _50.0 | 49 49.22 | SPT-28 - | 80 | 100 (7cm) | - | >100 | | | | | |

| Ca | JAHI NT ANN | | | | FIE | ELD | BOREHOLE L | OG | | | |
|-------------------|-------------------------------|----------------|-------------------|----------------------|------------|-------------------|--|--|----------------|-------------------------------|------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | ent :HRIDC | L | |
| BH Loc | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123189.55 m | <i>Forthing</i> :3123189.55 m <i>Easting</i> :696520.214 m | | | |
| Reduced | d Level (r | n):(+)263 | 3.955 | | | | 3H. No. :BH-P2 BH Termination Depth (m):50 | | | | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | : | | Water Table (m):34.55 Inclination : Vertical | | | | |
| Boring i | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casin | g (m) :Not Used | |
| Date of | Start :15 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | |
| | . 6 | | В | low cour per 15cn | nts 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Dbservatio |
| 0.0 | | DS | | | | | | | | | - |
| 0.5 1.0 1.5 | 1 | SPT-1 | 3 | 4 | 5 | 9 | | | | | |
| 2.0 2.5 | 2.5 | UDS-1 | | | | | | | | | |
| 3.0 | | | | | | | Brown, Loose to medium dense, Sandy silt of low plasticity | ML-CL | | | |
| 4.0 4.5 | 4 | SPT-2 | 5 | 7 | 11 | 18 | | | | | |
| 5.0 5.5 | 5.5 | UDS-2 | | | | | | | | | |
| 6.0 6.5 | | | | | | | | | | | |
| 7.0 7.5 | 7 | SPT-3 | 8 | 14 | 17 | 31 | | | | | |
| 8.0 8.5 9.0 | 8.5 | UDS-3 | | | | | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | CL | | | |
| 9.5 | 10 | _SPT-4_ | 12 | | | 34 | | | | | |

| Ca | Jani Terrana | | | | FIE | ELD | BOREHOLE L | OG | | | | |
|----------------|-------------------------------|----------------|------------------|----------------------|------------|-------------------|---|--|-----------------------------|-------------------------------|-----------------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | | |
| BH Loc | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123189.55 m | Northing :3123189.55 m Easting :696520.214 m | | | | |
| Reduced | d Level (r | n):(+)263 | .955 | | | | BH. No. :BH-P2 | BH | BH Termination Depth (m):50 | | | |
| Propose | ed / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | | | Water Table (m):34.55 | Incl | Inclination : Vertical | | | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing (n | ı) :Not Used | | |
| Date of | Start :15 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | | |
| | . 6 | | В | low coun per 15cm | its 1 | | | ion | | | suc | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatic | |
| _10.0_ | | | | | | | | 0 | | | | |
| 10.5_ 11.0_ | | | | | | | | | | | | |
| 11.5 | 11.5 | UDS-4 | | | | | | | | | | |
| 12.5_ | | | | | | | | | | | | |
| 13.0 | 13 | SPT-5 | 14 | 21 | 26 | 47 | | | | | | |
| 14.0 | | | | | | | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | CL | | | | |
| 14.5 | 14.5 | UDS-5 | | | | | | | | | | |
| 15.5_ | | | | | | | | | | | | |
| 16.0 | 16 | SPT-6 | 25 | 29 | 41 | 70 | | | | | | |
| _17.0_ | | | | | | | | | | | | |
| _17.5_ | 17.5 | UDS-6 | | | | | | | | | | |
| 18.0 | | | | | | | | | | | | |
| 19.0 | . 19 | SPT-7 | 20 | 23 | 32 | 55 | Brown, Hard, Silty clay of low plasticity with gravel | ML-CL | | | | |
| 19.5 | | | | | | | | | | | | |

| Ca | APRIL TELEVISION | | | | FIE | CLD | BOREHOLE L | OG | | |
|--|----------------------|-------------------------|------------------|--------------------------------|--------------|------------|--|----------------|-------------|---|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDO | Ľ |
| BH Loce | ation/Ch | ainage :28 | 8+900 kr | n | | | Northing :3123189.55 m | East | ing :69652 | 20.214 m |
| Reduced | l Level (r | n):(+)263 | .955 | | | | <i>H. No.</i> :BH-P2 <i>BH Termination Depth (m)</i> :50 | | | |
| Propose | d / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | | | Water Table (m):34.55 | Incli | ination : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | ng (m) :Not Used |
| Date of | Start :15 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | |
| Depth | itu ple (m) | Sample | В | low coun per 15cm | its 1 | SPT | Strata | cation | Graphic | tions ations |
| (m) | In-S Sam Depth | Туре | N1 | N2 | N3 | N Value | Description | IS Classifi | Log | V/S SPT N Value) 0 10 20 30 40 50 60 70 80 9100 |
| _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ | 20.5 22 23.5 | UDS-7 SPT-8 SPT-9 | 58 | 100 (10cm) 100 (15cm) | _ | >100 | | | | |
| _24.0_ _24.5_ _25.0_ _25.5_ _26.0_ | 25 | SPT-10 | 34 | 45 | 55 (8cm) | >100 | Brown, Hard, Silty clay of low plasticity with gravel | ML-CL | | |
| 26.5 27.0 | 26.5 | SPT-11 | 50 | 82 | 18 (2cm) | >100 | | | | |
| _27.5_ _28.0_ _28.5_ | 28 | SPT-12 | 25 | 52 | 48 (10cm) | >100 | | | | |
| _29.0_ _29.5_ _30.0_ | 29.5 | SPT-13 | 42 | 100 (15cm) | - | >100 | | | | |

| Ch | LAPIT TELEVISION | | | | FIE | 'LD | BOREHOLE I | OG | | |
|------------------|-------------------------------|----------------|-------------------|----------------------|--------------|-------------------|--|-------------------|----------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | Harsana | Kalan in the state of Haryana. | Clier | t :HRIDC | L |
| BH Loca | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123189.55 m | East | ing :69652 | 20.214 m |
| Reduced | l Level (n | n):(+)263 | .955 | | | | BH. No. :BH-P2 | n Depth (m):50 | | |
| Propose | d / Existi | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):34.55 | Incli | nation : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casin | g (m) :Not Used |
| Date of | Start :15 | -10-2021 | | | | | Date of Completion :18-10-2021 | ŀ | | |
| | , (r | | В | low cour per 15cm | nts า | | | tion | | |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth العنية) v/s SPT N Value) من م |
| _30.0_ | | | | | | | | | | |
| _30.5_ _31.0_ | 31 | SPT-14 | 44 | 60 | 40 (7cm) | >100 | | | | |
| _31.5_ | | | | | | | | | | |
| _32.0_ | | | | | | | | | | |
| _32.5_ | 32.5 | SPT-15 | 26 | 44 | 56 (11cm) | >100 | | | | |
| _33.0_ | | | | | | | | | | |
| _33.5_ | | | | | | | | | | |
| _34.0_ | 34 | SPT-16 | 30 | 85 | 15 (2cm) | >100 | | | | |
| _34.5_ | | | | | | | | <u> </u> | 34.55m | |
| _35.0_ | | | | | 50 | | Brown, Hard, Silty clay of low plasticity with gravel | ML-CL | | |
| 35.5 | 35.5 | SPT-17 | 32 | 50 | (7cm) | >100 | | | | • |
| 36.0 36.5 | | | | | | | | | | |
| 37.0_ | 37 | SPT-18 | 41 | 65 | 35 (8cm) | >100 | | | | |
| _37.5_ | | - | | | | - | | | | |
| _38.0_ | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-19 | 47 | 100 (5cm) | - | >100 | | | | |
| _39.0_ | | | | | | | | | | |
| _39.5_ | | | | | | | | | | |
| 40.0_ | 40 | SPT-20 | 45 | 100 _(7cm)_ | | _>100_ | | | | |

| Project Name :GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana. Client :HRIDCL PH Logation (Chain and 22+000 km Northing 22122190 55 m Easting 260520 214 m | |
|--|--|
| PLU Location / Chain and 19±000 km | |
| <i>Di Locauon/Chainage</i> :28+900 km // <i>Northing</i> :5125189.55 m // <i>Lasung</i> :090520.214 m | |
| Reduced Level (m):(+)263.955 BH. No. :BH-P2 BH Termination Depth (m):50 | |
| Proposed / Existing Structure : Major Bridge Water Table (m):34.55 Inclination : Vertical | |
| Boring type :Rotary Dia. of Boring :150 mm Depth of Casing (m) :Not Used | |
| Date of Start :15-10-2021 Date of Completion :18-10-2021 | |
| Blow counts E | |
| Depth n n SPT Strata Strata Strata Graphic Comparing (m) 1 N N3 Value N Description Strata Strad Strad Strata Stra | |
| 40.0 - | |

| Ca | APRIL THE CARDINAL | | | | FIE | ELD | BOREHOLE L | OG | | | | |
|--------------|-------------------------------|----------------|----------|----------------------|----------|-------------------|---|-------------------|-----------------------------|---|--|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | | |
| BH Loca | ation/Ch | ainage :2 | 8+900 kn | n | | | Northing :3123180.027 m | East | ing :69651 | 7.163 m | | |
| Reduced | l Level (n | n):(+)263 | .847 | | | | BH. No. :BH-A2 | BH | BH Termination Depth (m):40 | | | |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):34.50 | Incli | Inclination : Vertical | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used | | |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | | |
| | (r | | В | low coun per 15cm | its 1 | | | ion | | suc | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 00 se Construction 00 se Construction | | |
| | | DS | | | | | | | | | | |
| 0.5 | | | | | | | | | | | | |
| 1.0 1.5 | 1 | UDS-1 | | | | | | | | | | |
| 2.0 | | | | | | | Brown, Very stiff, Silty clay of low plasticity | CL | | | | |
| 2.5 | 2.5 | SPT-1 | 7 | 9 | 13 | 22 | | | | | | |
| 3.0 3.5 | | | | | | | | | | | | |
| 4.0 | 4 | UDS-2 | | | | | | | | | | |
| 4.5 | | | | | | | | | | | | |
| 5.0 | 5.5 | SPT-2 | 12 | 16 | 21 | 37 | Brown, Dense, Sandy silt of low plasticity with gravel | ML-CL | | | | |
| 6.0 | | | | | | | | | | | | |
| 6.5 | - | | | | | | | | | | | |
| 7.0 | / | UDS-3 | | | | | | | | | | |
| 8.0 | | | | | | | | | | | | |
| 8.5 | 8.5 | SPT-3 | 9 | 12 | 24 | 36 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | | |
| 9.0 9.5 | | | | | | | | | | | | |
| | 10 | UDS-4 | | | | | | | | | | |

| | Car | HII TARAANI | | | | FIE | ELD | BOREHOLE L | OG | | | | |
|----------|------------|-------------------------------|----------------|----------|------------|-------------|-------------------|--|---|-----------------|---|--|--|
| Pro | oject N | <i>lame</i> :G | TI for (H | ORC) pro | oject from | n Palwal te | o Harsana | Kalan in the state of Haryana. | alan in the state of Haryana. Client :HRIDCL | | | | |
| BH | I Loca | tion/Ch | ainage :2 | 8+900 kn | n | | | Northing :3123180.027 m | <i>Corthing</i> :3123180.027 m <i>Easting</i> :696517.163 m | | | | |
| Red | duced | Level (r | n):(+)263 | .847 | | | | BH. No. :BH-A2 | H. No. :BH-A2 BH Termination Depth (m):40 | | | | |
| Pro | oposed | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):34.50 | Inclination : Vertical | | | | |
| Bor | ring ty | pe :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing (n | n) :Not Used | | |
| Da | te of S | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | | |
| | | (| | В | low cour | nts 1 | | | uo | | su | | |
| De (I | epth m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS lassificati | Graphic Log | Depth (Depth v/s svc ciar SPT N Value) SPT N Value | | |
| 1 | 0.0 | | | | | | | | 0 | 0 10 | 20 30 40 50 60 70 80 90 100 U | | |
| _1 | 0.5 | | | | | | | | | | | | |
| | 1.0 1.5 | 11.5 | SPT-4 | 14 | 18 | 22 | 40 | | | | | | |
| _1: | 2.0 | | | | | | | | | | | | |
| _1: | 2.5_ | | | | | | | | | | | | |
| _1: | 3.0 | 13 | UDS-5 | | | | | | | | | | |
| _1: | 3.5_ | | | | | | | | | | | | |
| 1 | 4.0_ | 14 5 | edt 5 | 10 | 25 | 40 | 77 | Brown Hard Silty clay of low | | | | | |
| | 5.0_ | 14.5 | SF 1-5 | 10 | 55 | 42 | | plasticity with gravel | CL | | | | |
| _1 | 5.5_ | | | | | | | | | | | | |
| _1 | 6.0 | 16 | UDS-6 | | | | | | | | | | |
| _1 | 6.5 | | | | | | | | | | | | |
| _1' | 7.0_ | | | | | | | | | | | | |
| _1 | 7.5_ | 17.5 | SPT-6 | 16 | 19 | 29 | 48 | | | | | | |
| | 8.0 8.5 | | | | | | | | | | | | |
| _1 | 9.0_ | 19 | UDS-7 | | | | | | | | | | |
| _1 | 9.5_ | | | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | | |

| G | LATI I | | | | FIE | CLD | BOREHOLE L | OG | | | |
|---|-------------------------------|-------------------------|---------------------------|--------------------------------|-------------|-------------------|--|-------------------|------------------------|---|-----------------------|
| Project . | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDC | | |
| BH Loca | ation/Ch | ainage :2 | 8+900 kr | n | | | Northing :3123180.027 m | East | ing :69651 | 7.163 m | |
| Reduced | l Level (r | n):(+)263 | .847 | | | | BH. No. :BH-A2 BH Termination Depth (m):40 | | | | |
| Propose | d / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):34.50 | Incli | Inclination : Vertical | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing | g (m) :Not Used | |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | |
| | (| | В | low cour per 15cm | its າ | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 10 20 30 40 50 60 70 80 90 | Special Observatio |
| _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _24.0_ _24.5 | 20.5 22 23.5 | SPT-7 SPT-8 SPT-9 | 34 37 100 (10cm) | 100 (15cm) 100 (10cm) | - | >100 >100 | Brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| 25.0 25.5 | 25 | SPT-10 | 33 | 75 | 25 (3cm) | >100 | | | | | - |
| _26.0_ _26.5_ _27.0_ | 26.5 | SPT-11 | 45 | 100 (4cm) | - | >100 | | | | | |
| _27.5_ _28.0_ _28.5_ _29.0 | 28 | SPT-12 | 48 | 52 | 48 (4cm) | >100 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| 29.5 | 29.5 | SPT-13 | 51 | 100 (7cm) | - | >100 | | | | | - |

| Ca | LAPIT TELEVISION | | | | FIE | CLD | BOREHOLE L | OG | | | | | |
|--------------|-------------------------------|----------------|----------|----------------------|-------------|-------------------|---|-----------------------------|-----------------|--|--|--|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to |) Harsana | Kalan in the state of Haryana. | an in the state of Haryana. | | | | | |
| BH Loca | ation/Ch | ainage :28 | 8+900 kr | n | | | <i>Forthing</i> :3123180.027 m <i>Easting</i> :696517.163 m | | | | | | |
| Reduced | l Level (n | n):(+)263 | .847 | | | | 3H. No. :BH-A2 BH Termination Depth (m):40 | | | | | | |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):34.50 Inclination : Vertical | | | | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | De | oth of Casin | g (m) :Not Used | | | |
| Date of | Start :16 | -10-2021 | | | | | Date of Completion :18-10-2021 | | | | | | |
| | (c | | В | low cour per 15cm | its า | | | ion | | | | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth in the second se | | | |
| _30.0_ | | | | | | | | | | | | | |
| _30.5_ | | | | 50 | | | | | | | | | |
| _31.0_ | 31 | SPT-14 | 41 | 53 (7cm) | 47 | >100 | | | | | | | |
| _31.5_ | | | | | | | | | | | | | |
| _32.0_ | | | | | | | | | | | | | |
| _32.5_ | 32.5 | SPT-15 | 32 | 47 | 53 (4cm) | >100 | | | | | | | |
| _33.0_ | | | | | | | | | | | | | |
| _33.5_ | | | | | | | | | | | | | |
| 34.0 | 34 | SPT-16 | 45 | 59 | 41 (6cm) | >100 | | | | | | | |
| 34.5 | | | | | | | | | ⊻ 34.50m | | | | |
| _35.0_ | | | | | | | Brown, Hard, Silty clay of low | CL | | | | | |
| _35.5_ | 35.5 | SPT-17 | 58 | 100 (5cm) | - | >100 | plasticity with grave | | | | | | |
| 36.0 | | | | | | | | | | | | | |
| 36.5 | | | | | | | | | | | | | |
| 37.0 | 27 | SDT 10 | 25 | 10 | 52 (8cm) | >100 | | | | | | | |
| | 31 | JF I-10 | 33 | 40 | | - 100 | | | | | | | |
| _37.5_ | | | | | | | | | | | | | |
| _38.0_ | | | | | 45 | | | | | | | | |
| _38.5_ | 38.5 | SPT-19 | 38 | 55 | (6cm) | >100 | | | | | | | |
| _39.0_ | | | | | | | | | | | | | |
| _39.5_ | | | | | | | | | | | | | |
| _40.0_ | 40 | SPT-20 | 33 | 100 (15cm) | | _>100_ | | | | | | | |



SCALE:-

Geotechnical Investigation

| | Pi-29+028_BH-A2 Pi-29+028_BH-A2 Pi-26-28-9001 n.n. 2123046.953 n.n. OCH-28+9001 n.n. 0CH-28+9001 n.n. 0CH-28+9001 |
|--|---|
|--|---|



APPENDIX – B (LAB TEST RESULTS)

| Appendix No. | ITEMS |
|--------------|--|
| B-1 | SOIL CHARACTERISTICS SHEETS |
| B-2 | RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES |
| В-3 | RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLES |
| B-4 | GSD CURVES |
| B-5 | SHEAR CURVE |
| B-6 | CONSOLIDATION CURVE |


| e | -22 | | Compression Index (C _c) | | I | ı | | ı | ı | ı. | | ī | | | ı | | ī | ı | ı | ı | ı | |
|------------------------------|---------------------------|--------------------|--|------|-------|-------------------------|-------|-------|-------|-------|------------|-------------|-------|-------|-------|-------|-------|-------------|-------------|-----------------|-------|-----------------|
| tef. Cod | -544_21 | ameters | (cm ² /Kg) M _v x 10 ⁻² | ı | I | | ı | I | 1 | ı | | I | ı. | ı. | ı | ı | I | I | ı | 1 | ı | |
| В | SR | tion Par | (cm ² /Sec) C ^A X 10. ⁴ | 1 | ı | I | ı | I | 1 | I | 1 | I | I | I | ı | ı | I | T | I | 1 | I | |
| Ŀ | 946 m | onsolidat | Pressure Pressure | | | | | | | | | ı | 1 | 1 | ı | 1 | ı | | | | | 1 |
| R.] | (+)270. | | Void Ratio (e_) | | | | | | | | | ı | ı | ı | ı | 1 | ı | | | | ı | |
| | E E | Â | Permeabilit (cm/sec) | | ı | ı | | | | ı | | ı | ı | ı | ı | ı | ı | 1 | | | | |
| | 079.115 | nre | Swelling Press (kg/cm ²) | ı | ı | ı | ı | ı | ı | I | | i. | I | I | I. | ı | i. | 1 | ı | ı | ı | 1 |
| s (E,N) | 3123 | хәр | Free Swell Inc (%) | | - | ı | | | ı | 1 | 1 | ī | I | I | ī | ı | ī | ı. | ı | ı | ı | |
| ordinate | n | th | Angle of Friction (\$°) | I | 4 | I | I | I | 26 | I | I | - | - | - | 4 | T | - | - | 4 | I | I | 1 |
| C | 1786.663 I | ar Streng | Соћезіол С (kg/cm ²) | , | 0.53 | ı | | ı | 0.21 | ı | 1 | ı | ı | ı | 2.58 | ı | ı | ı | 3.13 | 1 | ı | ı |
| | 269 | She | tesT to sqvT | | TUU | | | | DST | | | - | - | - | TUU | - | - | - | UUT | | ı | |
| ination pth | 00 m | ţţ | vrað sifisəq2 | , | 2.68 | | , | ' | 2.66 | | , | , | ' | ' | 2.67 | ' | , | , | 2.68 | | | , |
| Termi De | 40.(| (_e wə | Dry Density (g/ | | 1.52 | | 1.52 | | 1.61 | | 1.60 | ı | 1.60 | ı | 1.69 | ı | ı | 1 | 1.70 | | | |
| Table | |) nre | teioM leruteN %) tnotnoD | | 13.26 | | 13.80 | | 13.34 | | 13.94 | ı | 14.25 | ı | 16.22 | ı | ı | ı | 17.84 | | | |
| f Water | 3.10 m | (_e mə) | Bulk Density (g | | 1.72 | | 1.73 | | 1.82 | ı | 1.82 | ı | 1.83 | ı | 1.96 | ı | ı | | 2.00 | | ı | |
| Depth of | 8 | <i>`°</i> | Shrinkage Limit | | - | | | | | | | - | - | - | - | - | - | - | | | | |
| . No. | -A1 | Limits 9 | Plasticity Index | | 6 | ı | 10 | | 7 | ı | 9 | | L | | 11 | - | 10 | - | 11 | | ı | 10 |
| B.H | ВН | Atterberg | Plastic Limit | , | 21 | | 21 | | 21 | | 20 | | 20 | ı | 20 | 1 | 20 | | 21 | | | 20 |
| ge ition |) dge | - | timiJ biupiJ | , | 30 | | 31 | 1 | 28 | ı | 26 | ı | 27 | ı | 31 | ı | 30 | ı | 32 | | 1 | 30 |
| Chainag m.)/Loca | 27+62(1ajor Bri | | Coarse | ' | 0 | ı | 0 | 1 | 0 | ı | 0 | ı | 0 | ı | 0 | ı | 0 | ' | 0 | 1 | ı | 0 |
| (k | V | etained | Pine S | , | 2 | ı | 5 | ı | m | I | 5 | I | 3 | I | L | I | 5 | ı | 9 | I | ı | 7 |
| |)-2021 | 1 % wt 1 | Coarse | , | 4 | ı | n | ı | e | ı | 1 | I | 5 | I | 4 | ı | 2 | ı | 4 | ı | I | 5 |
| ring | 12-1(| tributio | M muibəM | ı | 3 | ı | S | ı | 4 | ı | 1 | ı | 3 | ı | 3 | ı | 5 | ı | 4 | ı | ı | 4 |
| te of Bo | to | Size Dis | eniA | ' | 30 | | 26 | ' | 35 | ı | 38 | ı | 34 | ı | 19 | · | 21 | | 18 | | ı | 28 |
| Da | -2021 | Grain | IIIS | ı | 52 | ı | 54 | ı | 47 | ı | 51 | ı | 48 | I | 56 | ı | 57 | ı | 56 | ı | ı | 50 |
| | 11-10 | | Clay | ı | 6 | ı | 10 | ı | × | ı | 7 | ı | 7 | ı | 11 | ı | 10 | 1 | 12 | ı | ı | 6 |
| ssigning ital Rail | Q | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| report for de Haryana Orb | onnectivity | uoj | IS Classificati | | CL | 1 | CL | | ML-CL | 1 | ML-CL | ı | ML-CL | | CL | | CL | | CL | | | CL |
| technical 1 iction of F | ncluding c | | | | | | | | | | low | | | | | | | low | | | | |
| on of geo th constru | a Kalan in | | iption | | | ilty clay c ty | | | | | dy silt of | h gravel | | | | | | v clay of 1 | h gravel | | | |
| preparati ection wi | o Harsana ana. | | il Descri | | | ry stiff, S plastici | | | | | ense, San | ticity witl | | | | | | Hard, Silt | ticity with | | | |
| ∍stigation, nt in conn | m Palwal te of Hary | | So | | | rown, Vei | | | | | 3rown, De | plas | | | | | | Brown, E | plas | | | |
| mical inve mbankme | roject fro | Ţ | γ Δ Δ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α μ α α μ α α μ α α μ α α μ α α μ α α μ α α α μ α α α α α α α α α α α α α | | | | | | | 36 | - | 23 | 1 | 31 | , | 83 | , | 41 | ı | 100 8cm) | 80 | 100 (7cm) |
| ng geotecl. and for er | (HORC) p R network | ania Te | (N) | , | 1 | 15 | , | 16 | | 41 | , | 30 | 1 | 46 | ı | 83 | ı | 41 | | 100 18cm) (1 | 80 | 100 27cm) (2 |
| Conductir of bridges | Corridor (existing II | (w) " | I.Ə morî diqe | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 |
| | L OJect | Э | qvT əlqms2 | DS | UDS-1 | SPT-1 | UDS-2 | SPT-2 | UDS-3 | SPT-3 | UDS-4 | SPT-4 | UDS-5 | SPT-5 | 0DS-6 | SPT-6 | UDS-7 | SPT-7 | UDS-8 | SPT-8 | 6-TqS | SPT-10 |



| e | -22 | | u | Compression (,Compression | | | ı | ı | ı | ı | | | I. |
|---|--|--------------------|-----------------------|--|---------------|---------------|---------|---------------|--|---------|---------|---------------|---------|
| tef. Cod | -544_21 | ameters | | (cm ² /Kg) M _v x 10 ⁻² | ı | 1 | ı | 1 | I | 1 | ı | ı | I |
| Н | SR | ion Par | | (cm ² /Sec) C ^A x 10.4 | ı | ı | ı | , | ı | | I | ı | ı |
| j | 946 m | onsolidat | | Pressure Pressure | | | | | | | | | ı |
| R.I | (+)270. | | (^{0;} | 9) oita Ratio (e | | , | 1 | 1 | 1 | 1 | 1 | | ı |
| | 5 m | Â | ilit) (: | Permeabi (cm/sec | ı | 1 | ı | 1 | ı | 1 | T | 1 | I |
| | 23079.11 | nıç | (₇ ssə | org gnillow2 mɔ\gx) | ı | 1 | 1 | 1 | ı | 1 | ı | 1 | I |
| es (E,N | 31: | xəp | oul | Free Swell (%) | ı | ı | , | , | ı | | ı | 1 | i. |
| ordinate | F | th | (| fo slgnA [°] φ) noitsirA | ı | ı | ı | ı | I | ı | I | ı | T |
| ŭ | 786.663 1 | ar Streng | | Соћезіоп С (kg/cm ²) | | | | | | | | | |
| | 697 | She | 1 | izəT fo əqyT | | | | | | | - | | ı |
| nation oth | 0 m | ţţ | ЛB. | rƏ əffiə9Q | | | | | | | | | ı |
| Termi Del | 40.0 | (_e mə | /ð) | Dry Density | ı | | ı | | 1 | ı | | ı | ı |
| r Table | |) nre | tsi %) | Natural Mo Content (| | | | | ı | | | | 1 |
| of Wate | 33.10 m | (_e wə) | (B) | Bulk Density | , | , | , | , | , | , | ı | ı | ı |
| Depth | | % | | Shrinkage Limit | ' | ' | ' | ' | ' | ' | ' | ' | ' |
| H. No. | H-A1 | g Limits | | Plasticity Index | ı | 11 | ı | 1 | 11 | ı | ı | 11 | ı |
| B.I | BI | Atterber | Ĵ | imi.I siterII | | 22 | | ' | 22 | | ' | 21 | 1 |
| ge ation | 0 idge | | 1 | imiJ biupiJ | 1 | 33 | , | , | 33 | , | 1 | 32 | I |
| Chaina km.)/Loc | 27+62 Major Br | _ | ravel | Coarse | ' | 0 | ' | ' | 5 | ' | ' | 0 | 1 |
| | | retaineo | 0 | əniA | ı | 11 | ı | 1 | 6 | 1 | I | 8 | I |
| | 10-2021 | on % wt | I | Coarse | ı | 5 | 1 | 1 | S | 1 | ı | 4 | 1 |
| oring | 12- | istributi | Sand | muibəM | | ŝ | ı | 1 | ŝ | 1 | T | 4 | I |
| Date of B | to | in Size D | | əniA | ' | 21 | ' | ' | 20 | ' | ' | 23 | 1 |
| | -10-2021 | Gra | | IIIS | 1 | 52 | 1 | ' | 49 | 1 | 1 | 50 | 1 |
| g ii | 11. | | <u> </u> | Сіау | - | 11 | ' | ' | 12 | | | 11 | ' |
| yr designin Orbital Ra | vity to | | loc | dmv2 21 | | | | | | | | | |
| cal report fo of Haryana | 1g connecti | uo | ite: | IS Classific | ı | CL | ı | ı | CL | ı | ı | CL | ı |
| investigation, preparation of geotechni tement in connection with construction (| from Palwal to Harsana Kalan includii 2 state of Haryana. | | | Soil Description | | | | | Brown, Hard, Silty clay of low plasticity with gravel | | | | |
| technical or emban | project ork in th | Te | (°N IS | Corrected Value (1 | 100 (20cm) | 100 (24cm) | , | 100 (25cm) | 84 | 91 | , | 100 (18cm) | 88 |
| cting geoto ges and fo | or (HORC g IR netw | ənleV | ۲ ۲ | (N) Opserved SP | 100 (20cm) | 100 (24cm) | >100 | 100 (25cm) | 84 | 91 | >100 | 100 (18cm) | 88 |
| Condu of brid | ct Corrid existin; | (w) " | I. (| Depth from C | 1 28.00 | 2 29.50 | 3 31.00 | 4 32.50 | 5 34.00 | 6 35.50 | 7 37.00 | 8 38.50 | 9 40.00 |
| | roje | ə | đ٨ | T əlqms2 | SPT-1 | SPT-1 | SPT-1. | SPT-1. | SPT-1. | SPT-1 | SPT-1 | SPT-1. | SPT-1 |





| | 22 | | Compression Index (C _c) | ı | ı | ı | ī | 0.1260 | ı | ī | ı | ı | ı | ı | ı | ı | ı | ı | ī | ı | ı | ı |
|---|--|---|---|------|---|----------|--------------------------|---|-------|----------|-------|-------|----------|----------|--|-------|----------|-------|----------|-------|-------|---------------------------|
| ef. Code | 544_21- | ameters | (87/ ² m2) 2.01 x ¹ M | | | | | $ \begin{array}{r} 1.79 \\ 1.39 \\ 0.92 \\ 0.59 \end{array} $ | ı | | | ı | | | | | | | | | | , |
| R | SR- | ion Para | (cm ² /2ec) C ^A X 10.4 | | ı | | | 9.44 6.30 5.16 4.57 | | | | ı | | | | | | ' | | | ' | 1 |
| L. | .001 m | Consolidat | Pressure Pressure | | | | ı | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | ı | | | | ı | | | | | | | T | | |
| R. | (+)271 | Ū | Void Ratio (e_) | ı | ı | ı | I | 0.695 | ı | ı | - | - | ı | ı | ı | - | I | - | ı | - | - | ı |
| | 0 m | Â | Permeabilit; (cm/sec) | ı | ı | | | | | | | ı | | | | | | | | | | , |
| | 3062.116 | nıç | Swelling Press (kg/cm ²) | ı | ı | ı | ı | | ı | 1 | - | - | ı | ı | 1 | - | ı | - | ı | - | - | ı |
| s (E,N) | 312 | xəp | Free Swell Inc (%) | ı | | | | | | | | | | | | | | | | | | |
| ordinate | m | ţth | Angle of Friction (\$^) | ı | i | s | ı | 4 | ı | i | ı | ı | ı | s | ı | 4 | ı | 4 | 1 | 5 | i | 22 26 |
| Č | 786.520 | ar Streng | Cohesion C (kg/cm ²) | ı | ı | 0.23 | , | 0.88 | , | 1 | | ı | , | 1.17 | 1 | 1.75 | , | 2.50 | | 1.46 | ı | 0.26 0.21 |
| | 697 | She | ts9T to 9qvT | 1 | | UUT | | UUT | | 1 | | ı | 1 | UUT | 1 | UUT | 1 | UUT | | UUT | ı | CUT Total Effective |
| nation oth | 0 m | ţţ | verð sífisəq2 | | | 2.67 | | 2.68 | | | | - | | 2.67 | | 2.68 | | 2.68 | | 2.67 | - | |
| Termii Dep | 40.0 | (_e wə | Dry Density (g/ | | | 1.45 | ı | 1.58 | ı | 1.58 | - | 1.61 | | 1.61 | ı | 1.64 | ı | 1.69 | | 1.63 | - | 1.63 |
| Table | |) n.c | tsioM IsrutsN %) tnэtnoD | | ı | 12.30 | | 13.46 | ı | 14.06 | | 14.70 | | 15.26 | | 16.11 | | 16.80 | | 17.67 | ' | 18.10 |
| f Water | 32.90 m | (cm3) | Bulk Density (g/ | | | 1.63 | | 1.79 | | 1.80 | 1 | 1.85 | | 1.86 | | 1.90 | | 1.97 | | 1.92 | | 1.93 |
| Depth o | | | Shrinkage Limit | | ı | | | , | | | | 1 | | | | | | | | | | , |
| No. | P1 | Limits % | Plasticity Index | 1 | 11 | 11 | NP | 11 | ı | 11 | ī | 11 | | 11 | 1 | 11 | | 10 | | 11 | | 10 |
| B.H. | BH- | Atterberg | Plastic Limit | | 22 | 23 | Nil | 20 | | 21 | | 20 | | 23 | | 22 | | 21 | | 21 | 1 | 20 |
| e ion | ge | V | timi.I biupi.I | | 33 | 34 | | 31 | | 32 | | 31 | ' | 34 | | 33 | | 31 | | 32 | | 30 |
| Chainage 1.)/Locat | 27+620 ajor Brid | | Coarse | | 0 | 0 | 0 | 0 | | 0 | | 0 | ' | 0 | | 0 | | 0 | | 0 | | 1 |
| (kn | M | etained | Pani ^T | I | 0 | 1 | 0 | 2 | ı | 3 | 1 | 9 | ı | ю | 1 | 5 | 1 | 9 | 1 | 4 | ı | 4 |
| |)-2021 | n % wtn | Coarse | ı | 4 | 5 | 4 | 3 | ı | 5 | ı | 4 | , | б | ı | 2 | ı | 2 | | 2 | ı | 3 |
| ring | 12-10 | tributio | ManuibəM | 1 | Ś | с | 6 | 2 | ı | 1 | ı | 3 | · | Ś | ı | L | ı | 5 | ı | 2 | · | 4 |
| te of Bo | to | Size Dis | Pine | | 19 | 18 | 49 | 14 | | 16 | | 18 | ' | 20 | | 19 | | 23 | , | 22 | ' | 21 |
| Da | 0-2021 | Grain | IIIS | 1 | 09 | 63 | 38 | 68 | ı | 99 | 1 | 58 | , | 56 | , | 55 | , | 54 | , | 59 | ı | 57 |
| | 11-1 | | Clay | | 12 | 13 | 0 | 11 | ' | 12 | - | 11 | ' | 13 | ' | 12 | ' | 10 | | 11 | ' | 10 |
| signing of Rail | o existing | | lodmy2 2I | | | | | | | | | | | | | | | | | | | |
| oort for de na Orbital | nectivity t | uo | IS Classificati | , | С | ď | SM | CL | ı | C | ı | CL | | С | ı | CL | | CL | | CL | | Ъ |
| igation, preparation of geotechnical re connection with construction of Hary | Palwal to Harsana Kalan including co ana. | | Soil Description | | rown, Medium stiff, Silty clay of low plasticity | <u> </u> | Brown, Dense, Silty sand | | | <u> </u> | | | <u> </u> | <u> </u> | own, Very stiff to hard, Silty clay of low plasticity with gravel | | <u> </u> | | <u> </u> | | | |
| uical inves nkment in | oject from te of Hary | 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 | | | | | | | | | ı | 81 | ı | 4 | , | | | | | | | |
| g geotechn I for emba | HORC) pr | auls.V | (N) (V) | | 9 | | 34 | , | 26 | | 26 | , | 50 | | 34 | | 53 | | 81 | | 44 | , |
| onducting ridges and | Corridor (F R network | (w) " | Depth from G.L | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 |
| | | ə | qvT əlqms2 | DS | SPT-1 | UDS-1 | SPT-2 | UDS-2 | SPT-3 | UDS-3 | SPT-4 | UDS-4 | SPT-5 | UDS-5 | SPT-6 | 9-SQU | SPT-7 | UDS-7 | SPT-8 | NDS-8 | 6-TAS | 6-SQU |



| e | -22 | | 1 | Compression (Compression) | | ı | | | - | | | | I |
|--|--|--------------------|--|---|---------------|--|---------------|--------|--------|--------------------------------|------------------------|---------------|--------|
| ef. Cod | 544_21 | ameters | | (87/2m2) M ^{x x} 10 ⁻² | ı | ı | ı | ı | ı | ı | ı | ı | I |
| Я | SR | tion Par | | (cm ² /Sec) C ^x x 10 ⁻⁴ | ı | ı | ı | ı | ı | ı | ı | ı | I |
| | 001 m | onsolidat | | لاوي (لاور mo Pressure | 1 | | | ı | 1 | | | ı | ı |
| R.I | (+)271.0 | 0 | (@ | yoid Ratio (e | ı | | ı | ı | ı | ı | ı | ı | ı |
| | н | Á | اند <u>ز</u> اندر | Permeabi) | 1 | 1 | 1 | ı | 1 | 1 | 1 | ı | I |
| | 062.116 | nıç | () .556 | Pre ² mo/g <i>i</i> l) | ı | | 1 | ı | 1 | 1 | 1 | ı | ı |
| (E,N) | 3123 | xəp | <u>pu</u>] | Free Swell I (%) | ı | 1 | ı | ı | ı | ı | ı | ı | ı |
| rdinates | | h | | fo algnA (°φ) noit2irA | 1 | | - | ı | | - | - | ı | ı |
| Co | 786.520 n | ır Strengt | | Cohesion C (kg/cm²) | ı | 1 | ı | ı | ı | ı | ı | ı | I |
| | 697 | Shea | | tesT to sqvT | ı | 1 | | ı | | | | ı | I |
| th | ш (| ity | ve | srə əffiəəqZ | , | | | 1 | | | | 1 | ı |
| Termin Dep | 40.00 | (₂ mə |)/B) | Dry Density (| , | , | , | ı | | , | , | ı | ı |
| Table | |) nre | iasi 12 | ioM latural Moi) tnotnoD | | | | | | | | | ı |
| of Water | 32.90 m | (_e wə) | /ð) | YiinəU Alu B | ı | ı | I | ı | 1 | I | I | ı | I |
| Depth | | 10 | | Shrinkage JimiJ | ı | , | ı | ı | ı | ı | ı | ı | I |
| l. No. | I-P1 | g Limits 9 | | Plasticity Index | | 9 | | 11 | | 11 | | 10 | ı |
| B.H | BF | Atterberg | 1 | timi. Linite Limit | ı | 20 | ı | 20 | ı | 21 | ı | 21 | ı |
| je tion | lge | | 1 | himi.I biupi.I | ı | 26 | ı | 31 | 1 | 32 | ı | 31 | I |
| Chainag n.)/Loca | 27+620 Iajor Brid | | avel | Coarse | ı | 0 | ı | 0 | ı | 2 | ı | 0 | ı |
| (kı | 2 | etained | 5 | əni'i | ı | ∞ | ı | 10 | ı | L | ı | 8 | ı |
| |)-2021 | 1 % wt r | | Coarse | ' | 5 | ' | 1 | | 3 | ' | 4 | I |
| ring | 12-1(| tributior | Sand | muibəM | ı | ŝ | ' | 2 | ı | 4 | ' | 9 | I |
| ite of Boi | ţ | Size Dis | | aniT | 1 | 28 | | 19 | | 20 | | 18 | ı |
| Da |)-2021 | Grain | | HIS | ı | 49 | ı | 58 | ı | 52 | ı | 53 | ı |
| | 11-1 | | | VaIJ | 1 | 7 | - | 10 | 1 | 12 | 1 | 11 | 1 |
| signing of I Rail | to existing | | ю | dmy2 2I | | | | | | | | | |
| report for de yana Orbital | connectivity | uo | ite | IS Classifica | ı | ML-CL | ı | CL | ı | C | ı | CL | |
| restigation, preparation of geotechnical in connection with construction of Har | m Palwal to Harsana Kalan including (1ryana. | | | Soil Description | | Brown, Very dense, Sandy silt of low plasticity with gravel | | | | Brown, Hard, Silty clay of low | plasticity with gravel | | |
| thnical inv bankment | project frc state of Ha | T | Corrected SPT Value (N _c) | | 100 (25cm) | 1 | 1 | 80 | 06 | 86 | 100 (25cm) | 100 (23cm) | 91 |
| ing geotec ind for em | ·(HORC) | ənla | ۲J | (N) Opserved SP1 | 100 (25cm) | 100 (23cm) | 100 (17cm) | 80 | 06 | 86 | 100 (25cm) | 100 (23cm) | 91 |
| Conducti bridges a | Corridor IR netwo | (w) • | J. | D mort dtgan G | 28.00 | 29.50 | 31.00 | 32.50 | 34.00 | 35.50 | 37.00 | 38.50 | 40.00 |
| | Froject | ə | đ٨ | T slqms2 | SPT-10 | SPT-11 | SPT-12 | SPT-13 | SPT-14 | SPT-15 | SPT-16 | SPT-17 | SPT-18 |





| le | 1-22 | s | Compression (.C.) Compression | I | I | - | - | | I | I | I | 1 | I. | i. | | i. | I. | I. | i. | I | I | ī | I. |
|------------------------------|---------------------------------|--------------------|--|-------|--|-------|------|-------|-------|-------|-------|-------|--------|-------|--------|-------|-------|-------|--------------|-------|--------|-------|--------|
| tef. Cot | -544_2 | ameter | (сш ₇ \Кв) М ^{4 x} 10. ₂ | ı | | | | , | 1 | ı | ı | | i. | ı. | , | ı | 1 | 1 | ı | ı. | ı | | i. |
| R | SR | ion Par | (cm ² /Sec) | | | | | | | | | | | | , | | | | , | | | | ı |
| | | solidati | روستاری) (روستاری) | | | - | | | | | | | | 1 | | 1 | 1 | 1 | , | 1 | 1 | | 1 |
| R.L. | ı. | Con | Pressure | | | | | | | | | | | | | | | | | | | | |
| | | | Void Ratio (e ₀) | ' | ' | 1 | ' | I | ' | 1 | ' | ' | ' | I | ' | I | 1 | 1 | I | I | 1 | ' | 1 |
| | 17 m | Â | Permeabilit | ' | ' | I | 1 | I. | 1 | 1 | ' | ' | 1 | 1 | ' | ı | 1 | 1 | ' | 1 | 1 | 1 | ı |
| | 23021.1 | nre | Svelling Press (^s m ²) | | | ı | ' | I | 1 | ı | ı | ' | ı | T | ' | ı | T | T | I | T | ı | 1 | I |
| es (E,N) | 31 | хәр | Free Swell Inc (%) | ı | | ı | | I | ı | ı | ı | | ı | ı | 1 | i | i. | i. | ı | ı | ı | ı | I |
| ordinat | в | ţħ | Angle of Friction (\$\$) | | | 5 | | 5 | | | ' | | | 4 | | ı | 1 | 1 | ı | I. | 1 | 4 | ı |
| C | 786.129 | ur Streng | Cohesion C (kg/cm ²) | , | 1 | 0.37 | ı | 1.02 | 1 | , | , | 1 | I | 1.66 | ı | I | I | I | I | I | I | 1.98 | |
| | 697 | She | ts9T to 9qvT | | | UUT | ı | UUT | | | ı | | 1 | UUT | ı | I. | 1 | 1 | | T. | - | UUT | |
| ation th | m (| ţţ | Specific Grav | | 1 | 2.67 | ı | 2.68 | ı | | ı | | I | 2.67 | I | I | I | I | I | I | ı | 2.68 | I |
| Termin Dep | 60.00 | (_e mə | Dry Density (g/ | | | 1.48 | ı | 1.60 | | 1.60 | | 1.60 | 1 | 1.64 | ı | 1.63 | 1 | 1.64 | 1 | 1.64 | 1 | 1.66 | 1 |
| lable | |) n.e | 1210M IstutsN %) tnstnoD | | | 14.05 | | 15.23 | | 15.47 | | 15.60 | | 15.96 | , | 16.42 | ı | 16.23 | ı | 16.74 | ı | 17.02 | 1 |
| Water] | .13 m | (_e wə/ | Bulk Density (g | | | 69.1 | | 1.84 | | 1.85 | | 1.85 | | 06.1 | | 06.1 | | 1.91 | 1 | 1.91 | | 1.94 | 1 |
|)epth of | 33 | - | sprinkage Limit | | | - | | | | - | | - | | | , | - | , | | , | | , | | |
|). I | | mits % | хәриј | | 1 | 10 | ı | 10 | 1 | 11 | 1 | 11 | I | 11 | I | 11 | I | 11 | I | 10 | I | 11 | |
| B.H. No | BH-P3 | rberg Li | Plastic Limit | | | 21 | - | 20 | | 22 | | 20 | 1 | 23 | , | 22 | 1 | 20 | , | 20 | | 22 | |
| | | Atte | זיזענים דיושוי | | | 11 | - | 0 | | ñ | | | | 4 | - | 3 | | 11 | | 0 | | 33 | |
| nage ocation | 520 Bridge | | | | | | | (1 | | | | | | 61 | | 61 | | 61 | | 61 | | (1) | |
| Chai (km.)/L | 27+ Major | pç | | ' | | 0 | ' | 0 | ' | 0 | ' | 0 | ' | 0 | ' | 0 | | 0 | ' | 0 | 1 | 0 | |
| | | t retain | Fine | 1 | ' | 0 | ' | 1 | ' | ŝ | ı | 5 | ' | 7 | ' | 9 | 1 | 7 | I | 9 | 1 | ∞ | 1 |
| | 11-2021 | w % uc | Coarse | ı | ' | 1 | ' | 1 | 1 | 5 | I | ŝ | ' | 1 | ' | 3 | ' | 2 | I | 1 | | 5 | I |
| oring | 20- | istributi | Medium San | ı | 1 | 9 | I | S | I | 4 | ı | ŝ | I | 9 | I | 4 | I | ٢ | I | 5 | I | 9 | 1 |
| ate of B | to | n Size D | əniA | , | 1 | 28 | ı | 30 | 1 | 26 | 1 | 28 | I | 26 | I | 28 | I | 24 | I | 30 | I | 27 | 1 |
| D | 1-2021 | Grai | IIIS | ' | | 54 | 1 | 53 | ' | 53 | ' | 48 | 1 | 47 | 1 | 47 | 1 | 49 | 1 | 48 | 1 | 45 | ı |
| | 18-1 | | Clay | | ' | 11 | - | 10 | 1 | 12 | 1 | 11 | ' | 13 | 1 | 12 | - | 11 | 1 | 10 | - | 12 | ' |
| signing of Rail | o existing | | lodmy2 21 | | | | | | | | | | | | | | | | | | | | |
| eport for de ⁄ana Orbital | onnectivity t | uoj | IS Classificati | | 1 | CL | ı | CL | , | CL | | CL | ı | CL | I | CL | ı | CL | ı | CL | ı | CL | ı |
| technical re ion of Hary | ncluding co | | | | ry stiff, | ity | | | | | | | | | f low | | | | | | | | |
| tigation, preparation of ge | Palwal to Harsana Kalan ana. | | Soil Description | | wm, Medium stiff to very stiff, Silty clay of low plasticity rown, Hard, Silty clay of low plasticity with gravel | | | | | | | | | | | | | | | | | | |
| nical inver nkment in | oject fron te of Hary | | (°N) ənlaV | | 4 E | ı | 16 | ı | 31 | ı | 27 | | 33 | ī | 53 | ı | 43 | ī | 48 | ī | 53 | ı | 62 |
| geotechi for emba | IORC) pr in the sta | auls V | (N) | | 4 | ı | 16 | ı | 31 | | 27 | | 33 | ı | 53 | ı | 43 | ı | 48 | ı | 53 | | 62 |
| anducting | orridor (F . network | (w) " | I.Ə morî diqe | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 00.01 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 00.61 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 | 28.00 |
| CC CC | <u>й</u> В | ə | qyT əlqms2 | I-SC | PT-1 | DS-1 | PT-2 | DS-2 | PT-3 | DS-3 | PT-4 | DS-4 | PT-5 1 | DS-5 | PT-6 1 | DS-6 | PT-7 | DS-7 | PT-8 2 | DS-8 | 5 6-Tq | DS-9 | 7-10 2 |
| . Á | 2 | | | | S | U. | S | Ū. | S | D. | S | Ū. | S | U. | S | U. | S | Ū. | \mathbf{S} | U. | S | Ū. | SF |



| e | -22 | | Compression Index (C _c) | | | | | | | ı | | | I | | I | ı | ı | I | | I | ı | ı | |
|---|---|--------------------|---|---------|----------------------------------|-------|---------------|---------------|---------------|--------|---------|--------|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------|--------|--------|
| lef. Cod | -544_21 | ameters | (SM ² Kg) M ² X 10 ⁻² | | ı | I | I | 1 | | I | ı | ı | I | | I | I | I | I | ı | ı. | I | I | |
| X | SR | tion Par | (cm ² /Sec) | ı | ı | I | I | 1 | 1 | ı | ı | ı | I | 1 | ı | ı | I | I | ı | 1 | ı | I | |
| Ŀ | | onsolidat | Pressure | ı | | ı | ı | 1 | | | | | I | | ı | ı | ı | I | | I | | | |
| R.] | I | | Void Ratio (e_) | ı | | ı | ı | | | ı | ı | | I | | I | ı | ı | I | | I | ı | ı | |
| | 7 m | Á | Permeability (cm/sec) | ı | ı | ı | ı | | ı | ı | - | - | I | | ı | ı | ı | I | 1 | I | ı | - | |
| | 3021.11 | nıç | Swelling Press (kg/cm ²) | ı | ' | ı | ı | ı | ' | ı | ı | ı | I | 1 | I | ı | I | I | ' | I | ı | ' | |
| ss (E,N) | 312 | xəp | Free Swell Inc (%) | ı | | ı | ı | ı | ı | - | - | - | T | ı | ı | T | T | T | - | I | - | - | |
| ordinate | ш | ğth | Angle of Friction (°°) | 4 | ' | ı | ı | ı | ' | ı | · | | 4 | | I | ı | I | I | 1 | I | ı | ' | |
| C | 7786.129 | ear Streng | Cohesion C (kg/cm ²) | 3.12 | | | | 1 | | ı | ı | ı | 3.18 | 1 | ı | ı | ı | T | ı | T | ı | | |
| | 69 | She | ts9T fo 9qYT | UUT | ' | | , | | ' | | ' | | UUT | | ı | | ı | 1 | ' | 1 | | ' | |
| nation pth | 00 m | ity | vrað sitisser | 2.67 | , | ı | ı | ı | 1 | - | - | - | 2.68 | | ı | - | - | T | - | I | - | - | |
| Termi Dej | 60.0 | (_e mə | Dry Density (g/d | 1.69 | | ı | ı | ı | 1 | ı | 1.67 | | 1.70 | | ı | | ı | I | 1 | I | ı | 1 | |
| Table | |) nre | tsioM IsrutsN (%) tn9tnoD | 17.25 | | | | | | | 21.36 | | 20.64 | | | | | 1 | | 1 | | | |
| of Water | 33.13 m | (_e wə) | Bulk Density (g/ | 1.98 | ı | i | i | I | ı | I. | 2.03 | | 2.05 | 1 | ı | 1 | ı | I | 1 | I | I. | | |
| Depth o | | <i>`0</i> | Shrinkage Limit | I | ı | ı | ı | I | ı | - | - | - | I | ı | I | - | - | I | - | I | - | - | |
| No. | -P3 | Limits 9 | Plasticity Index | 11 | | | | 11 | | - | 10 | - | 11 | - | ı | 11 | - | - | 11 | - | - | 10 | |
| B.H. | ВН | tterberg | Plastic Limit | 20 | | | | 23 | | - | 12 | - | 22 | | ī | 12 | - | - | 20 | T. | - | 12 | |
| e ion | ge | V | timi.I biupi.I | 31 | | ı | 1 | 34 | | | 31 | - | 33 | | ī | 32 | ı. | T | 31 | T. | | 31 | |
| Chainag n.)/Locat | 27+620 lajor Brid | | Coarse | 0 | ' | ı | ı | 0 | 1 | ı | 0 | ı | 0 | 1 | I | 0 | I | I | 0 | I | ı | 0 | |
| (kı | N | etained | ni ^A | 10 | | | , | 11 | , | | 6 | | 10 | | ı | 10 | ı | T | 8 | , | | 12 | |
| | 1-2021 | 1 % wt r | Coarse | 5 | ' | | , | 5 | | ī | 1 | 1 | 2 | ı | ı | 2 | ı | T | 4 | 1 | ī | 3 | |
| ring | 20-1] | tribution | Nedium M | 9 | , | 1 | ı | 9 | ı | ı | 5 | ı | 6 | ı | ı | 9 | ı | T | L | ī | ı | 5 | , |
| tte of Bo | to | Size Dis | əniA | 24 | , | 1 | ı | 23 | ı | ı | 28 | ı | 28 | ı | ı | 25 | ı | T | 26 | ī | ı | 28 | , |
| Dŝ | 1-2021 | Grain | IIIS | 47 | ' | ı | ı | 45 | 1 | ı | 46 | 1 | 42 | 1 | I | 45 | I | I | 44 | I | ı | 42 | , |
| f | 18-1 | | ValJ | 1 | ' | ' | ' | 13 | | - | 11 | - | 12 | ' | , | 12 | | - | 11 | | - | 10 | , |
| lesigning o al Rail | / to existin | | lodmy2 2I | | | | | | | | | | | | | | | | | | | | |
| report for d yana Orbit | onnectivity | uo | IS Classificati | CL | | | | CL | , | ī | CL | ï | CL | ' | , | CL | | ı | CL | 1 | ī | CL | |
| vestigation, preparation of geotechnical t in connection with construction of Ha | om Palwal to Harsana Kalan including c aryana. | | Soil Description | | Brown, Hard, Sily clay of low GI | | | | | | | | | | | | | | | | | | |
| xchnical in nbankmen |) project fi state of H | T | Corrected SP Value (N _c) | ı | 80 | I | 100 (20cm) | 100 (20cm) | 100 (26cm) | 62 | 1 | 69 | I | 100 (27cm) | 100 (23cm) | 100 (20cm) | 100 (20cm) | 100 (22cm) | 100 (21cm) | 100 (20cm) | ı | I | 84 |
| ting geote and for er | r (HORC) ork in the | ənla\ | Observed SPT V (N) | | 80 | | 100 (20cm) | 100 (20cm) | 100 (26cm) | 62 | ' | 69 | ı | 100 (27cm) | 100 (23cm) | 100 (20cm) | 100 (20cm) | 100 (22cm) | 100 (21cm) | 100 (20cm) | >100 | >100 | 84 |
| Conduct bridges ; | Corrido IR netw | (w) • | J.Ə morî diqeU |) 29.50 | 31.00 | 32.50 | 33.00 | 34.00 | 35.50 | 37.00 | 1 38.50 | 40.00 | 2 41.50 | , 43.00 | 44.50 | 46.00 | 47.50 | 49.00 | 50.50 | 52.00 | 53.50 | 55.00 | 56.50 |
| Dector | rujec | ə | qvT əlqms2 | UDS-1(| SPT-11 | UDS* | SPT-12 | SPT-13 | SPT-14 | SPT-15 | 11-SQU | SPT-16 | UDS-12 | SPT-17 | SPT-18 | SPT-19 | SPT-20 | SPT-21 | SPT-22 | SPT-23 | SPT-24 | SPT-25 | SPT-26 |



| е | -22 | | τ | Compression Index (C _c) | ı | ı | ı |
|---|--|--------------------|-----------------------|---|---------|--|-------|
| Ref. Cod | R-544_21 | rameters | | (cm ² /Kg) M ⁴ x 10- ² | - | - | I |
| | SF | ation Pa | | (cm ² /Sec) C ^x x 10 ⁻⁴ | ı | ı | I |
| Т. | | Consolid | | Pressure Pressure | | | |
| R. | · | | (⁰ | 9) oits Ratio (| ı | ı | I |
| | 7 m | Â |) ;) | Permeabi Dem/sec | ı | - | I |
| | 3021.11 | enre | (₇ 559 | Transition Pro Markan (Kg/cm ² | ı | 1 | I |
| s (E,N) | 312 | хәр | uj | Free Swell (%) | , | | 1 |
| ordinate | n | th | (| Angle of [°q) noitoirA | - | - | I |
| CC | 786.129 r | ur Streng | | O noisəhoD (kg/ст ²) | | | I |
| | 697 | She | 1 | rs9T fo 9qvT | | | ı |
| aation oth | 0 m | ţţ | AB. | 1Ə əffiə9qZ | | | ı |
| Termiı Deț | 60.0 | (_e wə) | (8) | Dry Density | ı | | ı |
| Table | |) m.e | tsi %) | oM latural Mo) tnotnoD | ı | | ı |
| of Water | 33.13 m | (_e wə/ | B) | Bulk Density | - | - | I |
| Depth | | % | | Shrinkage JimiJ | 1 | , | ı |
| No. | P3 | Limits ' | | Plasticity Index | | 11 | |
| B.H. | BH- | Atterberg | 1 | imiJ siterI | - | 21 | ı |
| ion | ge | ł | 1 | ітіЛ bіиріЛ | · | 32 | |
| Thainage .)/Locat | 27+620 ijor Brid | | vel | Serse | ı | 0 | I |
| (km | Ma | tained | Gra | əniA | - | 6 | - |
| | -2021 | % wt re | | oarse | - | 3 | I |
| ing | 20-11 | tribution | Sand | muibəM | 1 | 4 | - |
| te of Boı | to | Size Dist | | əniA | ı | 26 | I |
| Da | -2021 | Grain | | HiS | · | 47 | ' |
| | 18-1 | | | Valəy | 1 | 11 | - |
| esigning of I Rail | to existing | | ю | dmy2 2I | | | |
| . report for de ryana Orbita | connectivity | uoj | ite. | officeral SI | - | CL | - |
| rvestigation, preparation of geotechnica at in connection with construction of H | om Palwal to Harsana Kalan including laryana. | | | Soil Description | | Brown, Hard, Silty clay of low plasticity with gravel | |
| chnical in nbankmen |) project fi state of H | Te | (°N IS | Corrected Dalue (D | 78 | 76 | I |
| ting geote and for en | r (HORC) ork in the | ənlaV | L | (N) Opserved SP | 78 | 76 | I |
| Conduct bridges a | L Corridoi IR netwo | (ɯ) " | 1.4 | Depth from O | , 58.00 | 59.50 | 60.00 |
| Duction | noloci | ə | đ٨ | T slqms2 | SPT-27 | SPT-28 | DS-2 |





| | | | (_o D) xəbnl | | | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | |
|---|-----------------------------------|--------------------|--|------|--|----------|---|------|-------|------------------------|-------------------------------------|------|-------|--------|-------|------|-------|-----------------|--|--------|--------|-----------------|----------|
| Code | L_21-22 | eters | (cm ² /Kg) Compression | | | | | | | | | | | | | | | | | | | | |
| Ref. | SR-544 | Parame | _z .01 x ^A W (cos _z ,26c) | ' | | ' | ' | ' | ' | ' | ' | 1 | | ' | ' | ' | | | 1 | ' | ' | 1 | |
| | | idation | C ^A X 10.4 | • | 1 | ' | ' | ' | 1 | ' | 1 | ' | 1 | ' | 1 | 1 | ı | 1 | 1 | ' | ' | ' | 1 |
| R.L. | ı | Consol | Pressure | ' | ' | ' | ' | 1 | | ' | ' | ' | ' | ' | ' | ' | 1 | 1 | ' | ' | ' | ' | ' |
| | | | Void Ratio (e ₀) | | ı | I | I | 1 | ' | ' | ı | ' | ı | ' | 1 | ı | I | 1 | ı | I | I | ' | |
| | 18 m | Â | Permeabilit | | ı | I | ı | 1 | 1 | 1 | ı | ı | 1 | ı | 1 | ı | I | ı | ı | ı | ı | , | 1 |
| | 23006.1 | əJN | Swelling Press (kg/cm ²) | , | ı | I | ı | 1 | 1 | ' | ı | 1 | 1 | 1 | 1 | ı | I | I | ı | ı | ı | 1 | , |
| es (E,N) | 31 | xəp | Free Swell Ind (%) | ı | ' | ı | ı | , | ı | , | - | , | 1 | , | 1 | ' | I | I | 1 | - | ı | 1 | |
| ordinat | ш | gth | Angle of Friction (\$°) | | 5 | ı | 27 | , | 1 | , | ' | , | 1 | , | ' | ' | 4 | I | 1 | ' | ı | | |
| 0 | 7785.986 | ear Stren |) noizənd (kg/cm ²) | ' | 0.37 | ' | 0.18 | | | ' | ' | ' | ' | ' | ' | ' | 2.24 | ı | ' | ' | | ' | , |
| | 69 | She | tesT to sqT | | TUU | · | DST | | ı | ' | - | | - | | | - | TUU | - | - | - | ı | | |
| nation oth | 0 m | ţţ | vraJ offic Grav | | 2.67 | | 2.66 | | | | | | | | | | 2.68 | ı | | | | | |
| Termii Del | 50.0 | (_e wə | Dry Density (g/ | ı | 1.48 | I | 1.60 | ı | 1.61 | ı | 1.59 | ı | 1.57 | ı | 1.67 | ı | 1.66 | I | 1.64 | T | I | ı | |
| Table | |) nre | tsioM IsrutsN %) tnotaoU | | 12.40 | ı | 13.22 | | 13.60 | | 14.02 | | 14.80 | | 15.26 | - | 15.40 | ı | 16.23 | - | | | |
| of Water | 33.14 m | (_e wə) | Bulk Density (g | | 1.66 | | 1.81 | | 1.83 | | 1.81 | | 1.80 | | 1.92 | | 1.92 | ı | 1.91 | | | | |
| Depth o | | . 6 | Shrinkage Limit | 1 | - | ı | ı | ı | I | 1 | - | | - | | ı | - | - | I | - | - | ı | | |
| No. | P4 | Limits % | Plasticity Index | | 11 | | 7 | | 7 | | 9 | | 7 | | 11 | | 11 | ı | 11 | - | ı | 10 | |
| B.H. | BH- | tterberg | Plastic Limit | | 20 | | 20 | | 21 | | 20 | | 19 | | 22 | | 21 | ı | 20 | | | 20 | |
| ion | ge | A | timi.I biupi.I | | 31 | | 27 | | 28 | | 26 | | 26 | | 33 | | 32 | 1 | 31 | | | 30 | |
| Chainage 1.)/Locat | 27+620 ajor Bridį | | Coarse | 1 | 0 | I | 0 | ı | 0 | ı | 0 | 1 | 0 | 1 | 0 | | 0 | I | 0 | T | I | 0 | |
| (km | M | tained | e B B B B B B B B B B B B B B B B B B B | 1 | 0 | ı | ю | I | Ś | i | 4 | 1 | 3 | 1 | 7 | ı | 9 | I | 4 | ī | ı | 6 | |
| | -2021 | % wt re | Coarse | ı | 0 | I | 5 | I | 1 | ı | 4 | ı | 3 | ı | 1 | | 1 | I | 3 | I | I | n | |
| ing | 20-11 | ribution | Sand Medium | | 9 | | 10 | ı | 7 | | 9 | | 9 | | 10 | - | L | - | 2 | - | I | 4 | |
| te of Bor | to | Size Dist | ьniЯ | | 33 | ı | 34 | 1 | 34 | ı | 35 | ı | 35 | ı | 30 | | 26 | ı | 28 | - | I | 27 | , |
| Da | -2021 | Grain | IIIS | , | 50 | ı | 4 | | 45 | , | 45 | , | 46 | , | 40 | ' | 49 | I | 49 | 1 | | 47 | , |
| | 18-11 | | Clay | | 11 | | 7 | | ∞ | - | 9 | | 7 | | 12 | - | 11 | - | 11 | - | | 10 | ' |
| signing of Rail | o existing | | lodmy2 21 | | | | | | | | | | | | | | | | | | | | |
| eport for de ana Orbital | nnectivity t | uoj | IS Classificati | | CL | | ML-CL | | ML-CL | | ML-CL | | ML-CL | | CL | | CL | 1 | CL | | | CL | |
| echnical re on of Hary | cluding co | | | | low | | MII | | | | | | | | | | | | low | | | | L |
| tigation, preparation of geo n connection with construct | Palwal to Harsana Kalan i ana. | | Soil Description | | Brown, Stiff, Silty clay o plasticity | | | | | Brown, Medium dense to | sanuy sur ur ruw piasucur gravel | | | | | | | | Brown, Hard, Silty clay c plasticity with grave | | | | |
| uical inves nkment ir | oject fron te of Hary | Ŧ | · 23 · 32 · 23 · 20 · 20 · 20 · 20 · 20 | | | | | | | 17 | | 90 | , | 66 | | 48 | ı | 100 5cm) | 100 (3cm) | | | | |
| geotechn for embai | ORC) pre in the stat | A SIUE | Miky Tq8 beyreedO · </th <th>25</th> <th></th> <th>06</th> <th>ı</th> <th>66</th> <th>1</th> <th>48</th> <th></th> <th>100 25cm) (2</th> <th>100 23cm) (2</th> | | | | | | | 25 | | 06 | ı | 66 | 1 | 48 | | 100 25cm) (2 | 100 23cm) (2 | | | | |
| unducting dges and | network | (u) " | I.Ə morî diqe | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 0.00 | 1.50 | 3.00 | 4.50 | 6.00 | 7.50 | 00.6 | 30.50 | 22.00 | 3.50 | 5.00 | :5.50 (2 | 36.50 (2 |
| Co | | ə | qyT əlqms2 |) SU | I-SO | PT-1 | DS-2 | PT-2 | DS-3 | PT-3 | DS-4 | PT-4 | DS-5 | PT-5 1 | DS-6 | PT-6 | DS-7 | PT-7 2 | DS-8 2 | PT-8 2 | JDS* 2 | PT-9 2 | PT-10 2 |
| | | | | 1 | | S | | Ś | | Ś | | Ś | | S | | Ś | | S | | S | | S | |



| a | -22 | | pression (_s O) xs | amo) Imo) | I | ı | ı | , | I | T | I | I | I | I | I. | ı | I | I | T | |
|--|------------------------------|---|---|-----------------|---------|---------|----------|-----------------|-----------------|-----------------|-----------------|----------------------------|-----------------------|-------|----------|-----------------|-----------------|-----------------|-----------------|-----------------|
| tef. Cod | -544_21 | ameters | r ² /Kg) x 10 ^{.2} | шэ) ^W | I | ı | ı | ı | I | T | I | I | I | I | I | I | I | I | I | |
| ł | SR | tion Par | (298/) 7,7960) 7,7960) | шэ) :^Э | I | - | ı | ı | I | I | I | I | I | I | I | I | I | I | I | ı |
| Ŀ | | Consolida | k/cm ₅₎ szence | у Рге Рге | | - | | | T | T | | ı | T | ı | 1 | 1 | | T | 1 | |
| R.] | ' |) | (₀ 9) oitsS | 4 bioV | ı | ı | 1 | 1 | I | I | ī | ī | I | I | I | I | I | I | I | ı |
| | ш | Â | rmeabilit (cm/sec) | Ъе | ı | 1 | 1 | 1 | I | I | ı | I | I | I. | I | ı | ı | I | I | ı |
| | 3006.118 | əıns | ling Press (kg/cm ²) |) II9WS | I | 1 | ı | ı | I | I. | T | I | I | I | I | I | I. | I | i. | ı |
| s (E,N) | 3120 | хәр | (%) (%) | Free | I | 1 | ı | ' | T | T | I | I | T | - | - | - | - | T | T | |
| ordinate | ш | gth | fo slg (°φ) noi | nA tricti | I | ı | 4 | 1 | I | I | I | I | I | I | I | I | I | I | I | ı |
| С | 785.986 | ar Streng | D noise (² m2) | gя) опоЭ | - | - | 3.15 | ' | Т | I | - | I | Т | I | I | I | I | Т | I | ı |
| | 697 | She | tesT fo | əqvT | ı | - | UUT | | I | - | - | - | I | - | - | - | - | I | - | I |
| lation th |) m | ŲŤ | verð offic | oədS | - | - | 2.68 | | T | ı. | | | T | ı | ı | ı | ı | T | , | ı |
| Termin Dep | 50.00 | (_e wə) | (g) ytiens(| D ελ D | 1.66 | | 1.70 | | ī | ı | ı | ı | ī | 1 | 1.69 | ı | 1 | ī | 1 | |
| Table | |) Inte | tzioM Isri %) tnotne | Natu Co | 18.25 | 1 | 20.34 | 1 | I | I | I | I | I | I | 20.85 | I | ı | I | I | |
| of Water | 33.14 m | (_e wə/ | g) ytiens(| I AluE | 1.96 | 1 | 2.05 | ı | I | I | I | I | I | I | 2.04 | I | I | I | I | ı |
| Depth o | | .0 | imit timit | L Shri | ı | - | ı | ı | T | I | ı | ı | T | I | I | I | I | T | I | ı |
| No. | P4 | Limits % | sticity x9br | sal¶ nI | 11 | | 10 | 1 | I | 11 | ı | ı | 11 | I | 10 | I | I | 11 | I | ı |
| B.H. | BH- | tterberg | imi.I si | itselA | 21 | | 21 | ı | I | 23 | ı | ı | 23 | I | 20 | I | I | 23 | I | I |
| ion | ge | Α | timi.I b | iupiJ | 32 | ı | 31 | 1 | T | 34 | ı | ı | 34 | ı | 30 | ı | ı | 34 | 1 | |
| Chainage n.)/Locat | 27+620 ajor Brid | | avel | 60J | 0 | - | 0 | | T | 0 | T | T | 0 | ı | 0 | ı | ı | 0 | 1 | |
| (kn | M | etained | с Б әи | ĿЫ | L | ı | 10 | ' | I | 12 | I | I | 10 | I | 8 | I | I | 6 | I | ı |
| | 1-2021 | ı % wtr | ILSG | воЭ | 1 | | 0 | ' | T | 1 | T | ı | 4 | ı | 0 | ı | ı | 2 | T | |
| ring | 20-1 | stributio | Sand muil | bəM | 7 | ı | 10 | , | I | 6 | ı | I | 5 | I | 12 | ı | i | 8 | i | |
| ate of Bo | to | Size Dis | əu | Εù | 25 | ' | 26 | ' | I | 23 | I | I | 22 | I | 22 | ı | I | 23 | I | ı |
| D | 1-2021 | Grain | માક | 5 | 48 | ' | 43 | ' | T | 46 | ı | ı | 46 | ı | 47 | ı | ı | 45 | ı. | ' |
| f | 18-1 | | yal' | 0 | 12 | - | 11 | • | • | 12 | - | - | 13 | ' | 11 | • | • | 13 | • | |
| esigning o al Rail | to existing | | lodmy2 2 | SI | | | | | | | | | | | | | | | | |
| report for d ryana Orbit | connectivity | uoj | Jassificati |) SI | CL | | CL | | ı | CL | ı | ı | CL | | CL | | 1 | CL | ı | 1 |
| a, preparation of geotechnical ection with construction of Ha | l to Harsana Kalan including | | Soil Description | | | | | | | | | ı, Hard, Silty clay of low | lasticity with gravel | | | | | | | |
| ivestigation it in conne | rom Palwa Iaryana. | | - | | | | | | | | | Brown | d | | | | | | | |
| schnical in nbankmen |) project fi state of H | Corrected SPT - | | | | | | | | | | | 100 (19cm) | | | | | | | |
| cting geote and for er | or (HORC vork in the | ənlaV | Ved SPT (N) | Opser | - |) 61 | - |) 100 (28cm) |) 100 (26cm) |) 100 (24cm) |) 100 (30cm) | 86 (|) 82 | . 78 | - (|) 100 (26cm) |) 100 (23cm) |) 100 (22cm) |) 100 (22cm) |) 100 (19cm) |
| Conduc bridges | Corrido IR netv | (ɯ) " | I.Ə morî | Depth | 9 28.00 | 1 29.50 | 10 31.00 | 2 32.50 | 34.00 | [4 35.5C | 37.00 | 6 38.5C | 17 40.00 | 41.50 | 11 43.00 | (9 44.5C | 30 46.00 | 11 47.50 | 22 49.00 | 23 50.00 |
| Proied | - Contra | ə | qvT slqm | вS | -SQU | SPT-1 | I-SQU | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | UDS-1 | SPT-1 | SPT-2 | SPT-2 | SPT-2 | SPT-2 |



| | 2 | | Compression Lindex (C _c) | | | | | | | | | | | | | | | | | | | | |
|-------------------------------|---------------------------|-------------------------|--|------|-----------------------|----------|-------|-------|-------|-------|----------|----------|-------|-------|--------------------------|-------|-------|-------|-------|----------|----------|---------|--------|
| . Code | H_21-2 | neters | (cm ² /Kg) | | | 1 | | | 1 | | | | | 1 | | 1 | 1 | | 1 | | | | |
| Ref | SR-54 | n Paran | (0) X ^A W (0) (0) (0) (0) (0) (0) (0) (0) (0) (0) | | | | | | 1 | | | | - | - | | - | - | | - | | | . | |
| | 0 m | nsolidatio | С ^x x 10.4 (kg/cm ²⁾ | | i | | | | | | | | | | | | | | | | , | 1 | |
| R.L. | +)271.08 | Co | Void Ratio (e_0) | | 1 | | | | 1 | | | | 1 | 1 | | | 1 | 1 | 1 | | | | |
| | | | (ɔəs/ɯɔ) | | ı | | | | 1 | | | 1 | | | | | | 1 | | 1 | , | | |
| | 47.116 m | A | Permeabilit | 1 | I | | | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | ı | 1 | 1 | 1 | 1 | |
| E,N) | 31230 | yan | (%) | | | | | 1 | 1 | | | , | | 1 | , | 1 | 1 | 1 | 1 | , | , | | |
| linates (| | vol | Friction (o°) | | 24 | | s | | ı | | | | 4 | - | | | 4 | 1 | - | | 5 | 1 | |
| Core | 6.377 m | Strength | ر ² ms/ga() | | 0.20 | | 1.12 | | 1 | 1 | | | 1.45 | 1 | | 1 | 1.78 | 1 | | | 2.02 | 1 | 1 |
| | 697786 | Shear S | 129 1 10 9d A 1 | |) TS | | UT | | | | | | UT | | | | UT | | | | L | | |
| ų | | 611 | | | 20 20 | | 57 U | | | | | | 58 U | | | | 57 U | | | | 58 U | | |
| rminatio Depth | 60.00 m | | Read officers | | 1 2. | | 0 2. | | 0 | | | | 3 2. | | Ю | | 5 2. | | 5 | | 6 2. | | |
| e Te | _ | (_e ɯɔ | Dry Density (2/ | 1 | 4 1.5 | 1 | 5 1.6 | i | 1.6 | 1 |) 1.6 | 1 |) 1.6 | 1 |) 1.6 | 1 | 4 1.6 | ı | 2 1.6 | 1 | 2 1.6 | 1 | 3 1.6 |
| ter Tabl | ш |) nLG | tsioM IsrutsN %) tratroD | 1 | 12.0 | 1 | 13.25 | ' | 13.5 | ı | 13.89 | ' | 14.29 | ' | 14.9(| ı | 15.3 | 1 | 16.42 | ' | 17.13 | ' | 17.88 |
| h of Wa | 33.00 | (_e wə) | Bulk Density (g/ | ı | 1.69 | ı | 1.81 | ' | 1.82 | ı | 1.83 | ' | 1.86 | ' | 1.87 | ı | 1.90 | ı | 1.92 | ' | 1.94 | 1 | 1.96 |
| Dept | | $o_{lo}^{\prime\prime}$ | Shrinkage JimiJ | 1 | ı | , | ' | ı | 1 | 1 | ' | ı | ı | ı | ı | ı | ı | ı | ı | ı | ı | 1 | - |
| I. No. | H-P2 | g Limits | Plasticity Index | ı | ٢ | | = | ı | 11 | ı | = | ı | 10 | ı | 10 | ı | 11 | I | 11 | ı | 10 | ı | Ξ |
| B.F | BI | Atterber | Plastic Limit | ı | 21 | | 21 | 1 | 22 | ı | 21 | ı | 20 | ı | 20 | ı | 23 | ı | 21 | ı | 21 | ı | 22 |
| e tion | lge | 7 | timiJ biupiJ | | 28 | ı | 32 | | 33 | ı | 32 | | 30 | - | 30 | | 34 | , | 32 | | 31 | ' | 33 |
| Chainag n.)/Loca | 27+620 lajor Bric | | Coarse Coarse | , | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | , | 0 | | 0 | , | 0 |
| (kı | V | etained | Pine G | ı | 0 | ı | ю | | 4 | ı | 5 | | 4 | | 4 | ' | 9 | , | 7 | | 9 | ' | ∞ |
| | -2021 | 1 % wt r | Coarse | ı | 1 | ı | 5 | ' | 2 | ı | - | ' | 2 | ' | - | ı | 2 | ı | 4 | ' | ŝ | ı | 5 |
| ing | 21-11 | cribution | Medium Sand | I | 5 | I | 4 | ı | ю | I | 9 | ı | 4 | - | 9 | 1 | L | ı | 2 | ı | 4 | ı | 9 |
| te of Bor | to | Size Dist | eniA | | 30 | ı | 28 | | 25 | , | 27 | i. | 26 | - | 30 | 1 | 24 | ī | 23 | i. | 25 | ı | 30 |
| Dai | -2021 | Grain | IIS | | 55 | ı | 52 | | 54 | , | 50 | i. | 54 | - | 49 | 1 | 48 | ī | 49 | i. | 51 | ı | 42 |
| | 18-11 | | Clay | | 6 | ı | 11 | | 12 | , | 11 | i. | 10 | - | 10 | 1 | 13 | ī | 12 | i. | 11 | ı | 12 |
| signing ital Rail | to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | | |
| report for de Iaryana Orbi | onnectivity 1 | uo | IS Classificati | ı | ML-CL | 1 | CL | 1 | CL | ı | CL | 1 | CL | ı | CL | ı | CL | ı | CL | 1 | CL | 1 | CL |
| technical J | ncluding c | | | | / silt of | <u> </u> | | | | | <u> </u> | <u> </u> | | | low | | | | | <u> </u> | <u> </u> | | |
| tion of geo ith constru | na Kalan ir | | ription | | nse, Sandy ticity | | | | | | | | | | ty clay of th gravel | | | | | | | | |
| n, preparat inection w | l to Harsaı ryana. | | oil Desci | | edium der low plas | | | | | | | | | | Hard, Sil Isticity wi | | | | | | | | |
| vestigatior ent in con | om Palwa tate of Har | | S | | łrown, Mi | | | | | | | | | | Brown, pla | | | | | | | | |
| shnical inv embankm | project fr k in the st | Te | Corrected SP Value (N _e) | | <u>д</u> - | 14 | | 33 | ı | 31 | | 35 | | 41 | | 47 | , | 51 | ı | 56 | 1 | 62 | |
| ing geotec s and for | (HORC) IR networ | ənleV | VDserved SPT V (N) | | | 11 | | 33 | | 31 | | 35 | | 41 | | 47 | | 51 | | 56 | | 62 | |
| Conducti of bridge | Corridor existing | (w) " | I.Ə morî diqeD | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 | 28.00 |
| Ductoot | 1 ujeu | ə | qvT slqms2 | DS | UDS-1 | SPT-1 | UDS-2 | SPT-2 | UDS-3 | SPT-3 | UDS-4 | SPT-4 | UDS-5 | SPT-5 | 9-SQU | SPT-6 | UDS-7 | SPT-7 | 8-SQU | SPT-8 | 6-SQU | 6-T4S | UDS-10 |



| a | -22 | | Compression Index (C _e) | ı | ı | ı | ı | ı | T | T | | ı | ı | ı | ı | ı | T | ı | ı | I | ı | ı | I |
|---|--|--------------------|--|----------|---|----------|----------|-----------------|-----------------|----------|----------|----------|-----------------|-----------------|---------------|----------|-----------------|----------|-----------------|-----------------|----------|----------|----------|
| tef. Code | -544_21- | ameters | (cm ² /Kg) M _v x 10. ² | ı | 1 | - | 1 | T | I | I | | 1 | - | ı | I | I | I | T | T | I | | ı | I |
| ł | SR | tion Par | (cm ² /Sec) C ^x X 10.4 | ı | 1 | T | 1 | T | I | I | 1 | ı | T | ı | I | I | I | T | I | ı | ı | 1 | I |
| .L. | .080 m | Consolida | Pressure (kg/cm ²⁾ | | - | - | - | | 1 | T | | | - | | ı | , | 1 | | - | | | | ı |
| R | (+)271 | | Void Ratio (e ₀) | | , | , | , | ī | 1 | ī | · | | ı. | ī | ı | , | 1 | ī | ı | ī | ı | | , |
| | 6 m | Â | Permeabilit (cm/sec) | ı | 1 | 1 | 1 | T | I | I | | 1 | | ı | I | I | I | T | ı | I | 1 | ı | ı |
| | 23047.11 | nre | Swelling Press (kg/cm ²) | ı | ı | 1 | ı | I | I | I | 1 | 1 | 1 | 1 | ı | I | I | I | ı | ı | ı | ı | 1 |
| tes (E,N) | 31. | хәр | Free Swell Inc (%) | ı | ı | ı | ı | ı | I | I | ı | ı | ı | 1 | I | I | I | ı | ı | ı | ı | ı | 1 |
| Cordina | 7 m | ngth | Angle of Friction (\$\$) | ' | 5 | ' | ' | 1 | 1 | T | ' | | | | 1 | T | 1 | 1 | | 1 | | ' | 1 |
| - | 97786.37 | ear Stre | Cohesion C (kg/cm²) | ' | 3.15 | ı | ı | ı | 1 | ı | ı | 1 | ı | ı | ı | ı | 1 | ı | ı | ' | ı | ı | 1 |
| | 69 | Sh | tsoT to of Test | , | TUU | ı | ı | I | I | I | ı | 1 | ı | 1 | I | I | I | I | ı | I | ı | , | I |
| ination pth | 00 m | ţţ | vraD officodd | ' | 2.67 | ' | ' | ı | I | I | ' | ' | ' | ' | ı | I | I | ı | ' | ı | ' | ' | I |
| Termi De | 60.0 | (_e wə | Dry Density (g/ | | 1.69 | | 1.70 | ī | ı. | ī | | | | | ï | ï | ı. | ī | | ı | | | I |
| Table | |) n.e | tsioM IsrutsN %) tnotnoD | | 20.45 | | 20.10 | | 1 | ı. | | | | | | , | 1 | | | | | | I |
| of Water | 33.00 m | (_e ɯə/ | Bulk Density (g | ı | 2.04 | - | 2.04 | T | T | ī | - | ı | 1 | ı | ı | ī | 1 | T | ı | ı | ı | ı | I |
| Depth o | | . 6 | Shrinkage JimiJ | ı | 1 | 1 | 1 | T | I | I | - | ı | 1 | ı | I | I | I | T | ı | ı | 1 | 1 | I |
| No. | P2 | Limits % | Plasticity Index | | 11 | ı | 10 | I | I | 10 | ı | 11 | ı | 11 | I | I | 11 | I | ı | 11 | ı | | 11 |
| В.Н. | BH | tterberg | Plastic Limit | , | 21 | 1 | 21 | ı | I | 21 | 1 | 20 | 1 | 23 | I | ı | 21 | ı | ı | 22 | ı | , | 23 |
| ion | ge | A | timiJ biupiJ | ı | 32 | - | 31 | - | I | 31 | - | 31 | - | 34 | I | ı | 32 | 1 | ı | 33 | - | ı | 34 |
| Chainage 1.)/Locat | 27+620 ajor Brid | | Coarse | ı | 0 | ı | 0 | ı | I | 0 | ı | 0 | ı | 0 | I | I | 0 | ı | ı | 0 | ı | ı | 0 |
| (kn | Μ | etained | 9niA | ı | L | - | 11 | T | T | 8 | ı | 10 | - | L | I | ı | 6 | T | ı | 8 | ı | ı | 11 |
| | -2021 | 1 % wt r | Coarse | ı | 2 | ı | 1 | ı | I | 1 | ı | 7 | 1 | 1 | I | I | 3 | ı | ı | 2 | ı | ı | 2 |
| ring | 21-11 | tribution | and Marina Marin | ' | 3 | - | 5 | | , | 7 | - | 9 | - | 9 | ı | ı. | 4 | | | 3 | | ' | ٢ |
| te of Bo | to | Size Dis | əniT | ' | 28 | - | 23 | | , | 26 | - | 30 | - | 26 | ı | ı. | 24 | | | 26 | | ' | 22 |
| Da | 1-2021 | Grain | IIIS | ı | 48 | ı | 50 | ı | I | 47 | ı | 41 | ı | 47 | I | I | 49 | ı | ı | 49 | ı | ı | 45 |
| | 18-1 | | Clay | | 12 | - | 10 | ' | - | 11 | 1 | 11 | - | 13 | 1 | ı | 11 | ' | ' | 12 | 1 | , | 13 |
| lesigning bital Rail | / to | | lodmy2 21 | | | | | | | | | T | | | | | | | | | | | |
| l report for c Haryana Or | connectivity | uoj | IS Classificati | | CL | ı | CL | I | ı | CL | ı | CL | ï | CL | I | ı | CL | I | ı | CL | I | | CL |
| rvestigation, preparation of geotechnic nent in connection with construction o | rom Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | 2 C C C C C C C C C C C C C C C C C C C | | | | | | | | | | | | | | | | | | |
| echnical i ar embankı |) project: ork in the | Te | Corrected SI Value (N.) | 64 | ' | 80 | ' | 100 (25cm) | 100 (22cm) | 62 | 88 | 66 | 100 (23cm) | 100 (23cm) | 100 (20cm) | I | 100 (24cm) | ı | 100 (22cm) | 100 (21cm) | 1 | ' | 85 |
| icting geot lges and fc | lor (HORC ig IR netw | ənlaV | (N) Observed SPT V | 64 | - |) 80 | - |) 100 (25cm) |) 100 (22cm) |) 62 | 88 (| 66 (|) 100 (23cm) |) 100 (23cm) |) 100 (20cm) |) >100 |) 100 (24cm) |) >100 |) 100 (22cm) |) 100 (21cm) |) >100 |) >100 |) 85 |
| Condu of brid | Corrid existin | (w) " | I.Ə morî diqe | 10 29.50 | 11 31.00 | 11 32.50 | 12 34.00 | 12 34.50 | 13 36.50 | 14 37.00 | 15 38.50 | 16 40.00 | 17 41.50 | 18 43.00 | 19 44.50 | 20 46.00 | 21 47.50 | 22 49.00 | 23 50.50 | 24 52.00 | 25 53.50 | 26 55.00 | 27 56.50 |
| Ducio | vfor r | 9 | qvT əlqms2 | SPT-1 | -SQU | SPT-1 | -SQU | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | I-T42 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | 2-T-2 | 5-Tq2 | 5-T-2 |



turbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated ulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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124 of 222

| e | -22 | | U | Compression Index (C _c) | ı | I | I |
|---|---|--------------------|-----------------------|--|---------|--|--------|
| Ref. Cod | -544_21 | rameters | | (cm ² /Kg) M ⁴ x 10 ⁻² | - | I | I |
| ſ | SR | tion Pa | | (cm ² /Sec) C ^v x 10.4 | - | I | ı |
| L. | l.080 m | Consolida | | Pressure (kg/cm ²⁾ | ï | ı | 1 |
| R | (+)27 | | (⁰ | 9) oita Ratio (e | ı | ı | I |
| | ó m | Â | ;) ;) | Permeabi (cm/sec | ı | I | I |
| | 3047.11 | ente | (₇ 559 | mə\gailləw2 | ı | I | i |
| s (E,N) | 312 | хәр | uj | Free Swell (%) | | ı | |
| ordinate | n | th | (| Angle of [°q) noitoirA | - | I | ı |
| Co | 97786.377 n | hear Streng | | O noizəndO) (kg/cm ²) | I | I | I |
| | 9 | S | 1 | les of Test | ' | 1 | , |
| nination)epth | .00 m | ŢŢŢ | AB. | 1Ə əffiəqZ | ' | 1 | , |
| Terı D | 90 | (_e wə | / 3) | Dry Density | ' | I | ı |
| r Table | |) m.e | tsi %) | oM latural Mo) tnotno) | ı | I | I |
| of Wate | 33.00 m | (_ք աշ/ | 3) | Bulk Density | ı | I | ı |
| Depth | | 20 | | Shrinkage Jimit | ı | I | I |
| . No. | I-P2 | Limits 9 | | Plasticity Index | ı | ı | ı |
| B.H | BH | Atterberg | ļ | imi. Linia Limi | - | I | I |
| e ion | ge | V | 1 | imiJ biupiJ | - | T | ı |
| Chainag n.)/Locat | 27+620 ajor Brid | | avel | Coarse | ı | I | I |
| (kı | M | etained | Gr | əniA | ı | ı | ı |
| | 1-2021 | n % wt r | | Coarse | ı | I | ı |
| ring | 21-1 | tributio | Sand | muibəM | ı | I | I |
| te of Bo | to | Size Dis | | əniA | ' | ı | ı |
| $\mathbf{D}_{\mathbf{a}}$ | 1-2021 | Grain | | 1IIS | ' | ı | ı |
| | 18-1 | | | Clay | , | , | , , |
| esigning vital Rail | / to | | 100 | dmy2 2I | | | |
| report for d Iaryana Or t | connectivity | uoj | de. | IS Classific | ı | ı | , |
| investigation, preparation of geotechnical ament in connection with construction of 1 | from Palwal to Harsana Kalan including s state of Haryana. | | | Soil Description | | Brown, Hard, Silty clay of low plasticity with gravel | |
| technical or embank | C) project /ork in the | Te | (°N IS | Corrected Value (1 | 80 | 95 | ı |
| cting geot ges and fc | lor (HORC g IR netw | ənlaV | L | Opserved SP' (N) | 80 | 95 | - |
| Condu of brid | existing | (u) " | 1.4 | Depth from C | 8 58.00 | 9 59.50 | 60.00 |
| Ductor | aforta | ə | đ٨ | T əlqms2 | SPT-2 | SPT-2 | |





| | | | 1 | | | | | | | | | | | | | | | | | | | |
|--|---|--------------------|---|------|------------------------------------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|--|-------|-------|-------|-------|-------|-------|-------|
| е | -22 | | Compression Index (C _c) | | ı | ı | 1 | ı | | ' | ı. | 1 | | ī | ı | ı | , | ī | ī | ī | ı | ı |
| tef. Cod | -544_21 | ameters | (Sy/zmo) z-01 x M | | ı | ı | I | 1 | I | 1 | I | I | ı | I | I | I | I | I | I | I | I | I |
| R | SR | tion Par | (cm ² /Sec) C ^x x 10 ⁻⁴ | | ı | ı | ı | ı | ı | 1 | I | I | ı | I | I | I | I | I | I | ı | I | 1 |
| L. | | Consolida | (k&\cm ³⁾ Pressure | | | | | | | | | 1 | | 1 | | | | 1 | | | | ı |
| R. | · | Ŭ | (09) oitsA bioV | | T | - | T | I | I | ı | I | I | - | I | I | I | T | I | I | I | I | I |
| | 9 m | Â | Permeabilit, (cm/sec) | ı | ı | 1 | 1 | 1 | ı | , | ı | ı | 1 | I | ı | I | I | I | ı | I | ı | I |
| | 2989.11 | nıç | Swelling Press (kg/cm ²) | | | ı | - | , | | | | 1 | | 1 | I | I | I | 1 | I | I | 1 | , |
| s (E,N) | 312 | xəp | Free Swell Inc (%) | I | | ı | ı | | ı | | ı | I. | | I | I | I | T | I | I | I | I | I |
| ordinate | n | th | fo slgnA Friction (φ°) | ı | ı | 24 | I | s | ı | 1 | ı | i | I | 4 | I | 5 | i | I | i | I | I | 4 |
| C | 7785.825 1 | ear Streng | Cohesion C (kg/cm ²) | 1 | ' | 0.20 | ' | 1.36 | | | ' | 1 | | 1.59 | , | 2.02 | 1 | 1 | ı | ī | | 2.67 |
| | 69 | She | tsəT fo əqyT | ı | ı | DST | ı | UUT | , | , | ı | ı | ı | UUT | ı | UUT | I | T | ı | ī | ı | UUT |
| nation oth | 0 m | ţţ | vraD offic Grav | ı | ı | 2.66 | ı | 2.68 | ı | | I | I | | 2.67 | I | 2.67 | T | I | I | I | I | 2.68 |
| Termi Del | 40.0 | (_e wə | Dry Density (g/ | ı | ı | 1.54 | | 1.62 | ı | 1.62 | ı | 1.62 | | 1.63 | ı | 1.67 | ı | 1.67 | ı | 1.68 | ı | 1.69 |
| Table | |) nre | tsioM IsrutsN %) tnotnoD | I | T | 13.26 | I | 18.41 | I | 18.96 | - | 19.10 | T | 19.32 | - | 20.11 | T | 20.60 | - | 20.78 | - | 21.05 |
| f Water | 33.12 m | (_ք աշ, | g) yiiznəU Aluß | | ı | 1.74 | - | 1.92 | ı | 1.93 | ı | 1.93 | - | 1.94 | ı | 2.01 | I. | 2.01 | ı | 2.03 | ı | 2.05 |
| Depth o | | 2 | Shrinkage Limit | I | ı | 1 | I | | ı | | I | I | 1 | I | I | I | I | I | I | I | I | I |
| No. | -A2 | Limits 9 | Plasticity Index | ı | ı. | 7 | | 11 | | 11 | , | 10 | | 11 | | 11 | i. | 11 | , | 10 | 1 | 11 |
| B.H. | BH | Atterberg | Plastic Limit | I | ı | 21 | - | 21 | ı | 22 | ı | 20 | ı | 20 | ı | 23 | T | 22 | ī | 20 | I | 22 |
| e ion | ge | 1 | timi.I biupi.I | I | 1 | 28 | - | 32 | ı | 33 | I | 30 | - | 31 | I | 34 | I | 33 | I | 30 | I | 33 |
| Chainag n.)/Locat | 27+620 ajor Brid | | Coarse | ı | ı | 0 | - | 0 | I | 0 | I | 0 | - | 0 | I | 0 | i | 0 | i | 0 | I | 0 |
| (kr | M | etained | 9niA | I | ı | 0 | ı | 4 | ı | 5 | I | 5 | ı | 9 | I | 8 | I | 9 | I | ٢ | I | 9 |
| | 1-2021 | 1 % wt r | Coarse | I | 1 | 0 | - | - | ı | 2 | ı | 0 | | 3 | ı | 2 | T | 1 | ı | 1 | ı | 0 |
| ring | 19-1 | stributio | S Medium S M | I | ı | 7 | ı | 12 | ı | 9 | I | 8 | 1 | 5 | I | 4 | I | 7 | I | 9 | I | ∞ |
| ate of Bo | to | Size Di | əniA | ı | 1 | 32 | ' | 26 | | 25 | 1 | 27 | ' | 30 | 1 | 28 | ı | 27 | ı | 33 | 1 | 28 |
| Dî | 1-2021 | Grain | ilis | ı | I | 52 | I | 46 | ı | 50 | I | 50 | ı | 45 | I | 45 | T | 47 | I | 43 | I | 47 |
| | 18-1 | | Clay | ı | ı | 6 | | 11 | ı | 12 | ı | 10 | | 11 | ı | 13 | ı | 12 | ı | 10 | ı | 11 |
| signing of Rail | o existing | | lodmy2 2I | | | | | | | | | | | | | | | | | | | |
| report for de yana Orbital | connectivity 1 | uo | IS Classificati | | | ML-CL | | CL | | CL | ı | CL | ı | CL | 1 | CL | ı | CL | ı | CL | | CL |
| nvestigation, preparation of geotechnical antin connection with construction of Ha | rom Palwal to Harsana Kalan including (Haryana. | | Soil Description | | Brown, Medium dense, Sandy silt of | low plasticity | | | | | | | | | Brown, Hard, Silty clay of low plasticity with gravel | | | | | | | |
| echnical i mbankme | () project e state of | Te | Corrected SI Value (N.) | ı | 19 | ı | 19 | | 38 | ı | 43 | ı | 40 | T | 48 | ı | 82 | T | 63 | ī | 56 | ' |
| ting geote and for er | ər (HORC ⁄ork in thε | ənleV | (N) Opserved SPT V | 1 | 12 | , | 17 | 1 | 38 | , | 43 | - | 40 | - | 48 | 1 | 82 | - | 63 | - | 56 | ' |
| Conduc bridges | Corridc IR netw | (ɯ) " | J.Ə morî diqəD | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 |
| Droiord | and an a | Э | qvT əlqms2 | DS | SPT-1 | UDS-1 | SPT-2 | UDS-2 | SPT-3 | UDS-3 | SPT-4 | UDS-4 | SPT-5 | UDS-5 | SPT-6 | 0DS-6 | 2-T-T | UDS-7 | SPT-8 | UDS-8 | 6-TqS | 0-SQU |



| | 52 | | ι | Compression (₅) xəbnl | | | | | | | - | | - |
|------------------------------|---------------------------|-------------------|--------------------------------|---|--------|--------|-----------------|-----------------|---------------------------|-----------------|--------|--------|--------|
| ef. Code | 544_21- | meters | - | (cm ² /Kg) | | , | , | , | | | | | ı |
| R | SR- | on Para | | (con ² /2,mo) | | | | | | | | | ı |
| | | nsolidati | - | (kg/cm ²⁾ | , | , | , | , | | | | , | ı |
| R.L. | | Co | (0 | 9) oits Ratio (e | | | | | | | | | |
| | | |) ;) | oəs/mo) | 1 | 1 | 1 | 1 | 1 | 1 | ı | 1 | I |
| | 89.119 n | T TLG | ++!! (₂ 552 | ^m 2%2%2%2%2%2%2%2%2%2%2%2%2%2%2%2%2%2%2% | 1 | , | 1 | 1 | 1 | 1 | ı | 1 | ı |
| (E,N) | 31229 | xə | puj | (%) (%) | , | | 1 | ı | | | ı | , | I |
| dinates | | | | Angle of (°q) noticitation (q°) | 1 | 4 | ı | ı | 1 | 1 | ı | 1 | I |
| Cor | 5.825 m | Strength | - | (_z ɯə/ฮิมุ) ว นอเรอนอว | 1 | 3.17 | 1 | 1 | | | ı | 1 | I |
| | 69778 | Shear | | les T to sqvT | | UT | | - | | | - | | |
| = | | 60 | | | | 57 U | | | | | | | |
| rminatio Depth | 40.00 m | VÌ | <u>д</u> в. | a£) aftingar2 | |) 2.6 | | | | | | | |
| Tei | 4 | (_e ua |) /8) | Dry Density (| ' |) 1.7(| 1 | ı | 1 | 1 | 1 | 1 | 1 |
| er Table | н |) TLG | usi | oM letuteN) tnotnoO | ' | 20.60 | ' | ' | ' | ' | ' | ' | 1 |
| ı of Wat | 33.12 1 | (_ք աշ | /ð) | Bulk Density | ' | 2.05 | 1 | ı | ' | ' | ı | ' | I |
| Dept | | % | | Shrinkage Limit | ' | ' | ı | ı | 1 | ı | ï | , | I |
| . No. | -A2 | t Limits | | Plasticity Index | , | 11 | ı | ı | 11 | ı | 10 | , | I |
| B.H | ВН | Atterberg | 1 | limi.I siterla | ı | 23 | ı | - | 22 | ı | 21 | ı | I |
| e ion | ge | V | 1 | imiJ biupiJ | | 34 | , | - | 33 | ı. | 31 | , | I. |
| Chainag n.)/Locat | 27+620 ajor Brid | | avel | Coarse | ı | 0 | ı | ı | 0 | ı | 0 | ı | I |
| (kn | W | etained | 6r | əniA | ı | 10 | ı | - | 6 | ı | 8 | ı | I |
| | -2021 | % wt r | | Coarse | ı | 1 | ı | - | 0 | ı | 2 | ı | I |
| ing | 19-11 | ribution | Sand | muibəM | | L | | - | 11 | i. | 6 | , | 1 |
| e of Bor | to | Size Dist | | aniA | | 23 | | | 25 | | 26 | | - |
| Dat | -2021 | Grain 9 | | 1IIS | ı | 46 | ı | ı | 43 | ı | 44 | ı | I |
| | 18-11 | | | VrIJ | 1 | 13 | ı | ı | 12 | | 11 | ' | I |
| igning of Aail | existing | | 10 | dmy2 21 | | | | | | | | | |
| ort for desi 1a Orbital I | nectivity to | uo | ite | IS Classific | , | C | | 1 | C | | CL | | ı |
| hnical rep of Haryar | uding com | | | | | | | | w | | | | |
| n of geotec onstruction | Kalan inclu | | | iption | | | | | y clay of lo h gravel | | | | |
| preparatic tion with c | to Harsana | | | oil Descr | | | | | Hard, Silt sticity wit | | | | |
| stigation, in connect | m Palwal t 'yana. | | | и́х | | | | | Brown, pla: | | | | |
| unical inve ankment i | roject froi ate of Har | T | (°) dS | Corrected Value (V | 86 | | 100 [25cm] | 100 [22cm] | 100 (20cm) | 100 [22cm] | 79 | 88 | 86 |
| ig geotech d for emb | HORC) p k in the st | aula | ر د ۱ | Observed SP1 (N) | 86 | ' | 100 (25cm) (| 100 (22cm) (| 100 (20cm) (| 100 (22cm) (| 62 | 88 | 86 |
| Conductin ridges and | Corridor (. R networl | (ɯ) • | T. | Depth from C | 28.00 | 29.50 | 31.00 | 32.50 | 34.00 | 35.50 | 37.00 | 38.50 | 40.00 |
| | roject | a | ٨b | T əlqms2 | SPT-10 | JDS-10 | SPT-11 | SPT-12 | SPT-13 | SPT-14 | SPT-15 | SPT-16 | SPT-17 |





| de | 1-22 | SJ | Compression Index (C _c) | ı | ı | | | | 1 | ı | ı | | ı | | ı | ı | ı | | | ı | ı | ı | ı |
|--|---|--------------------|--|------|------|-------|------|-------------------------------|--|--------|-------|---------|-------|---------|--------------------------------|------------------------|-------|---------|-------|----------------------------------|----------------------------|---------|---------------|
| Ref. Co | 8-544_2 | rametei | (cm ² /Kg) M ^a x 10. ² | ı | ı | ' | ' | | | ı | ı | ı | ı | ı | ı | ı | ı. | ı | ' | ı | ı | ı | ı |
| | IS | tion Pa | (cm ⁵ /Sec) C ^a x 10.4 | I | ı | - | , | - | | I | ī | ı | - | - | I | I | I | ı | I | | ı. | I | I. |
| .L. |).806 m | Consolida | Pressure Pressure | | ı | 1 | , | | 1 | ı | ı | | 1 | 1 | ı | ı | ı | | , | 1 | ı | ı | I |
| Я | (+)26 | | Void Ratio (e_) | ı | | ı | ı | i. | ı | ı | ı | | ı | ı | I | I | ı | | ï | ı | I | I | i. |
| | ó m | Â | Permeability (cm/sec) | ı | | ı | | 1 | ı | ı | ı | | ı | ı | - | - | ī | | ' | ı | - | ı | ı. |
| | 3086.720 | nıç | Swelling Press (kg/cm ²) | ı | | ı | | 1 | ı | ı | ı | | ı | ı | - | - | ī | | ' | ı | - | ı | ı. |
| s (E,N) | 3120 | xəp | Free Swell Inc (%) | ı | | ī | | , | ı | ı | ı | | ī | ī | I | I | ı | | | ī | I | I. | I. |
| ordinate | n | th | Angle of Friction (\$^0) | I | I | 27 | I | T | 1 | ı | ı | ı | I | 5 | I | 5 | I | 28 | I | I | I | 30 | I |
| ŭ | 7330.702 I | ar Streng | Cohesion C (kg/cm ²) | | I | 0.22 | ı | ı. | ı | ı | ı | | ı | 1.39 | ı | 1.59 | ı | 0.21 | , | ' | ı | 0.18 | 1 |
| | 69 | She | ts9T to 9qvT | | ı | DST | | - | | ı | ı | | - | TUU | ı | UUT | | DST | | - | ı | DST | T |
| nation oth | 0 m | ţţ | vrað sífis Grav | | ı | 2.66 | | | | | | | ı | 2.67 | | 2.68 | | 2.66 | | ı | ı | 2.66 | I |
| Termi Del | 55.0 | (₂ mə | Dry Density (g/ | | ı | 1.60 | , | 1.59 | 1 | 1.58 | ı | 1.58 | ı | 1.63 | ı | 1.63 | ı | 1.62 | | 1.61 | ı | 1.62 | I |
| . Table | |) nre | tsioM Istural (%) tnətnoD | I | I | 12.17 | ı | 12.80 | | 13.24 | ı | 13.76 | I | 15.06 | I | 15.29 | ı | 16.23 | ı | 16.89 | I | 17.10 | I |
| of Wateı | 32.67 m | (_e wə, | Bulk Density (g/ | ı | I | 1.79 | ' | 1.79 | ı | 1.79 | ı | 1.80 | - | 1.88 | - | 1.88 | ı | 1.88 | ' | 1.88 | - | 1.90 | ı. |
| Depth e | | 9 | Shrinkage Limit | ı | I | - | ' | - | ı | ı | ı | | ı | ı | ı | ı | I | | ' | ı | ı | ı | ı |
| . No. | -A1 | Limits 9 | Plasticity Index | ı | I | L | , | L | 1 | 9 | ı | 7 | ı | 11 | ı | 11 | ı | 7 | , | 9 | I | ٢ | I |
| B.H | ВН | Atterberg | Plastic Limit | I | I | 20 | ı | 21 | ı | 20 | I | 19 | T | 20 | I | 22 | ı | 21 | ı | 20 | I | 20 | 1 |
| e tion | lge | V | timi.I biupi.I | I | I | 27 | , | 28 | 1 | 26 | ı | 26 | I | 31 | I | 33 | I | 28 | , | 26 | I | 27 | 1 |
| Chainag m.)/Loca | 28+075 Íajor Bric | | Coarse | | ı | 0 | ' | 0 | | 0 | ı | 0 | ı | 0 | ı | 0 | ī | 5 | ' | 1 | ı | 0 | |
| (k | N | etained | Pine Q | I | I | 2 | ı | С | ı | 4 | ı | Ś | I | 5 | I | ٢ | ı | Ś | ı | L | I | 10 | 1 |
| | 0-2021 | n % wt r | Coarse | | ı | 5 | ' | 2 | | m | | 4 | I | 4 | I | 3 | I | m | ' | 4 | I | 3 | 1 |
| oring | 18-1 | stributio | Sand Medium | , | 1 | 12 | ' | 3 | , | 13 | | 6 | ı | 11 | ı | 4 | ī | 4 | ' | 6 | ı | 5 | 1 |
| te of Bc | to | Size Di | əniA | 1 | ı | 26 | ' | 31 | 1 | 23 | ı | 26 | ı | 16 | ı | 18 | ı | 27 | ' | 25 | ı | 30 | I |
| D | -2021 | Grain | IIIS | ı | , | 48 | , | 53 | ı | 51 | ı | 49 | ı | 54 | I | 56 | ı | 51 | ' | 48 | I | 45 | 1 |
| | 16-1(| | Clay | ı | ı | L | ' | 8 | ı | 9 | ı | ٢ | ı | 10 | ı | 12 | | ∞ | ' | 9 | ı | 7 | 1 |
| signing tal Rail | 0 | | lodmy2 21 | | | | | | | | | | | | | | | | | | | | |
| report for des Iaryana Orbi | onnectivity t | uo | IS Classificati | ı | | ML-CL | , | ML-CL | | ML-CL | | ML-CL | , | CL | | CL | , | ML-CL | , | ML-CL | ' | ML-CL | ı |
| nvestigation, preparation of geotechnical ment in connection with construction of | from Palwal to Harsana Kalan including e state of Haryana. | | Soil Description | | I | | L | Brown, Medium dense to dense, | Sandy sut or low plasticity with gravel | I | | I | | | Brown, Hard, Silty clay of low | plasticity with gravel | | | L | Brown, Very dense, Sandy silt of | low plasticity with gravel | | |
| echnical i vr embank | () project ork in the | L | AS betrected SP Value (N,) | | 30 | 1 | 29 | 1 | 27 | | 23 | | 22 | 1 | 42 | ı | 48 | | 36 | 1 | 37 | I | 1 |
| cting geot ges and fc | or (HORC g IR netw | ənleV | Observed SPT V (N) | | 19 | ı | 26 | ı | 29 | | 29 | - | 31 | - | 42 | - | 48 | - | - 68 | - | 75 | - | 100 (20cm) |
| Conduc of bridg | Corride existing | (w) " | J.Ə morî diqəU | 0.00 | 1.00 | 2.50 | 4.00 | 2 5.50 | 7.00 | 3 8.50 | 10.00 | t 11.50 | 13.00 | 5 14.50 | 16.00 | 5 17.50 | 19.00 | 7 20.50 | 22.00 | 3 23.50 | 25.00 |) 26.50 | 9 28.00 |
| | njer | ə | qvT slqms2 | DS | PT-1 | DS-1 | PT-2 | JDS-2 | SPT-3 | JDS-3 | SPT-4 | JDS-4 | 3PT-5 | JDS-5 | SPT-6 | JDS-6 | PT-7 | 7-SQ(| SPT-8 | 3-SQ(| 9-T4 | 3-SQ1 | PT-1(|



| | | | Index (C _c) | | | | | | | | | | | | | | | | | | 1 |
|---|---|--------------------|---|----------|----------------|----------|----------|----------|----------|----------|----------------|----------------------------------|----------------------------|----------------|----------------|----------------|----------|----------------|----------------|----------------|----------------|
| . Code | 4_21-22 | neters | (cm ² /Kg) | | | - | - | | - | - | | - | | | | - | - | 1 | - | - | |
| Ref | SR-54 | n Paran | 01 X M (39S/zw3) | | | | | | | | | | | | | | | | | | |
| | в | olidation | C ^A X 10.4 (K8/cm ₅₎ | | | | | | | | | | | | | | | | | | |
| R.L. | 269.806 | Cons | Pressure | ' | ' | | | | | 1 | ' | | | | | ' | | | 1 | | ' |
| | (+) | | Void Ratio (e ₀) | 1 | 1 | ı | ı | 1 | 1 | ı | ' | 1 | 1 | 1 | 1 | ı | 1 | i | ı | 1 | ı |
| | 726 m | Â | Termeabilit | ' | ' | ' | ' | 1 | ' | 1 | ' | ' | ' | ' | ' | ' | ' | ı | 1 | ' | 1 |
| e | 123086.7 | ente | Swelling Press | ' | ' | ' | ' | 1 | ' | 1 | ' | ' | ' | ' | ' | ' | ' | ı | 1 | ' | 1 |
| ttes (E,N | 3] | хәр | Free Swell Ind | 1 | ı | ı | ı | ı | 1 | ı | ' | I | ı | ı | I | ı | I | I | ı | 1 | ' |
| Cordina | 2 m | ngth | fo signA (°e) noitsirA | ' | ' | 1 | ' | 1 | 1 | ı | ' | 1 | 1 | 1 | ı | ı | 1 | I | ı | 1 | 1 |
| - | 697330.70 | Shear Stre |) noisəho Cohesion C | , | | 1 | 1 | , | 1 | I | ' | 1 | 1 | 1 | 1 | | 1 | I | I | | ' |
| | | •1 | ts9T to 9qvT | 1 | 1 | 1 | ' | ' | ' | ı | ' | 1 | ' | ' | 1 | 1 | 1 | I | ı | ' | ' |
| ination pth | 00 m | ŢţŢ. | vrað sifisga | , | ' | | ' | | | | ' | | | | ' | ' | | ı | | | ı |
| Term De | 55. | (_e wə | Dry Density (g/ | 1 | ı | ı | ı | ī | ī | ı | ı | ı | , | , | ı | ı | ı | I | ı | ī | 1 |
| Table | |) nre | tsioM IsrutsV %) tn9tn0J | | 1 | ı | ı | ı | 1 | I. | 1 | ı | i | i | ı | 1 | ı | ı | I. | 1 | ı |
| of Water | 32.67 m | (_e ɯə/ | Bulk Density (g | | 1 | ı | ı | ı | 1 | I. | 1 | ı | i | i | ı | 1 | ı | ı | I. | 1 | ı |
| Depth o | | 0 | Shrinkage Limit | ı | ı | ı | 1 | ı | 1 | ı | 1 | ı | ı | ı | ı | ı | ı | I | ı | - | ı |
| No. | ١٢ | Limits % | Plasticity Index | 7 | ı | 9 | - | 7 | - | 7 | ı | 9 | ı | 7 | ı | L | - | 9 | - | L | 1 |
| В.Н. | BH- | terberg] | Plastic Limit | 21 | ı | 21 | 1 | 20 | 1 | 19 | 1 | 20 | 1 | 21 | ı | 20 | 1 | 20 | ı | 20 | , |
| u | e | At | timiJ biupiJ | 28 | | 27 | | 27 | | 26 | | 26 | | 28 | | 27 | | 26 | | 27 | |
| hainage .)/Locati | 28+075 jor Bridg | | Coarse | 0 | | 0 | ı | 0 | ı | 1 | | 0 | ı | 0 | ı | 1 | ı | 0 | ı | 0 | ı |
| C (km | Ma | tained | Rine G | 13 | | 5 | | 7 | | 8 | | 10 | | 12 | | 8 | | 11 | ı | 12 | , |
| | 2021 | % wt re | Coarse | ŝ | ı | 2 | ı | ŝ | ı | 2 | 1 | 1 | ı | 1 | ı | 2 | ı | 0 | ı | 1 | , |
| ng | 18-10- | ribution | Medium Sand | 10 | | 9 | - | 8 | - | 3 | | 6 | | 2 | | 3 | - | 1 | - | 3 | |
| e of Bor | to | Size Dist | əniA | 22 | 1 | 33 | 1 | 26 | | 30 | 1 | 25 | ı | 29 | ı | 30 | 1 | 27 | | 30 | ı |
| Dat | -2021 | Grain 9 | IIIS | 4 | | 48 | · | 49 | ı | 49 | 1 | 49 | ı | 48 | ı | 49 | T | 55 | I | 47 | ı |
| | 16-10 | | Clay | 8 | | 9 | | 7 | | 7 | | 9 | | 8 | | 7 | | 6 | | 7 | ı |
| signing tal Rail | 0 | | lodmy2 21 | | | | | | | | | | | | | | | | | | |
| l report for de Haryana Orbi | connectivity t | uoj | IS Classificati | ML-CL | ı | ML-CL | 1 | ML-CL | ı | ML-CL | ı | ML-CL | ı | ML-CL | ı | ML-CL | ı | ML-CL | ı | ML-CL | ı |
| nvestigation, preparation of geotechnica ment in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | | | | | | | Brown, Very dense, Sandy silt of | low plasticity with gravel | | | | | | | | |
| stechnical or embanl | C) project vork in the | Te | Corrected St Value (N _e) | 37 | - | 35 | 28 | 25 | 27 | 27 | - | 28 | - | - | - | - (; | - | - (1 | - | - (; | - |
| acting gec lges and f | dor (HOR 1g IR netv | ənlaV | (N) Opserved SPT V | 0 80 | 0 100 (25cm | 0 77 | 0 89 | 0 78 | 0 85 | 0 85 | 0 100 (19cm | 0 88 | 0 100 (27cm | 0 100 (25cm | 0 100 (28cm | 0 100 (23cm | 0 >100 | 0 100 (28cm | 0 100 (22cm | 0 100 (23cm | 0 100 (22cm |
| Condu | existir existir | (u) " | J.Ə morî diqaG | 11 29.50 | 12 31.00 | 13 32.50 | 14 34.00 | 15 35.50 | 16 37.00 | 17 38.50 | 18 40.00 | 19 41.50 | 20 43.00 | 21 44.50 | 22 46.00 | 23 47.50 | 24 49.00 | 25 50.50 | 26 52.00 | 27 53.50 | 28 55.00 |
| to to | l n | Ð | qvT əlqms2 | SPT-1 | SPT-] | SPT-1 | SPT-1 | SPT-] | SPT-] | SPT-1 | SPT-] | SPT-1 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 |



| a | 22 | | Compression Index (C _c) | ı | I | ı | | ı | 0.126 | I | ı | | | | ı | | ı | | ı | ı | I | 1 |
|--|---|--------------------|---|------|---------------------------|------|----------------------------|-----------------------|---|------|---------|-------------------------------|------------------|---------|---------|---------|---------|---------|--------------------------|--------------------------|---------|-------|
| Ref. Cod | -544_21 | rameters | (cm ² /Kg) M _v x 10. ² | | ı | | | | 2.02 1.44 0.97 0.59 | ı | ı | | | | | | | | | ı | ı | ' |
| 4 | SR | tion Par | (cm ² /Sec) C [^] x 10.4 | ı | 1 | | | ı | 7.05 6.30 5.15 4.23 | I | I | ı | ı | ı. | ı | ı | | ı. | 1 | ı. | ī | |
| L. | .070 m | Consolida | Pressure Pressure | - | ı | | | 1 | $\begin{array}{c} 0.5 - 1.0 \\ 1.0 - 2.0 \\ 2.0 - 4.0 \\ 4.0 - 8.0 \end{array}$ | ı | - | - | , | 1 | , | - | | 1 | | - | - | |
| R | (+)270 | • | Void Ratio (e ₀) | | ı | ı | | | 0.705 | ı | ı | | | | | | | | - | | ī | |
| | 26 m | Â | Permeabilit (cm/sec) | ı | | | , | 1 | 1 | ı | ı | ı | 1 | 1 | 1 | ı | ' | 1 | , | ı | ı | , |
| _ | 23064.72 | ane | Swelling Press (kg/cm ²) | ı | ' | ı | · | ï | 1 | I | ı | ı | ı | ï | ı | ı | ı | ï | ' | ı | ı | ' |
| es (E,N) | 31: | хәр | Free Swell Ind (%) | ı | ı | ı | ' | 1 | | I | I | 1 | ' | ' | ı | ' | ı | ' | 1 | I | I | , |
| ordinat | в | gth | fo slgnA (°φ) noticity | ı | 30 | , | 26 | ı | 5 | I | 4 | ı | , | 1 | s | ı | 27 | 1 | | I | 29 | , |
| C | 97330.717 | ear Strenș | Cohesion C (kg/cm ²) | ' | 0.00 | | 0.22 | ' | 0.82 | I | 0.70 | ' | ' | ' | 1.26 | ' | 0.21 | ' | ' | ı | 0.22 | , |
| | 69 | Sh | Type of Test | ı. | DST | | DST | | UUT | ı | UUT | ı. | | | UUT | | DST | | i. | ī | DST | |
| nation pth | 00 m | ŢţŢ | verð sífisøq8 | - | 2.62 | ı | 2.66 | | 2.68 | ı | 2.67 | - | | | 2.68 | - | 2.66 | | | T | 2.66 | |
| Termi De | 55.(| (_e mə) | Dry Density (g/ | ı. | 1.60 | | 1.63 | | 1.57 | ı | 1.55 | ı. | 1.55 | | 1.61 | , | 1.60 | | 1.61 | ī | 1.61 | |
| Table | |) nre | tsioM IsrutsN %) tnotnoD | ı | 10.34 | ı | 12.19 | ı | 14.30 | I | 15.24 | | 15.90 | 1 | 16.43 | | 15.10 | 1 | 15.76 | ı | 16.43 | 1 |
| f Water | 32.68 m | (_e wə/ | Bulk Density (g | - | 1.77 | ı | 1.83 | I | 1.79 | I | 1.79 | - | 1.80 | ı | 1.87 | - | 1.84 | ı | 1.86 | - | 1.87 | |
| Depth o | <i>a</i> , | é | Shrinkage Limit | - | | | ı | ı | 1 | ı | ı | | , | ı | , | | | ı | 1 | ı | ı | |
| No. | P1 | Limits 9 | Plasticity Index | ı | ďN | ı | ٢ | ı | 11 | I | 11 | ı | 11 | ı | 11 | | 9 | ı | 7 | ī | Ζ | |
| В.Н. | BH- | tterberg] | Plastic Limit | | Nil | | 21 | | 22 | 1 | 20 | | 23 | | 21 | | 20 | | 21 | | 20 | ' |
| uo | še | Α | timiJ biupiJ | ı | i | ı | 28 | ı | 33 | i | 31 | ı | 34 | ı | 32 | ı | 26 | ı | 28 | i | 27 | , |
| Jhainage 1.)/Locati | 28+075 ijor Bridş | | Coarse | 1 | 0 | ı | 0 | ı | -1 | I | 0 | | 1 | ı | 0 | - | 1 | ı | 0 | I. | 2 | |
| (km | Má | etained | P B B B B B B B B B B B B B B B B B B B | ı | ю | I | 4 | I | c, | I | 3 | | 2 | ı | 5 | | 7 | ı | 6 | T | 5 | 1 |
| | -2021 | % wt re | Coarse | - | 1 | ı | 3 | | 3 | ı | 5 | - | 4 | | 1 | - | 4 | | 2 | T | 4 | |
| ing | 15-10 | ribution | Sand Maina Maina Maina Maina Maina Main | | 5 | | 9 | | 4 | ı | 2 | | 5 | | 4 | | 9 | | 3 | ı. | 5 | |
| e of Bor | to | Size Dist | Aine | - | 69 | ı | 32 | | 20 | - | 23 | - | 23 | | 21 | - | 28 | | 30 | | 29 | |
| Dat | 2021 | Grain 9 | IIIS | ı | 25 | I | 48 | ı | 57 | I | 57 | ı | 53 | ı | 58 | 1 | 48 | ı | 51 | I | 48 | |
| | 11-10 | | Clay | - | 0 | ı | 7 | | 12 | ı | 10 | - | 12 | | 11 | - | 9 | | 8 | I. | 7 | |
| igning al Rail | 0 | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| eport for des laryana Orbit | onnectivity to | uoi | IS Classificati | 1 | SM | 1 | ML-CL | 1 | CL | 1 | CL | 1 | CL | , | CL | , | ML-CL | 1 | ML-CL | 1 | ML-CL | ı |
| otechnical r ruction of H | including co | | | | y sand | | of low | | | | | lty clay | | | | | | | silt of | el | | |
| nvestigation, preparation of ge ment in connection with const | from Palwal to Harsana Kalan state of Haryana. | | Soil Description | | Brown, Medium dense, Silt | | Brown, Dense, Sandy silt o | plasticity with grave | | | | Brown, Very stiff to hard, S. | UI IUW PIABULULY | | | | | | Brown, Very dense, Sandy | low plasticity with grav | | |
| echnical i vr embank | () project ork in the | Tq | Corrected SI Value (N _c) | ı | ı | 31 | 1 | 44 | 1 | 24 | ı | 21 | 1 | 19 | 1 | 37 | | 31 | 1 | 34 | ı | 31 |
| cting geot ges and fo | or (HORC g IR netw | ənlaV | (N) Opserved SPT V | ı | i | 24 | , | 4 | | 24 | 1 | 21 | | 19 | | 37 | | 55 | | 99 | | 99 |
| Conduc of bridg | Corride existing | (w) " | I.Ə morî diqed | 0.00 | 1 1.00 | 2.50 | 2 4.00 | 5.50 | 3 7.00 | 8.50 | 4 10.00 | 11.50 | 5 13.00 | ; 14.50 | 5 16.00 | ; 17.50 | 7 19.00 | , 20.50 | 3 22.00 | 3 23.50 |) 25.00 | 26.50 |
| | 5 | 2 | ample typ | SC | DS-1 | T-1 | DS-2 | PT-2 | DS-3 | PT-3 | DS-4 | PT-4 | DS-5 | PT-5 | DS-6 | PT-6 | DS-7 | PT-7 | 3-SQ | PT-8 | 5-SQ | PT-9 |



| е | -22 | | Compression Index (C _c) | ı | ı | T | | | ı | ı | T | T. | I. | i. | | ı | T. | ı | T | I. | ī | |
|--|---|--------------------|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|--------|--------|--------|--------|---------------|---------------|---------------|---------------|---------------|
| tef. Cod | -544_21 | ameters | (cm ² /Kg) M _v x 10 ⁻² | I | I | I | ı | ı | I | ı | I | I | I | I | ı | ı | I | I | I | I | I | , |
| R | SR | tion Par | (cm ² /Sec) C ^x x 10.4 | ı | 1 | ı | | | ı | 1 | ı | T | 1 | i. | | | T | ı | ı | ı | ı | , |
| .Т. | .070 m | Consolida | Pressure Pressure | - | ı | ı | - | | - | - | I | I | I | I | - | - | I | I | ı | I | I | I |
| R | (+)27(| | Void Ratio (e ₀) | ı | ı | ı | | | ı. | | ı | ı. | i. | , | | | ı. | ı | ı | , | ï | |
| | 6 m | Â | Permeabilit) (cm/sec) | I | ı | I | - | | I | T | I | T | T | I. | - | ı | T | I | I | ī | ī | , |
| | 3064.72 | nıç | Swelling Press (kg/cm ²) | I | I | I | ı | ' | I | ı | I | I | I | I. | | ı | I | I | ı | I | I | ı |
| es (E,N) | 312 | xəp | Free Swell Inc (%) | ı | ı | ı | 1 | | ı | ı | ı | I. | ı. | 1 | 1 | ı | I. | ı | ı | 1 | ī | , |
| ordinate | n | th | Angle of Friction (φ°) | | , | | | | | | | | ı | I | ı | | | ı | | ı | I | ı |
| CC | 7330.717 1 | ar Streng | Cohesion C (kg/cm ²) | ı | ı | ı | | | ı | | I | I | ı | T | - | 1 | I | I | ı | 1 | I | ı |
| | 69 | She | ts9T to 9qYT | | | | | | | | | T | 1 | ī | - | | T | ı | | T | ı | ı |
| ination spth | 00 m | ţţ | vrað sifis Grav | ı | ı | ı | | , | ı | ı | ı | I | I | ı | 1 | , | I | I | ı | I | ı | ı |
| Term De | 55. | (_e wə | Dry Density (g/ | ' | ' | | ' | | | ' | | 1 | 1 | 1 | ' | ' | 1 | ı | | 1 | ı | 1 |
| r Table | |) nıç | tsioM IsrutsN %) tnstnoD | ı | ı | I | ı | ' | ı | ı | I | I | ı | ī | ' | ı | I | ı | I | ı | ı | 1 |
| of Wate | 32.68 m | (_e wə/ | Bulk Density (g | ı | | I | ı | | | ı | ı | 1 | | I | ı | | 1 | I | I | I | I | i. |
| Depth | | % | Shrinkage Limit | I | I | I | ı | ı | I | ı | I | I | I | I | ' | ı | I | I | I | I | I | I |
| . No. | [-P1 | Limits | Plasticity Index | 7 | I | 7 | ı | 7 | I | 7 | I | 9 | I | L | ı | 7 | I | 9 | I | L | I | ı |
| B.H | BH | Atterberg | Plastic Limit | 19 | I | 21 | ı | 19 | I | 20 | I | 20 | I | 19 | ı | 21 | I | 20 | I | 20 | I | ı |
| ge ítion | dge | V | timiJ biupiJ | 26 | ı | 28 | ı | 26 | ı | 27 | ı | 26 | ı | 26 | ' | 28 | ı | 26 | ı | 27 | ı | ı |
| Chainag m.)/Loca | 28+075 Major Brio | | Coarse | 1 | ı | 0 | ı | - | I | 2 | ı | 0 | I | 0 | 1 | 1 | I | 0 | ı | 2 | ı | , |
| (k | N | retained | Deni Deni Deni Deni Deni Deni Deni Deni | 7 | ı | 9 | ı | 6 | ı | 7 | ı | 11 | I | 6 | ı | 8 | I | ٢ | ı | 8 | I | , |
| | 10-2021 | on % wt | Coarse | 2 | I | 3 | ı | S | I | 2 | I | 3 | I | 5 | 1 | 5 | I | 2 | I | 3 | I | ' |
| oring | 15-1 | istributic | S muibəM | 3 | 1 | 2 | | ю | ı | 3 | ı | 3 | 1 | 5 | ' | 4 | T | 9 | ı | 7 | ı | 1 |
| ate of B | to | n Size Di | Fine | 27 | 1 | 30 | ' | 25 | 1 | 27 | 1 | 25 | 1 | 28 | ' | 26 | 1 | 26 | ı | 27 | ī | 1 |
| D | 0-2021 | Grai | IIIS | 54 | 1 | 52 | ı | 50 | ı | 51 | I | 51 | 1 | 49 | ' | 48 | 1 | 53 | ı | 46 | ı | 1 |
| | 11-1 | | Clay | 9 | , | 7 | - | 7 | - | 8 | - | 7 | - | 7 | - | 8 | - | 9 | - | 7 | | |
| ssigning ital Rail | to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| l report for de Haryana Orb | connectivity | uoj | IS Classificati | ML-CL | ı | ML-CL | ı | ML-CL | ı | ML-CL | ı | ML-CL | I | ML-CL | 1 | ML-CL | ı | ML-CL | ı | ML-CL | I | ı |
| eotechnical truction of] | including o | | | | | | | | | | | | / silt of .vel | | | | | | | | | |
| investigation, preparation of g kment in connection with cons | from Palwal to Harsana Kalan e state of Haryana. | | Soil Description | | | | | | | | | | Brown, Very dense, Sand low plasticity with gra | | | | | | | | | |
| technical or embanl | project ork in th | Te | IS betzected SI Value (N _e) | 33 | 37 | 42 | 45 | 28 | 25 | 27 | 27 | 29 | 28 | 26 | 24 | 26 | 26 | - | - | - | | - |
| ting geot es and fc | or (HORC ; IR netw | 9ulsV | V) VD3served SPT (N) | 71 | 80 | 92 | 76 | 06 | 77 | 83 | 83 | 92 | 06 | 82 | 70 | 80 | 82 | 100 (25cm) | 100 (22cm) | 100 (20cm) | 100 (23cm) | 100 (18cm) |
| Conduc of bridg | Lorridc existing | (w) " | J.Ə morî diqe | 28.00 | 29.50 | 31.00 | 32.50 | 34.00 | 35.50 | 37.00 | 38.50 | 40.00 | 41.50 | 43.00 | 44.50 | 46.00 | 47.50 | 49.00 | 50.50 | 52.00 | 53.50 | 55.00 |
| Diction | LIUJEC | Э | qvT əlqms2 | SPT-10 | SPT-11 | SPT-12 | SPT-13 | SPT-14 | SPT-15 | SPT-16 | SPT-17 | SPT-18 | SPT-19 | SPT-20 | SPT-21 | SPT-22 | SPT-23 | SPT-24 | SPT-25 | SPT-26 | SPT-27 | SPT-28 |



| | | | (_o O) xəbnl | | | | | | | | | | | | | | | | | | | _ |
|--|---|--------------------|---|------|---|--------|-------|--------|-------|--|-------|---------|---------|---------|---------|----------------------------|------------------------|--------------------------|---------|---------|---|---------------|
| Code | | ters | (cmpression Compression | | ' | | ' | | | | - | - | 1 | - | | ' | ' | ' | I | 1 | | ' |
| Ref. (| SR-544 | Paramet | _z .0I X ^A W | I | ' | I | I | 1 | 1 | 1 | 1 | 1 | I | 1 | I | I | I | ' | I | I | I | 1 |
| | - | idation] | C ^A X 10.4 | | ı | 1 | ' | ' | 1 | 1 | ı | I | I | I | ı | ' | ' | ' | I | I | I | ' |
| R.L. | 70.499 m | Consoli | Pressure Pressure | 1 | ı | 1 | ' | | ı | ı | ı | ı | T | ı | ı | ' | 1 | 1 | ı | | ı | 1 |
| | (+)2 | | Void Ratio (e_) | ı | ı | 1 | ı | 1 | 1 | ı | ı | I | I | I | I | ı | 1 | ' | i | I | I | ' |
| | 26 m | Â | Permeability (cm/sec) | | ı | ' | ' | ' | | ' | ı | I | I | I | 1 | ' | ' | ı | I | ı | ı | 1 |
| | 23026.7 | nıç | Swelling Press | ı | I | ı | ı | ı | ı | ı | ı | I | I | I | ı | ı | i | ı | I | I | I | 1 |
| tes (E,N | 31 | xəp | Free Swell Inc (%) | 1 | ı | 1 | , | i | ı | ı | ı | ı | I | ı | ı | , | i | ı | I | ı | I | 1 |
| Cordina | m t | ıgth | Angle of (°0) and (°°) | 1 | ı | 24 | ' | 29 | ' | ' | 1 | ı | T | 5 | 1 | 4 | ' | 24 27 | ı | 29 | ı | ı |
| U | 97330.724 | iear Stren | Соћезіоп С (kg/cm²) | | ı | 0.20 | ' | 0.11 | ' | ' | 1 | ı | I | 1.69 | ı | 1.95 | 1 | 0.23 0.20 | I | 0.21 | I | I |
| | 9 | Sh | tesT to sqvT | | ı | DST | ' | DST | , | , | , | ı | ı | UUT | 1 | UUT | ' | CUT Total Effectiv | ı | DST | ı | ı |
| ination spth | 00 m | ţţ | vrað sífis Grav | ı | ı | 2.66 | ı | 2.65 | 1 | 1 | I | I | I | 2.68 | 1 | 2.67 | ı | 2.67 | I | 2.66 | I | 1 |
| Term De | 55. | (_e mə | Dry Density (g/ | ı | ı | 1.51 | ı | 1.61 | 1 | 1.61 | ı | 1.60 | I | 1.64 | ı | 1.66 | 1 | 1.66 | ı | 1.65 | ı | i. |
| Table | |) nıç | tsioM Isruts ^N %) tnətnoJ | I | I | 11.63 | ı | 12.10 | 1 | 12.36 | ı | 12.89 | I | 15.11 | ı | 15.80 | I | 16.24 | I | 16.30 | I | ı |
| of Water | 33.20 m | (_e mə) | Bulk Density (g | I | I | 1.69 | ı | 1.80 | ı | 1.81 | ı | 1.81 | I | 1.89 | T | 1.92 | I | 1.93 | I | 1.92 | I | ı |
| Depth o | | .0 | Shrinkage Limit | I | I | I | ı | ı | T | ı | ı | I | I | I | I | ı | I | ı | I | I | I | ı |
| No. | -P2 | Limits % | Plasticity Index | I | 6 | 7 | ı | S | 1 | 5 | ı | 5 | I | 10 | ı | 11 | ı | 11 | I | 7 | I | 7 |
| В.Н. | BH | tterberg | Plastic Limit | ı | 21 | 20 | | 21 | ı | 20 | ı | 20 | T | 21 | ı | 22 | ı | 21 | ı | 21 | ı | 20 |
| ion | ge | Α | timiJ biupiJ | | 27 | 27 | | 26 | 1 | 25 | 1 | 25 | I | 31 | ı | 33 | 1 | 32 | I | 28 | ı | 27 |
| Chainage n.)/Locat | 28+075 ajor Brid | | Coarse | ı | 0 | 0 | | 0 | - | 0 | | 2 | T | 0 | | 2 | | 0 | T | 0 | T | 0 |
| (kn | Μ | etained | Pani ^A | ı | 1 | 1 | ı | б | ı | 4 | ı | 4 | I | 5 | ı | 4 | ı | 9 | I | 9 | ı | 6 |
| |)-2021 | 1 % wt r | Coarse | | 4 | ŝ | ' | ŝ | 1 | 3 | ı | 2 | I | 5 | ı | ŝ | ' | 2 | I | 3 | ı | 3 |
| ring | 14-10 | tribution | Sand Medium | ı | 13 | 8 | ' | 14 | ı | 8 | ı | 11 | I | 11 | ı | ٢ | 1 | 4 | I | 13 | I | 10 |
| te of Boı | to | Size Dist | eniA | I | 25 | 29 | ı | 34 | - | 41 | ı | 38 | I | 19 | 1 | 20 | ı | 25 | i | 25 | I | 26 |
| Da | -2021 | Grain | IIS | | 51 | 52 | | 41 | - | 40 | T | 38 | T | 50 | T | 52 | | 52 | ī | 45 | T | 45 |
| | 11-10 | | VaIJ | | 9 | 7 | ' | Ś | , | 4 | ı | 5 | ı | 10 | ı | 12 | 1 | 11 | ı | 8 | ı | ٢ |
| ssigning ital Rail | to | | lodmy2 2I | | | | | | | | | | | | | | | | | | | |
| eport for de laryana Orb | onnectivity | uo | IS Classificati | ı | ML-CL | ML-CL | ı | SM-SC | ı | SM-SC | ı | SM-SC | I | CL | ı | CL | , | CL | I | ML-CL | | ML-CL |
| technical r iction of H | icluding co | | | | low | | | | | ense, vel | | | | | | Mo | | | | | ilt of I | |
| nvestigation, preparation of geo ment in connection with constr | from Palwal to Harsana Kalan i state of Haryana. | | Soil Description | | Brown, Loose, Sandy silt or plasticity | | | | | Brown, Medium dense to d Silty sand with clay & gra | | | | | | Brown. Hard. Siltv clav of | plasticity with gravel | | | | Brown, Very dense, Sandy s low plasticity with grave | |
| echnical i r embank | () project ork in the | T | Corrected SI Value (N _e) | | 14 | 1 | 25 | | 36 | ı | 33 | ı | 30 | ı | 51 | 1 | 59 | ı | 63 | ī | I | ' |
| cting geot ges and fo | or (HORC g IR netw | ənleV | Opserved SPT V (N) | | 6 | , | 22 | | 38 | ı | 41 | 1 | 42 | 1 | 51 | | 59 | | 63 | | 100 (24cm) | 100 (24cm) |
| Conduc of bridg | cu Corride existing | (w) " | J.Ə morî diqəU | 0.00 | 1.00 | 1 2.50 | 3.00 | 2 5.50 | 3.00 | 3 8.50 | 10.00 | 4 11.50 | ; 13.00 | 5 14.50 | 5 16.00 | 5 17.50 | 19.00 | 7 20.50 | 3 22.00 | 3 23.50 |) 25.00 | 0 26.50 |
| D | LUG | Э | qvT əlqmsZ | DS | SPT-1 | UDS-1 | SPT-2 | UDS-2 | SPT-3 | UDS-3 | SPT-4 | UDS-4 | SPT-5 | UDS-5 | SPT-6 | 9-SQU | SPT-7 | UDS-7 | SPT-8 | UDS-8 | 6-TAS | SPT-1(|



| le | -22 | s | Compression Index (C _c) | - | | ı | | - | - | | - | - | - | - | - | - | | - | - | - | - | |
|---|--|--------------------|---|-------------|----------|----------|----------|----------|----------|----------|----------|----------|--|----------|----------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Ref. Cod | R-544_21 | rameter | (cm ² /Kg) M ^a x 10 ⁻⁵ | ı | ı | ı | 1 | 1 | ı | ı | I | I | ı | I | ı | ı | ı | I | ı | I | I | , |
| | SI | lation Pa | (cm ² /Sec) C ^a x 10.4 | ı | , | ı | | ı | ı | , | ı | T | ı | T | ı | ı | ı | ı | ı | T | ı | , |
| R.L. | 70.499 m | Consolid | (kg/cm ²⁾ | 1 | ı | ı | ı | 1 | ı | 1 | I | T | ı | T | 1 | ı | I | ı | 1 | 1 | I | |
| | (+)2 | | Void Ratio (e_) | , | ı | , | ' | 1 | ı | ı | I | I | ı | I | ı | ı | ı | ı | ı | I | I | ' |
| | 726 m | Â | Permeability (cm/sec) | 1 | ı | ı | 1 | 1 | ı | 1 | I | I | ı | I | I | I | ı | I | I | I | I | ' |
| (t | 123026.7 | nıç | Swelling Press | 1 | ' | 1 | ' | 1 | ı | ı | I | I | I | I | I | I | I | I | I | I | I | ' |
| ates (E,N | 3. | xəp | Free Swell Ind | 1 | ' | ı | ' | 1 | ' | ' | I | I | I | I | I | I | I | I | I | I | I | 1 |
| Cordina | 4 m | ngth | fo signA | ı | ' | ı | ı | ı | 1 | 1 | I | I | I | I | 31 | I | I | I | I | I | I | 1 |
| | 697330.72 | Shear Stre |) noisəho) O noisəho) | ' | ' | ı | ' | ' | 1 | 1 | I | I | | I | Г 0.18 | I | I | | I | 1 | I | ' |
| | - | | tsəT to əqvT | 1 | 1 | ı | 1 | 1 | 1 | 1 | I | I | I | I | DST | I | I | I | I | I | I | 1 |
| mination Jepth | 5.00 m | ity | vraD offic Grav | ' | ' | ' | ' | ' | ' | ' | 1 | 1 | 1 | 1 | 2.66 | ı | 1 | 1 | ı | 1 | 1 | ' |
| Ter | 5. | (_e wə | Dry Density (g/ | , | , | | ' | 1 | 1 | 1 | I | I | ı | I | 1.66 | ı | ı | ı | ı | I | I | ' |
| er Table | и |) nte | wiew (%) training %) training (%) training (| 1 | 1 | , | ' | ı | ı | 1 | ı | T | ı | T | 18.00 | ı | ı | ı | ı | T | I | ' |
| ı of Wat | 33.201 | (_ք աշ, | Bulk Density (g/ | 1 | 1 | I | ı | 1 | I | ı | I | I | I | I | 1.96 | I | I | I | I | I | I | |
| Depth | | % | Shrinkage Limit | , | ' | ı | ' | , | ı | , | ı | I | ı | I | ı | ı | ı | ı | ı | 1 | ı | ' |
| I. No. | H-P2 | g Limits | Plasticity Index | , | 7 | ı | 9 | 1 | ٢ | 1 | 7 | I | 7 | I | 9 | I | 9 | I | 7 | I | ٢ | ' |
| B.1 | В | Atterbei | Plastic Limit | 1 | 21 | ı | 20 | 1 | 20 | 1 | 21 | I | 19 | I | 20 | I | 21 | ı | 20 | I | 19 | ' |
| ge ation | 5 idge | | timi.I biupi.I | ' | 28 | , | 26 | ' | 27 | ' | 28 | ı | 26 | ı | 26 | ı | 27 | 1 | 27 | ı | 26 | ' |
| Chaina (m.)/Loc | 28+07 Major Br | | Coarse | ı | 0 | ı | - | 1 | 0 | | 0 | T | 2 | T | 0 | ı | 0 | ı | 2 | T | 0 | ' |
| D | | retained | eni ^a | 1 | ∞ | , | ٢ | ı | 10 | ı | 6 | I | 4 | I | 7 | ı | 10 | ı | 6 | I | 11 | ' |
| | 10-2021 | on % wt | Coarse | ı | 1 | ı | - | ' | 2 | 1 | 3 | I | 5 | I | 3 | I | 5 | I | 5 | I | 4 | |
| soring | 14- | istributi | a ManuibəM | ' | 13 | ı | 17 | ' | 11 | ' | 4 | 1 | 8 | 1 | 11 | 1 | 7 | 1 | 3 | 1 | 13 | ' |
| Date of F | to | in Size D | Fine | 1 | 24 | ı | 20 | 1 | 24 | 1 | 30 | I | 27 | I | 24 | I | 28 | I | 30 | I | 20 | ' |
| _ | 10-2021 | Gra | IIS | 1 | 47 | I | 48 | 1 | 47 | ı | 49 | I | 47 | I | 49 | I | 47 | I | 44 | I | 45 | ' |
| 5 1 | 11- | | Clay | • | 7 | - | 9 | • | 9 | , | 8 | - | 7 | - | 9 | - | 9 | - | 7 | - | 7 | • |
| designing Orbital Rai | ty to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| al report for f Haryana C | g connectivi | uo | IS Classificati | ı | ML-CL | ' | ML-CL | ı | ML-CL | | ML-CL | I | ML-CL | I | ML-CL | ı | ML-CL | ı | ML-CL | I | ML-CL | ' |
| investigation, preparation of geotechnic cment in connection with construction c | from Palwal to Harsana Kalan includin state of Haryana. | | Soil Description | | | | | | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | | | | | | | | | |
| technical or embanl | C) project vork in th | Te | Corrected SF Value (N _c) | 35 | 39 | 45 | , | 25 | 28 | 28 | 26 | 25 | 25 | 25 | ı | - | - | - | - | - | - | - |
| icting geo lges and fo | lor (HOR) 1g IR netw | ənleV | VD56FV6d SPT V (V) | <i>LT</i> (|) 84 | 86 (|) >100 | 76 | 88 (| 88 (|) 81 | 77 (|) 76 | 77 (| - (|) 100 (26cm) |) 100 (22cm] |) 100 (18cm] |) 100 (21cm) |) 100 (23cm) |) 100 (19cm) |) 100 (27cm) |
| Condu of brid | existin | (W) " | J.Ə morî diqeD | 11 28.00 | 12 29.50 | 13 31.00 | 14 32.5(| 15 34.00 | 16 35.50 | 17 37.00 | 18 38.50 | 19 40.00 | 20 41.50 | 21 43.00 | -9 44.50 | 22 46.00 | 23 47.50 | 24 49.00 | 25 50.50 | 26 52.00 | 27 53.5(| 28 55.00 |
| | all | ə | qvT əlqms2 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-2 | SPT-2 | -SQU | SPT-2 |



| Micro | ting geotec es and for r (HORC) 1 IR networ | schnical ii r embankı) project fi rk in the | nvestigation, preparation of geotechnical ment in connection with construction of F rom Palwal to Harsana Kalan including costate of Haryana. | report for desi Haryana Orbita onnectivity to | igning al Rail | 16-10-202 | Date of | Boring | 10-2021 | C (km. | Jhainage J/Location 28+075 jor Bridge | | B.H. No. BH-A2 | Dep | 33.21 | ter Table | Tern D(55. | ination spth 00 m | 697 | Co 330.724 m | rdinates | (E,N) 312300 | 04.726 m | (+) | R.L. 70.616 m | | Ref. Cod R-544_21 | e -22 |
|---|--|---|---|---|-------------------|-----------|--------------|-------------------------|-----------|----------|---|--------------|-----------------------------|--------------------|--------------------|-----------------------------|-------------------|-------------------------|--------------|-------------------------------------|---------------------------|--------------------------|--|--|--|---|--|--|
| Mathematical constraints Mathema | L | | | uoj | | G | rain Size I | Distributi | on % wt r | etained | | Atter | berg Lim | its % | (_ք աշ) |) m.e | (sm3) | Ţţ, | She | ur Strengt | | xəp | ۸ عسو | | Consoli | lation Pa | rameters | |
| 111 <th1< th=""><th>Uorrected SF</th><th>(_sN) ənlaV</th><th>Soil Description</th><th>IS Classificati</th><th>lodmy2 21</th><th>Clay</th><th>Tine Fine</th><th>San Medium Medium</th><th>Coarse</th><th>eni G</th><th>Coarse</th><th>timiJ biupiJ</th><th>Plastic Limit Plasticity</th><th>xəbnl Shrinkage</th><th>Bulk Density (g</th><th>tsioM larutaN %) tnotnoO</th><th>Dry Density (g/</th><th>vrað sítisəqZ</th><th>test to sqyT</th><th>Соћезіоп С (kg/cm²)</th><th>fo algaA (°φ) noitoirT</th><th>(%) (%)</th><th>(kg/cm²) (kg/cm²) Tilits</th><th>(cm/sec) Void Ratio (e₀)</th><th>Pressure Pressure</th><th>(cm⁵/2ec) C^ax 10.4</th><th>(cm²/Kg) M_v x 10⁻²</th><th>Compression Index (C_c)</th></th1<> | Uorrected SF | (_s N) ənlaV | Soil Description | IS Classificati | lodmy2 21 | Clay | Tine Fine | San Medium Medium | Coarse | eni G | Coarse | timiJ biupiJ | Plastic Limit Plasticity | xəbnl Shrinkage | Bulk Density (g | tsioM larutaN %) tnotnoO | Dry Density (g/ | vrað sítisəqZ | test to sqyT | Соћезіоп С (kg/cm ²) | fo algaA (°φ) noitoirT | (%) (%) | (kg/cm ²) (kg/cm ²) Tilits | (cm/sec) Void Ratio (e ₀) | Pressure Pressure | (cm ⁵ /2ec) C ^a x 10.4 | (cm ² /Kg) M _v x 10 ⁻² | Compression Index (C _c) |
| The control of | | | | , , | | 1 | ' | , | ı | , | | 1 | 1 | ' | ' | ' | , | ' | ' | , | , | | , | | ' | , | ı | |
| 1 | | 1 | Brown, Stiff, Silty clay of low plasticity | CL | | 12 5 | 59 16 | 5 10 | 2 | - | 0 | 34 2 | 21 15 | - | 1.69 | 12.64 | 1.50 | 2.67 | UUT | 0.44 | 4 | 1 | | 0.780 | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | 9.39 8.23 5.96 4.78 | 2.28 1.85 1.24 0.72 | 0.159 |
| Weighter frame betweighter frame betweighter frame betweighter frame betweighter frameWeighter frame betweighter frame betweighter frame betweighter frame betweighter frameWeighter frame betweighter frame betweig | | 12 | <u> </u> | , | | ı | 1 | 1 | 1 | ı | ı | ı | , | 1 | ' | ı | ı | ' | | ı | ı | ı | | | ı | ı | - | |
| 1 monutational 1 <t< td=""><td></td><td></td><td>Brown, Dense, Sandy silt of low</td><td>ML-CL</td><td></td><td>8</td><td>46 31</td><td>i 11</td><td>2</td><td>2</td><td>0</td><td>28 2</td><td>21 7</td><td>1</td><td>1.82</td><td>12.36</td><td>1.62</td><td>2.66</td><td>DST</td><td>0.18</td><td>27</td><td>ı</td><td>1</td><td></td><td>ı</td><td>ı</td><td>I</td><td></td></t<> | | | Brown, Dense, Sandy silt of low | ML-CL | | 8 | 46 31 | i 11 | 2 | 2 | 0 | 28 2 | 21 7 | 1 | 1.82 | 12.36 | 1.62 | 2.66 | DST | 0.18 | 27 | ı | 1 | | ı | ı | I | |
| 1 | | 41 | plasticity with gravel | 1 | | ı | ' | , | ' | , | | 1 | | ' | ' | ' | ' | ' | | | | | | | ' | ' | ı | |
| 1 | - | | | CL | | 10 6 | 52 15 | 5 7 | 4 | 2 | 0 | 34 2 | 22 12 | | 1.80 | 14.16 | 1.58 | 2.68 | UUT | 0.85 | 5 | | - | ' | ' | 1 | - | · |
| 1 | | 25 | <u> </u> | <u>,</u> | | 1 | · · | | | | | | | ı | | , | | | ı | | | | | | | | I | |
| 1 Processential conditionation of the conductation of the conduct | - | | <u> </u> | CL | | 12 4 | t9 21 | 4 | 6 | 2 | 0 | 33 2 | 22 11 | ' | 1.84 | 14.80 | 1.60 | 2.67 | UUT | 1.06 | S | , | • | , | | | ı | |
| Cl. Cl. <td></td> <td>31</td> <td>Brown, Very stiff to hard, Silty clay of low plasticity with gravel</td> <td>•</td> <td></td> <td>-</td> <td>, '</td> <td>1</td> <td>1</td> <td>1</td> <td></td> <td>1</td> <td>1</td> <td>I</td> <td></td> <td></td> <td>,</td> <td></td> <td>1</td> <td></td> <td></td> <td>1</td> <td></td> <td>1</td> <td>ı</td> <td>ı</td> <td>I</td> <td></td> | | 31 | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | • | | - | , ' | 1 | 1 | 1 | | 1 | 1 | I | | | , | | 1 | | | 1 | | 1 | ı | ı | I | |
| | - | ı | 1 | CL | | 11 5 | 58 15 | 5 7 | s. | 4 | 0 | 32 2 | 21 11 | ' _ | 1.84 | 15.04 | 1.60 | | ı | | ı | | | | ı | ı | I | |
| | | 31 | <u> </u> | , , | | 1 | | | ' | , | | | | ' | ' | ' | , | | ' | | | | | | , | | ı | i. |
| ···································· | | ı | <u> </u> | CL | | 11 5 | 53 20 | 9 (| ŝ | 7 | 0 | 31 2 | 20 11 | - | 1.84 | 15.26 | 1.60 | | | 1 | , | 1 | | | , | , | ı | ı |
| NILCL NILCL 1 45 31 8 2 7 20 1 160 266 DST 0.0 28 7 1 | | 1 | | 1 | | ı | , | , | I | 1 | 1 | 1 | 1 | 1 | ' | 1 | , | ' | | 1 | ı | 1 | 1 | | ' | , | - | 1 |
| 28 31 32 31 1 32 32 33 34 35 36 36 37 38 39 39 39 39 39 39 39 39 | | ı | <u> </u> | ML-CL | | 7 4 | 45 31 | 8 | 5 | L | 0 | 27 2 | 20 7 | ' | 1.86 | 16.11 | 1.60 | 2.66 | DST | 0.20 | 28 | 1 | | | ' | , | - | |
| Image: binombase binomb | | 28 | <u> </u> | 1 | | 1 | - | , | ' | , | 1 | , | | 1 | ' | , | , | | | 1 | , | 1 | | | ' | , | - | , |
| 31 31 | | ı | Brown, Very dense, Sandy silt of | ML-CL | | 8 | 49 29 |) 3 | 0 | 6 | 2 | 28 2 | 21 7 | ' | 1.86 | 16.30 | 1.60 | ' | - | ı | , | | - | | ' | 1 | - | |
| . ML-CL . 49 19 12 3 10 0 28 21 7 . 1.89 16.74 1.62 2.66 DST 0.22 29 . < | | 31 | low plasticity with gravel | 1 | | 1 | - | , | ' | , | 1 | , | | 1 | ' | , | , | ' | | 1 | , | 1 | | | ' | , | - | , |
| - | | | L | ML-CL | | 7 4 | t9 19 |) 12 | 3 | 10 | 0 | 28 2 | 21 7 | 1 | 1.89 | 16.74 | 1.62 | 2.66 | DST | 0.22 | 29 | 1 | | | ' | , | 1 | 1 |
| 40 ML-CL | | ı. | | 1 | | ı | , | | , | 1 | | | , | - | , | , | , | ' | ' | | ı | 1 | | | 1 | 1 | I | |
| | | 40 | | ML-CL | | ر» ور | 54 22 | 6 | 4 | 8 | 0 | 26 2 | 20 6 | | ' | I | · | ' | ' | ı | ı | | ' | | ' | ı | ı | |



| | 0 | | Index (C _c) | | | I | | I | I | ı | ı | I | I | ı | ı | I | I | ı | ı | ı | |
|----------------------------|----------------------------|--------------------|--|--------|--------------|--------|------------------------------------|----------|--------------|--------------|--------|----------|------------|------------|--------|--------|--|--------------|--------------------------|--------------|--------------|
| . Code | 4_21-22 | neters | (cm ² /Kg) | | | | | | | | - | | | - | - | - | | - | - | - | |
| Ref | SR-54 | n Paran | W ^x x 10. ₅ (cos ₇ /2ec) | | | | | | | | | | | - | | - | | | | | |
| | ш | olidatio | С ^x x 10.4 (kg/cm ²⁾ | | | | | | | | | | | | | | | | | | |
| R.L. | 270.616 | Cons | Pressure | | | | | | | | | | | | | | | | | | |
| | (+) | | Void Ratio (e ₀) | 1 | ' | 1 | 1 | ' | ' | ' | 1 | ' | 1 | ' | 1 | ' | ' | 1 | 1 | 1 | 1 |
| | 726 m | Â | (ms/gy/cm) Permeability | I | I | I | I | 1 | 1 | 1 | ı | 1 | 1 | ı | I | 1 | 1 | I | I | I | 1 |
| (Z | 123004. | nıç | (%) Svelling Press | 1 | 1 | 1 | 1 | 1 | ' | 1 | ı | 1 | 1 | 1 | I | ' | ' | I | I | I | 1 |
| ates (E,] | | хәр | Freedon (9') | 1 | ' | 1 | ı | ' | ' | ' | 1 | ' | 1 | ' | 1 | ' | ' | ' | 1 | I | 1 |
| Cordin | 24 m | ngth | io algaA | 1 | 1 | 1 | ı | ' | ' | ' | 1 | ' | 1 | ' | 1 | ' | ' | ' | 1 | I | 1 |
| | 97330.72 | ear Stre | D noisendD | 1 | ' | ı | ı | ' | ' | ' | ' | ' | 1 | 1 | 1 | ' | ' | 1 | 1 | ' | 1 |
| | 9 | Sh | test to sqr | ı | ı | ı | ı | ı | ' | ı | ı | ı | ı | 1 | ı | ' | ' | ı | ı | ı | ı |
| lation th | m (| ţţ | Specific Grav | ı | ı | ı | ı | 1 | | , | ı | 1 | ı | | ı | 1 | | ı | ı | ı | ı |
| Termir Dep | 55.0(| (_e wə | Dry Density (g/ | ı | 1 | ı | ı | 1 | 1 | 1 | ı | 1 | 1 | 1 | ı | 1 | 1 | ı | ı | ı | ı |
| able | |) n.c | tsioM Istutsvi %) tnotnoD | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | ı | 1 | 1 | ı | ı | ı | ı |
| Water J | 21 m | (_ք աշ/ | Bulk Density (g/ | 1 | , | 1 | 1 | | | | 1 | | | 1 | ı | | | ı | ı | ı | 1 |
| epth of | 33 | | January JimiJ | | i | | | , | 1 | 1 | 1 | , | | 1 | ı | 1 | 1 | ı | ı | 1 | 1 |
| . D | | nits % | xəpul | 1 | 7 | 1 | 9 | 1 | 7 | 1 | 10 | 1 | 11 | | 11 | | 9 | 1 | - | 6 | 1 |
| B.H. No | BH-A2 | berg Lir | Plasticity | | 0 | | 0 | | 6 | | 1 | | 5 | | 1 | | 0 | | | 0 | |
| | | Atter | | | 7 2 | | 6 | | 6 1 | | 1 2 | | 6 | | 2 | | 6 | | | 9 | |
| nage ocation | 075 Bridge | | timi I binoi I | | 5 | | 5 | | 2 | |) 3 | | 3 | | 3 | | 2 | | | 5 | |
| Chai (km.)/L | 28+ Major | ed | dravel Gravel | | | | | | 5 | | | | | | 0 | | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ | | | | |
| | | rt retain | əniA | 1 | 6 | 1 | 2 | ' | 1 | ' | ∞ | ' | | 1 | 1(| ' | 1 | 1 | 1 | 6 | ' |
| | -10-2021 | ion % w | Coarse | I | 5 | I | ω | 1 | 5 | 1 | 5 | 1 | 5 | I | 1 | 1 | 1 | I | I | 2 | 1 |
| 3 oring | 18 | Distribut | n E muib∍M | 1 | ∞ | ' | 4 | 1 | 10 | 1 | 6 | 1 | 7 | 1 | 4 | 1 | 10 | ı | 1 | 9 | 1 |
| Date of H | to | in Size I | Fine | I | 25 | I | 29 | 1 | 24 | 1 | 18 | 1 | 16 | I | 17 | I | 24 | I | I | 28 | I |
| Ι | 10-2021 | Grai | IIIS | ı | 48 | ı | 49 | ' | 45 | ' | 50 | ' | 52 | 1 | 55 | ' | 45 | 1 | 1 | 48 | 1 |
| | 16- | | Clay | • | 7 | 1 | 9 | | 7 | | 10 | | 12 | - | 11 | - | 7 | - | | 9 | , |
| lesigning bital Rail | y to | | lodmy2 21 | | | | | | | | | | | | | | | | | | |
| report for 6 Haryana Oi | connectivit | uoj | IS Classificati | | ML-CL | | ML-CL | | ML-CL | | CL | | CL | | CL | | ML-CL | ï | ī | ML-CL | , |
| otechnical uction of] | ncluding o | | | | | | silt of el | <u> </u> | <u> </u> | <u> </u> | | <u> </u> | low | | | | | | silt of el | | <u> </u> |
| tion of geo ith constr | na Kalan i | | ription | | | | e, Sandy s with grav | | | | | | ty clay of | th gravel | | | | | e, Sandy : with grav | | |
| ı, preparat nection w | to Harsaı yana. | | oil Desci | | | | ⁷ ery dens lasticity | | | | | | Hard, Sil | sticity wi | | | | | /ery dens | | |
| restigation | om Palwal ate of Har | | õ | | | | Brown, V low p | | | | | | Brown, | pla | | | | | Brown, V low p | | |
| hnical inv mbankme | project frc k in the st | L | (_S N) sulus (N _s) | 35 | ı | 36 | 25 | 29 | | ı | 82 | 06 | 88 | 86 | 83 | 92 | | ı | 1 | ı | ı |
| ıg geoteci and for ε | (HORC) I R networl | aulaV | VDserved SPT (N) | 75 | 100 19cm) | 79 | 77 | 92 | 100 22cm) | 100 23cm) | 82 | 06 | 88 | 86 | 83 | 92 | 100 25cm) | 100 24cm) | 100 22cm) | 100 23cm) | 100 23cm) |
| Conductir of bridges | Corridor (»xisting II | (w) " | I.Ə morî diqaD | 29.50 | 31.00 | 32.50 | 34.00 | 35.50 | 37.00 | 38.50 | 40.00 | 41.50 | 43.00 | 44.50 | 46.00 | 47.50 | 49.00 | 50.50 | 52.00 (| 53.50 | 55.00 (|
| | | Ð | qvT əlqms2 | SPT-11 | SPT-12 | SPT-13 | SPT-14 | SPT-15 | SPT-16 | SPT-17 | SPT-18 | SPT-19 | SPT-20 | SPT-21 | SPT-22 | SPT-23 | SPT-24 | SPT-25 | SPT-26 | SPT-27 | SPT-28 |



| <u>م</u> | -22 | | Compression Index (C _c) | I | I | ı | ı | | I | I | I | I | I | I | I | I | I | I | I | I | I | |
|--|---|--------------------|--|------|------------------------|------------------------|--------|--------|--------------------------|-----------|---------|---------|--------------------------|---------|---------|---------|---------|---------|--|---------|-----------------|----------------|
| Ref. Cod | R-544_21 | rameters | (cm ² /Kg) M _v x 10 ⁻² | I | I | ı | ı | 1 | I | I | I | I | I | I | I | I | I | I | I | I | I | |
| | SI | tion Pa | (cm ² /Sec) C ^x x 10.4 | | | | | | | | | | , | | | , | | | | | | |
| Ľ | .602 m | Consolida | (kg/cm ²⁾ | ı | ı | | ı | 1 | ı | ı | ı | T | ī | I | ı | ı | I | ı | ı | ī | ī | |
| R | (+)268 | | Void Ratio (e_) | I | I | ı | ı | | ı | I | I | I | I. | I | I | ı | I | I | I | T | I | |
| | 6 m | Â | Permeability (cm/sec) | ı | ı | , | , | | 1 | ı | ı | ı | ı | ı | ı | ı | ı | ı | ı | 1 | ı | ı |
| | 3109.16 | nıç | Swelling Press (kg/cm ²) | I | I | ı | | | | I | I | I | I | I | I | ı | I | I | I | I | I | ı |
| s (E,N) | 312 | xəp | Free Swell Inc (%) | I | I | ı | ı | ī | T | T | I | I | T | T | T | I | T | I | I | T | I | 1 |
| ordinate | n | th | Angle of Friction (°°) | I | i | 28 | ı | ı | ı | 27 | I | 31 | I | I | I | 28 | I | I | I | 30 | I | ı |
| Ŭ | 7053.722 1 | ar Streng | Cohesion C (kg/cm ²) | ı | I | 0.00 | ı | | ı | 0.10 | I | 0.00 | I | I | I | 0.18 | I | I | I | 0.19 | ı | I |
| | 69, | She | rype of Test | I | I | DST | ı | 1 | I | DST | I | DST | I | I | I | DST | I | I | I | DST | I | ı |
| nation pth | 0 m | ity | vrað sifis Grav | ı | ı. | 2.62 | - | - | - | 2.63 | - | 2.62 | i. | i. | | 2.66 | i. | - | ı. | 2.66 | - | |
| Termi Dej | 40.0 | (_e mə | Dry Density (g/ | - | ı | 1.47 | | 1.56 | | 1.57 | T | 1.60 | - | 1.60 | - | 1.61 | - | 1.62 | T | 1.66 | ı | |
| r Table | |) nre | tsioM latural Moist (%) tnətnoD | ı | ı | 10.36 | - | 11.20 | ı | 11.49 | ı | 12.40 | ı | 12.77 | ı | 14.16 | T | 14.80 | ı | 15.64 | ı | ı |
| of Wateı | 34.78 m | (_e wə, | Bulk Density (g/ | , | , | 1.62 | | 1.73 | ı. | 1.75 | T | 1.80 | i. | 1.80 | ī | 1.84 | , | 1.86 | ı. | 1.92 | ı. | |
| Depth | | 10 | Shrinkage Limit | I | ı | 1 | ı | 1 | ı | ı | ı | I | I | I | ı | I | I | I | I | ı | ı | |
| . No. | -A1 | Limits 9 | Plasticity Index | ı | dN | dN | ı | 5 | ı | 5 | I | NP | I | NP | I | 7 | I | 9 | ı | L | I | ٢ |
| B.H | BH | Atterberg | Plastic Limit | ı | Nil | Nil | ı | 20 | ı | 20 | I | Nil | I | Nil | I | 20 | I | 20 | ı | 21 | I | 20 |
| çe tion | lge | 4 | timiJ biupiJ | ı | I | ı | ı | 25 | I | 25 | ı | I | I | I | ı | 27 | I | 26 | ı | 28 | I | 27 |
| Chainag m.)/Loca | 28+360 Aajor Brio | | Coarse | I | 0 | 0 | ı | 0 | I | 0 | I | 0 | I | 0 | I | 0 | T | 2 | I | 1 | I | 0 |
| (k | V | retained | D D D D | I | 0 | 0 | ı | 2 | ı | 3 | ı | 5 | I | 6 | ı | 6 | I | 5 | I | L | ı | 6 |
| | 0-2021 | on % wt | Coarse | I | 1 | - | ı | 1 | I | 2 | I | 3 | I | 1 | I | 2 | I | 9 | I | 4 | I | |
| oring | 14-1 | stributio | S muib9M | ı | 5 | 9 | ı | 4 | I | 9 | I | 11 | I | 9 | I | 11 | I | 10 | ı | 13 | I | ٢ |
| ate of B | to | n Size Di | əniA | 1 | 62 | 68 | ' | 53 | ı | 55 | ı | 60 | 1 | 55 | ı | 28 | 1 | 24 | ı | 22 | ı | 25 |
| П | 0-2021 | Grai | 11!S | i | 32 | 25 | ı | 36 | i | 29 | i | 21 | I | 32 | i | 46 | I | 47 | i | 46 | i | 51 |
| | 13-] | | Clay | | 0 | 0 | - | 4 | - | 5 | - | 0 | - | 0 | ' | 7 | - | 9 | - | 7 | - | 2 |
| esigning ital Rail | to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| report for de Haryana Ort | connectivity | uo | IS Classificati | ' | SM | SM | ı | SM-SC | ı | SM-SC | ı | SM | ı | SM | ı | ML-CL | ı | ML-CL | ı | ML-CL | ı | ML-CL |
| otechnical ruction of l | including o | | | | | | | | ty sand | | | | with | | | | | | silt of vel | | | |
| investigation, preparation of ge cment in connection with const | from Palwal to Harsana Kalan e state of Haryana. | | Soil Description | | Damma I arres 0:14, 22 | BTOWII, LOOSE, MILY SA | | | Brown, Medium dense, Sil | with clay | | | Brown, Dense, Silty sand | gravel | | | | | Brown, Very dense, Sandy low plasticity with grav | | | |
| technical or embank | C) project vork in the | T | Corrected SP Value (N.) | 1 | ~ | | 11 | | 28 | ı | 22 | T | 31 | 1 | 28 | ' | 36 | ı | 43 | 1 | - | - |
| icting geo lges and fi | lor (HOR) ig IR netv | 9ulsV | V TAS bəvrəsdO (V) | I | 5 | ı | 10 | ı | 29 | ı |) 27 | - (|) 42 | - |) 43 | - (|) 60 | - (| 78 | - (|) 100 (28cm] |) 101 (24cm |
| Condu of brid | cu Corrid existin | (w) " | J.Ə morî diqeD | 0.00 | 1 1.00 | 1 2.50 | 2 4.00 | 2 5.50 | 3 7.00 | 3 8.50 | 4 10.00 | 4 11.50 | 5 13.00 | 5 14.50 | 5 16.00 | 6 17.50 | 7 19.00 | 7 20.50 | 3 22.00 | 8 23.50 | \$ 25.00 | 0 26.5(|
| | afoil | ə | qvT эlqms2 | DS | SPT-1 | -SQU | SPT-2 | ;-SQU | SPT-3 | UDS-C | SPT∠ | -SQU | SPT-£ | UDS-; | SPT-6 | UDS-(| €-T-C | UDS- | SPT-6 | -SQU | 5-Tq2 | SPT-1 |



| e | -22 | | ľ | Compression (Compression) | ı | | ı | ı | ī | ī | ı | ı | T |
|--|---|--------------------|-------------|--|-----------------|-----------------|-----------------|-----------------|--|-----------------|-----------------|-----------------|-----------------|
| lef. Cod | -544_21 | ameters. | | (cm ² /Kg) M _v x 10 ⁻² | | | | | | | | | 1 |
| I | SR | tion Par | | (cm ² /Sec) C ^x 10. ⁴ | ı | ı | ı | ı | ı | ı | ı | ı | I |
| .L. | :.602 m | Consolida | | Pressure (kg/cm ²⁾ | | | | | | | | | 1 |
| R | (+)268 | | (0 | yoid Ratio (e | ı | 1 | ı | ı | | i. | ı | ı | I |
| | В | Â | lit; (| Permeabi (cm/sec | | | | | | | | | ı |
| | 3109.166 | nre | () ISS(| Pre Swelling Pre (kg/cm ² | | | | | 1 | | | | T |
| s (E,N) | 312 | xəp | puj | Free Swell I (%) | ı | ı | ı | ı | ı | ı | ı | ı | I. |
| ordinate | в | ţth | , | Angle of Friction (o°) | ı | ı | ı | ı | 1 | ı | ı | ı | I |
| Ŭ | 1053.722 | ear Streng | | Соћеsion С (kg/cm²) | , | ' | , | , | | | , | , | 1 |
| | 59 | Sh | : | tsəT to əqvT | ' | ' | ' | ' | | ' | ' | ' | ı |
| uination epth | .00 m | ţţ | [VB | srð sifiseq2 | ' | ' | ' | ' | | ' | ' | ' | ı |
| Tern D | 40 | (_e mə |) /ð | Dry Density (| 1 | ' | , | 1 | | | , | 1 | I |
| ır Table | - |) nre | (% USI | ioM leruteN) tnotnoO | ' | | ' | ' | | | ' | ' | ' |
| of Wate | 34.78 m | (_e wə) | /ð) | Tiensu Jula Density | , | ' | ' | , | | | ' | , | ı |
| Depth | | % | | Shrinkage Jimit | ı | ı | ı | 1 | 1 | ı | ı | 1 | I |
| H. No. | H-A1 | g Limits | _ | Plasticity Index | ' | 7 | ' | 7 | ' | 9 | ' | 9 | 1 |
| B.1 | B | Atterbei | 1 | timiJ siterIA | 1 | 21 | 1 | 19 | ' | 21 | 1 | 20 | I |
| ge ition |) dge | | 1 | imiJ biupiJ | ' | 28 | 1 | 26 | 1 | 27 | 1 | 26 | I |
| Chainag m.)/Loca | 28+36(⁄Iajor Bri | | ravel | Coarse | ' | 0 | ' | 0 | | 0 | ' | 0 | 1 |
| (k | 4 | retained | G | Fine | ı | 11 | ı | 10 | ı | ∞ | ı | 11 | I |
| | 0-2021 | n % wt | | Coarse | ı | 5 | ı | 1 | ı | 5 | ı | 7 | I |
| oring | 14-1 | stributio | Sand | muibəM | ı | 9 | ı | 13 | ı | S | ı | ٢ | I |
| ate of Bc | to | ı Size Di | | Fine | , | 26 | ' | 25 | | 27 | ' | 26 | ı |
| D | 0-2021 | Graiı | | HIS | ' | 47 | ' | 4 | | 52 | ' | 47 | I |
| | 13-1 | | | Clay | - | ∞ | 1 | 7 | - | 9 | - | 7 | - |
| lesigning bital Rail | y to | | ю | dmy2 2I | | | | | | | | | |
| ıl report for c Haryana Or | g connectivit | uo | ite | IS Classifica | ı | ML-CL | ı | ML-CL | , | ML-CL | ı | ML-CL | ı |
| investigation, preparation of geotechnica ment in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | | Soil Description | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | | | | |
| technical or embank | C) project vork in the | Т | (°) dS | Corrected Value (N | - | - | - | - | - | - | - | - | - |
| ucting geot dges and fc | dor (HORC ng IR netw | ənle | \ J | (N) (N) | 0 100 (21cm) | 0 100 (23cm) | 0 100 (22cm) | 0 100 (23cm) | 0 100 (21cm) | 0 100 (22cm) | 0 100 (20cm) | 0 100 (23cm) | 0 100 (28cm) |
| Condi of bric | ect Corric existin | (w) • | T ' | Depth from G | 11 28.0 | 12 29.5 | 13 31.0 | 14 32.5 | 15 34.00 | 16 35.5 | 17 37.0 | 18 38.51 | 19 40.0 |
| | for | ə | dÂ | T əlqmsZ | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- |





| ð | 22 | | Compression Index (Cc) | | | | | | | | | | | | | | | | | | |
|---|---|--------------------|--|------|--|---------|----------|---------------------------------|------------------------|---------|--------------------------------------|------------------------|----------|---------|-----------------------------------|------------------------------------|----------|---------|---------------------------|--|---------|
| lef. Cod | -544_21 | ameters | (831/2m2) 2.01 x M | I | | 1 | 1 | | ı | 1 | 1 | | | | ı | | | | | 1 | |
| R | SR | tion Par | (cm ² /Sec) C ^x x 10.4 | I | ı | I | 1 | ı | I | I | ı | 1 | ı | ı | 1 | ı | ı | 1 | | 1 | |
| ; | 361 m | onsolidat | (kg/cm ²⁾ | 1 | | | | | | | | | | | ı | | | | ı | ı | |
| R.I | (+)267.8 | 0 | (09) oitsA bioV | | | | | | | | | | | | | | | | 1 | | |
| | н | Â | Permeabilit (cm/sec) | I | | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | | | 1 | |
| | 3091.386 | nıç | Swelling Press (kg/cm ²) | I | ı | ı | 1 | 1 | ı | | | | 1 | 1 | ı | ı | 1 | | | ı | |
| s (E,N) | 3123 | xəp | Free Swell Inc (%) | I | I | ı | ı | ı | I | I | ı | I | ı | ı | ı | ı | ı | I | | ı | 1 |
| ordinate | ш | ţth | Angle of Friction (\$^) | i | 26 | ı | 26 | ı | ı | ı | S | ı | 27 | ı | ı | ı | 28 | ı | 24 26 | 1 | |
| Ċ | 050.915 | ır Streng | Cohesion C (kg/cm ²) | I | 0.11 | ı. | 0.21 | , | , | ı | 2.93 | 1 | 0.20 | , | ı | ı | 0.22 | 1 | 0.21 0.18 | ī | |
| | 697 | Shea | Type of Test | I | DST | ı | DST | ı | ı | ı | UUT | | DST | ı | 1 | ı | DST | | CUT Total Effective | , | |
| nation oth | 0 m | ity | лагд эйіээqZ | ı | 2.63 | | 2.66 | | ı | ı | 2.67 | | 2.66 | | ı | | 2.66 | | 2.68 | ı | ı |
| Termir Dep | 50.00 | (_e mə | Dry Density (g/ | | 1.52 | | 1.61 | | 1.62 | | 1.60 | | 1.60 | | 1.60 | | 1.62 | | 1.62 | | |
| Table | |) nre | tsioM IsrutsN %) tnotnoD | | 11.03 | | 12.74 | | 13.10 | | 14.79 | | 14.60 | | 15.03 | | 15.41 | | 16.74 | | |
| of Water | 34.10 m | (_e mə) | g) viiensd Aluß | I | 1.69 | - | 1.82 | ı | 1.83 | ı | 1.84 | | 1.83 | ı | 1.84 | - | 1.87 | | 1.89 | - | 1 |
| Depth | | 20 | Shrinkage Limit | ı | I | - | | | | I | | | | | - | - | | | ı | - | |
| . No. | -P1 | Limits 9 | Plasticity Index | ı | 5 | | 9 | ı | 7 | ı | 11 | ı | 9 | ı | L | | L | ı | 10 | ı | ı |
| B.H. | Ha | tterberg | Plastic Limit | ī | 20 | - | 21 | , | 20 | ı | 21 | ı | 20 | , | 20 | - | 21 | ı | 20 | - | |
| e tion | lge | V | timiJ biupiJ | ı | 25 | ı | 27 | ı | 27 | ı | 32 | 1 | 26 | ı | 27 | ı | 28 | 1 | 30 | 1 | |
| Chainag m.)/Loca | 28+360 1ajor Brid | | e Coarse | , | 0 | ' | 0 | | 0 | | 0 | | 0 | | 1 | ' | 0 | | 0 | ' | |
| (kı | 2 | retained | Pine G | I | 0 | ı | S | 1 | 9 | ı | 4 | 1 | 4 | 1 | 5 | ı | 7 | 1 | 4 | 1 | |
| | 0-2021 | n % wt 1 | Coarse | ı | 7 | ' | 4 | ' | 5 | | 7 | ' | ŝ | ' | 3 | ' | 4 | ' | 5 | ' | |
| oring | 15-1 | stributio | Sand Medium | , | 14 | ' | 4 | ' | e | | 10 | | 12 | ' | 13 | ' | 11 | | 9 | | |
| ate of Bc | to | n Size Di | əniA | ı | 4 | ı | 28 | 1 | 26 | 1 | 18 | 1 | 26 | 1 | 25 | ı | 27 | 1 | 19 | ı | |
| D | 0-2021 | Grair | HIS | i | 30 | ı | 53 | ı | 56 | 1 | 50 | 1 | 49 | ı | 46 | ı | 4 | 1 | 57 | ı | ' |
| | 13-1 | | Valay | - | 5 | | 9 | | 7 | • | 11 | 1 | 9 | | 7 | - | 7 | | 6 | | |
| designing rbital Rail | y to | | lodmy2 2I | | - 11 - 11 - 1 - 11 - 11 - 11 - 11 - 11 | | | | | | | | | | | | | | | | |
| l report for Haryana O | connectivit | uo | IS Classificati | | SM-SC | | ML-CL | | ML-CL | , | CL | | ML-CL | | ML-CL | | ML-CL | | CL | ı | |
| investigation, preparation of geotechnic kment in connection with construction o | from Palwal to Harsana Kalan including e state of Haryana. | | Soil Description | | Brown, Medium dense, Silty sand with clay | | | Brown, Dense, Sandy silt of low | plasticity with gravel | | Brown, Very stiff, Silty clay of low | plasticity with gravel | | | Brown, Dense to very dense, Sandy | silt of low plasticity with gravel | | | | Brown, Hard, Silty clay of low plasticity with gravel | |
| otechnical for emban | (C) projec work in th | T | Corrected SR Value (N _c) | | | 15 | ' | 34 | ' | 39 | ' | 29 | ' | 30 | ' | 33 | ' | 39 | ı | 39 | ' |
| lucting geo dges and 1 | idor (HOR ing IR netv | ənleV | - Dbserved SPT V | - 0 | - 0 | 0 12 | - 0 | 0 34 | - 0 | 0 45 | - 0(| 0 29 | - 0(| 0 | - 0(| 0 53 | - 0(| 69 0 | - 0(| i0 39 | - 0 |
| Cond of brid | ect Corri existi | (w) " | d (a code of the defendence o | 0.00 | 3-1 1.00 | -1 2.5(| 3-2 4.00 | -2 5.5(| 3-3 7.00 | -3 8.5(| 3-4 10.0 | 4 11.5 | 3-5 13.0 | -5 14.5 | 3-6 16.0 | -6 17.5 | 3-7 19.0 | -7 20.5 | 3-8 22.0 | -8 23.5 | S* 25.0 |
| Duroit | | ə | avT slqms2 | DS | UDS | SPT | UDS | SPT | UDS | SPT | UDS | SPT | UDS | SPT | UDS | SPT | UDS | SPT | UDS | SPT | Ĩ |



| í. | 22 | | Compression Index (C _c) | - | T | | | | T | - | | | 1 | | - | ı | | T | - | T | ı. |
|--|---|--------------------|---|----------|---------|---------|---------|---------|---------|----------|-----------------|----------------------------------|----------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------|
| ef. Code | 544_21- | ameters | (کس ₇ ,W3) 10. ₂ (SW | 1 | ı | ı | | 1 | ı | ı | 1 | | | 1 | I | ı | 1 | ı | I | ı | |
| R | SR- | ion Par | (cm ² /Sec) (c ^x x 10.4 | ı | ı | | | ı | ı | | | | | ı | ī | ı | ı | ı | ı | 1 | ī |
| . 1 | 861 m | onsolidat | ressure Pressure | ı | ı | | | 1 | ı | | | | | 1 | ı | ı | 1 | ı | ı | ı | ı |
| R.I | (+)267.8 | C | Void Ratio (e_) | 1 | I | ı | | 1 | ı | ı | | | | 1 | I | ı | 1 | ı | I | 1 | 1 |
| | m | Â | Permeabilit (cm/sec) | ı | ı | 1 | ı | 1 | ı | ı | ı | ı | 1 | 1 | i | 1 | 1 | ı | ı | ı | ı |
| | 091.386 | ente | Swelling Press (kg/cm ²) | ı | I | I | ı | ı | I | I | ı | ı | 1 | ı | I | ı | ı | ı | I | I | 1 |
| s (E,N) | 3123 | хәр | Free Swell Inc (%) | | ı | - | | - | 1 | - | | | | - | ī | - | - | - | ı | 1 | ī |
| ordinate | n | th | Angle of Friction (\$\$) | I | I | I | ı | 29 | I | 31 | ı | ı | 1 | - | I | I | - | I | I | I | I |
| Č | 150.915 | r Streng | Cohesion C (kg/cm²) | ı | I | ı | | 0.18 | ı | 0.19 | , | | 1 | | I | ı | | ı | I | ı | T |
| | 697(| Shea | test to sqvT | | ı | | | DST | ı | DST | | | | | I | ı | | ı | ı | 1 | I |
| nation oth | 0 m | ţţ | vrrð sifiseq2 | | | | | 2.66 | | 2.65 | | | | | | | | | | | , |
| Termir Dep | 50.00 | (_e mə) | Dry Density (g/ | ı. | ı | - | | 1.60 | ı. | 1.65 | | | | - | T. | | - | 1 | ı. | ı. | ı |
| Table | |) me | tsioM IsrutsN %) tnotnoO | 1 | ı | 1 | | 17.68 | ı | 18.10 | | | | | I | ı | | ı | I | ı | |
| f Water | 4.10 m | (_e mə/ | Bulk Density (g | | 1 | | | 1.88 | | 1.95 | | | | | | | | | ı | | ı |
| Depth of | 3 | | Shrinkage Limit | ı | I | | | - | 1 | | ı | ı | | - | I | | - | - | I | T | I |
| No. | .P1 | Limits % | Plasticity Index | 7 | ı | L | 1 | L | 1 | 9 | 1 | 7 | | L | ı | 9 | | 7 | ı | 7 | I |
| В.Н. | BH- | tterberg | Plastic Limit | 20 | ı | 21 | | 19 | T | 21 | | 21 | | 20 | ī | 21 | - | 19 | T | 21 | ı |
| ion | ge | V | timi.I biupi.I | 27 | 1 | 28 | | 26 | ı. | 27 | | 28 | | 27 | 1 | 27 | | 26 | ı. | 28 | ı. |
| Chainage n.)/Locat | 28+360 ajor Brid | | Coarse | 0 | ı | 0 | | 1 | ı | 0 | ' | 1 | | 0 | I | 2 | - | 2 | ı | 1 | , |
| (kr | M | etained | 9ni ^A | 8 | I | 9 | ı | 5 | I | 9 | ı | 10 | ı | 8 | I | 6 | ı | L | I | 10 | I |
| | -2021 | 1 % wt r | Coarse | 3 | I | L | ' | 4 | I | 8 | ' | c, | 1 | 5 | I | 2 | 1 | 5 | I | 3 | I |
| ring | 15-10 | tribution | Mandan Manda Mandan Manda Mandan Mandan Manda Mandan Mandan Manda Mandan Mandan Mand | 7 | ı | 12 | ' | 6 | ı | L | ' | 4 | | L | ı | 9 | | 4 | ı | 7 | ı |
| te of Bo | to | Size Dis | эпiЯ | 26 | ı | 21 | ' | 28 | T | 25 | ' | 23 | | 27 | T | 25 | 1 | 30 | T | 27 | |
| Da | -2021 | Grain | IIIS | 49 | ı | 46 | ' | 46 | ı | 48 | ' | 51 | ' | 46 | ı | 50 | | 45 | ı | 44 | ı |
| | 13-1(| | Clay | 7 | 1 | 8 | | L | - | 9 | | ~ | | L | ' | 9 | - | L | 1 | 8 | |
| esigning ital Rail | to | | lodmy2 21 | | | | | | | | | | | | | | | | | | |
| . report for de Haryana Orb | connectivity | uoj | ttsoffassificati | ML-CL | ı | ML-CL | ı | ML-CL | ı | ML-CL | | ML-CL | | ML-CL | I | ML-CL | ı | ML-CL | I | ML-CL | ı |
| nvestigation, preparation of geotechnical ment in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | | | | | | | Brown, Very dense, Sandy silt of | low plasticity with gravel | | | | | | | | |
| stechnical or embanl | C) project vork in the | Te | Corrected SI Value (N.) | 45 | 46 | 25 | 29 | , | 29 | , | - | - | - | - | - | - | - | - | - | - | - |
| ucting geo lges and fi | dor (HOR ng IR netv | ənlaV | (N) VD28ETVEd SPT V (V) | 0 93 | 0 98 | 0 54 | 0 63 | - 0 | 0 62 | - 0 | 0 100 (22cm) | 0 100 (20cm) | 0 100 (22cm) | 0 100 (21cm] | 0 100 (20cm) | 0 100 (20cm] | 0 100 (22cm) | 0 100 (22cm] | 0 100 (22cm) | 0 100 (21cm] | 5 >100 |
| Condt of bric | ect Corric existin | (ɯ) " | I.Ə morî diqaD | -9 25.51 | 10 26.5 | 11 28.0 | 12 29.5 | -9 31.0 | 13 32.5 | .10 34.0 | 14 35.50 | 15 37.0 | 16 38.50 | 17 40.0 | 18 41.50 | 19 43.0 | 20 44.5 | 21 46.0 | 22 47.5 | 23 49.0 | 24 49.2 |
| | ĥ | ə | qvT slqms2 | SPT. | SPT- | SPT- | SPT- | SQU | SPT- | UDS- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- |



| | | | | | | | | | | [| | | | | | | | | | | | |
|--|---|--------------------|--|------|---|--------|----------------------------|-----------|--------|--------|---------|---------|---------|---------|-----------------------------|-------------------------------|-----------------|---------|-----------------|---------|-----------------|---------|
| e | -22 | | Compression Lndex (C _e) | | | | | | | | | | | | | | | | | | | |
| Ref. Cod | -544_21 | rameter | (cm ² /Kg) M _v x 10 ⁻² | ı | | ı | ı | ı | ı | ı | I | ı | ı | I | ı | ı | ı | I | ı | ı | I | |
| - | SR | tion Pa | (cm ² /Sec) C ^x X 10.4 | I | ı | ı | 1 | ı | ı | I | ı | | | T | ı | | | T | ı | T | I | ı |
| L. | .285 m | Consolida | Pressure Pressure | ı | | 1 | 1 | 1 | 1 | 1 | ı | | | ı | 1 | | | ı | 1 | 1 | I | I |
| R. | (+)267 | U | Void Ratio (e ₀) | I | ı | ı | 1 | | ı | ı | I | - | - | T | | - | - | T | | - | I | |
| |) m | Â | Permeabilit (cm/sec) | 1 | | | | | | | 1 | | | ı | | | | ı | | | ı | ı |
| | 3064.68(| əıne | Swelling Press (kg/cm ²) | ı | | | | - | | | ı | - | - | ī | - | | - | ī | - | - | ı | |
| s (E,N) | 312 | хәр | Free Swell Inc (%) | ı | ı | , | ı | ı | , | ı | ı | ı | ı | ı | ı | ı | ı | ı | ı | ı | I | |
| ordinate | ш | gth | Angle of (°q) noticity | 1 | ' | 23 | ' | 27 | ' | 27 | ı | 28 | ' | ı | ' | 30 | ' | ı | ' | ' | ı | 1 |
| C | 7046.700 | ear Streng | Cohesion C (kg/cm²) | ı | ı | 0.20 | ı | 0.09 | ı | 0.18 | ı | 0.18 | ı | ī | ı | 0.19 | ı | ī | ı | 1 | ı | ı |
| | 69 | She | rsoT to of Test | , | ' | DST | ' | DST | ' | DST | 1 | DST | | ı | | DST | | ı | | | ı | ı |
| nation pth |)0 m | ŢŢŢ | vrað sifiseq2 | 1 | , | 2.66 | , | 2.65 | | 2.66 | ı | 2.65 | 1 | 1 | 1 | 2.66 | 1 | 1 | 1 | 1 | ı | ı |
| Termi Dej | 50.0 | (_e mə) | Dry Density (g/ | ı | , | 1.52 | , | 1.56 | , | 1.60 | ı | 1.62 | , | 1.61 | , | 1.65 | , | , | , | , | ı | |
| Table | |) nre | tsioM IsrutsN %) tnətnoD | ı | | 11.67 | | 11.26 | | 13.27 | ı | 14.36 | | 14.89 | - | 15.74 | | ı | - | | ı | ı |
| f Water | 3.85 m | (_e ɯə/ | Bulk Density (g | ı | ı | 1.70 | ' | 1.74 | | 1.81 | ı | 1.85 | 1 | 1.85 | 1 | 1.91 | 1 | ı | 1 | 1 | I | ı |
| Depth of | 3 | . 0 | Shrinkage JimiJ | ı | | | | | | | 1 | | | ı | , | | | ı | , | | I | |
| No. | -P2 | Limits % | Plasticity Index | ı | | ٢ | 1 | 5 | 1 | ٢ | | 9 | - | L | - | 9 | - | - | L | - | 7 | I |
| B.H. | Ηđ | tterberg | Plastic Limit | 1 | | 21 | | 20 | | 20 | - | 20 | - | 20 | - | 20 | - | T | 20 | - | 21 | I |
| e tion | lge | V | timi.I biupi.I | ı | | 28 | 1 | 25 | 1 | 27 | 1 | 26 | - | 27 | - | 26 | - | ī | 27 | | 28 | I |
| Chainag m.)/Loca | 28+360 1ajor Bric | | Coarse | ı | , | 0 | , | 0 | , | 0 | ı | 0 | 1 | 1 | ı | 0 | 1 | ı | 0 | ı | 0 | I |
| (k | N | retained | Q. ani ^A | 1 | ' | - | ' | 2 | ' | 4 | 1 | 9 | ' | 5 | ' | 8 | ' | ı | 10 | ' | 7 | ı |
| | 0-2021 | n % wt | Coarse | ı | ' | с | ' | 4 | ' | 4 | ı | 3 | ı | 2 | 1 | 3 | ı | ı | 1 | ı | 2 | ı |
| oring | 14-1 | stributio | Sand muibəM | ı | ı | ٢ | ı | 12 | ï | 5 | ı | 5 | ı | 9 | ı | 4 | ı | ı | 9 | ı | 7 | ı |
| ate of Bo | to | Size Di | əniA | 1 | ' | 34 | ' | 43 | ' | 28 | ı | 27 | ' | 30 | ' | 30 | ' | I | 30 | ' | 26 | I |
| Ö | 0-2021 | Grain | IIIS | ı | ı | 48 | ' | 34 | 1 | 55 | ı | 53 | ' | 49 | ' | 49 | ' | ı | 46 | ' | 50 | ı |
| | 12-1 | | Clay | 1 | 1 | 7 | | s | | 7 | - | 9 | - | 7 | - | 9 | - | 1 | 7 | 1 | 8 | ' |
| ssigning ital Rail | to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| report for de Haryana Orb | connectivity | uoj | IS Classificati | , | | ML-CL | , | SM-SC | , | ML-CL | | ML-CL | | ML-CL | ı | ML-CL | ı | ı | ML-CL | | ML-CL | ı |
| technical 1 iction of F | ncluding c | | | | 'low | | sand | | | | | | | | Sandy | avel | | | | | | |
| investigation, preparation of gec ment in connection with constri | from Palwal to Harsana Kalan i state of Haryana. | | Soil Description | | Brown, Loose, Sandy silt of plasticity | | Brown, Medium dense, Silty | with clay | | | | | | | Brown, Dense to very dense, | silt of low plasticity with g | | | | | | |
| technical : or embank | project ork in the | Te | IS betzered SI Value (N _c) | I | 16 | ' | 23 | 1 | 32 | | 33 | 1 | 40 | I | 36 | ı | - | I | - | 1 | - | |
| tting geol ges and fc | lor (HORC g IR netw | ənlaV | Observed SPT (N) | 1 | 10 | ' | 20 | ' | 34 | ' |) 40 | - |) 55 | - (|) 55 | - |) 100 (20cm) | - (|) 100 (20cm) | - |) 100 (19cm) | - |
| Condu of brid | et Corrid existin | (u) " | I.Ə morî diqeD | 0.00 | 1 1.00 | 1 2.50 | 2 4.00 | 2 5.50 | 3 7.00 | 3 8.50 | 4 10.00 | 4 11.50 | 5 13.00 | 5 14.50 | 5 16.00 | 6 17.50 | 7 19.00 | ⊧ 20.50 | 3 22.00 | * 23.50 |) 25.00 | * 26.50 |
| | afor | ə | qvT əlqms2 | DS | SPT-1 | -SQU | SPT-2 | :-SQU | SPT-3 | S-SQU | SPT⊣ | UDS-≁ | SPT-5 | -SQU | SPT-6 | NDS-(| ?-Tq2 | UDS* | 3-T-S | UDS* | SPT-5 | UDS* |



| | | | | | 1 | | | | | | | | | | | | | | |
|---|--|--------------------|--|---------|---------|------------|-------|------------|---------|------------|-----------------------------------|------------------------------------|------------|------------|---------|---------|---------|---------|-------|
| a | -22 | | Compression Index (C _c) | ı | ı | ' | ' | ı | ı | I | I | ı | ı | I | ı | ı | ı | I | |
| tef. Cod | -544_21 | ameters | (cm ² /Kg) M _{v x} 10 ⁻² | 1 | ı | ı | ı | ı | ı | I | I | ı | I | I | ı | ı | ı | I | ı |
| R | SR | tion Par | (cm ² /Sec) C ^A X 10.7 | I | I | ı | 1 | ı | ı | I | I | ı | I | I | ı | ı | ı | I | I |
| Ŀ | 285 m | Consolidat | Pressure Pressure | 1 | | | | | | ı | 1 | | ı | | | | | | ı |
| R | (+)267. |) | Void Ratio (e_) | | | | | ı | ı | I | ı | ı | ı | ı | ı | ı | ı | ı | ı |
| | m | Â | Permeabilit (cm/sec) | | | | | | | 1 | 1 | | 1 | 1 | 1 | | | 1 | |
| | 064.680 | ane | Swelling Press (kg/cm ²) | I | I | ı | 1 | ı | ı | I | I | ı | I | I | ı | ı | ı | I | I |
| (E,N) | 3123 | хәр | Free Swell Inc (%) | I | I | ı | ı | ı | ı | I | i | ı | I | ı | ı | ı | ı | I | ı |
| rdinates | ſ | h | Angle of Friction (\$^) | 1 | ı | 1 | 1 | | | I | I | | I | I | ı | ı | | I | |
| Co | 046.700 n | ar Strengt | Cohesion C (kg/cm ²) | ı | ı | | | - | - | ı | I | - | 1 | I | | - | - | I | ı |
| | 697 | She | tsəT to əqvT | ı | I | | | - | - | ı | ı | - | | - | - | | - | | ı |
| ination pth | 00 m | ţţ | verð sifisøq2 | 1 | ı | , | , | | | | 1 | | | 1 | 1 | | | 1 | ı |
| Term | 50.(| (_e wə | Dry Density (g/ | ı | ı | ' | ' | ' | ' | ı | ı | ' | ı | ı | 1 | 1 | ' | ı | ' |
| r Table | |) Inte | tsioM IsrutsN %) tnətnoD | ı | ı | ' | ' | | | ı | ı | | ı | ı | | ı | | ı | ' |
| of Wate | 33.85 m | (_e wə/ | g) ytiznəU AluB | | I | ı | ' | ' | ' | I | I | ' | ı | I | ı | ı | ' | I | I |
| Depth | | % | Shrinkage Limit | I | I | ı | ' | ' | ' | I | I | ' | ı | I | ı | ı | ' | I | I |
| . No. | I-P2 | g Limits ' | Plasticity Index | ٢ | ı | 9 | ' | 9 | | 7 | 1 | L | | 7 | | L | | ı | |
| B.H | BF | Atterberg | Plastic Limit | 20 | ı | 21 | ' | 20 | | 20 | ı. | 21 | 1 | 20 | | 19 | | ı | |
| e tion | lge | | timi.I biupi.I | 27 | ı | 27 | ' | 26 | | 27 | ı. | 28 | ı | 27 | ı | 26 | | ı | |
| Chainag n.)/Loca | 28+360 ajor Bric | | Coarse | 0 | I | 0 | ' | 0 | | 0 | I | 0 | I | 1 | ı | 1 | | I | I |
| (kr | M | retained | eni E | ∞ | | 10 | , | L | | 6 | ı | 8 | 1 | L | ı | 6 | | ı | ı |
| | 0-2021 | n % wt | Coarse | 2 | ı | б | ı | 1 | 1 | 4 | I | 2 | ı | 1 | ı | 4 | 1 | I | ı |
| oring | 14-1 | stributio | Sand Medium | ٢ | ı | 9 | ' | 5 | | 8 | ı | 10 | ı | 11 | | 6 | | ı | ' |
| ate of Bo | to | ı Size Di | Pine | 28 | I | 24 | ı | 29 | ı | 22 | I | 24 | I | 26 | ı | 25 | ı | I | I |
| Q | 0-2021 | Graiı | IIIS | 47 | ı | 50 | ı | 52 | 1 | 50 | I | 48 | ı | 47 | ı | 45 | 1 | I | ı |
| | 12-1 | | VaD | ∞ | | L | | 9 | - | 7 | - | 8 | - | L | - | L | - | - | |
| lesigning bital Rail | , to | | lodmy2 21 | | | | | | | | | | | | | | | | |
| l report for d Haryana Orl | connectivity | uoj | IS Classificati | ML-CL | | ML-CL | | ML-CL | · | ML-CL | ı | ML-CL | ı | ML-CL | ī | ML-CL | · | | |
| nvestigation, preparation of geotechnica ment in connection with construction of | rom Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | | | | | | Brown, Dense to very dense, Sandy | silt of low plasticity with gravel | | | | | | | |
| echnical i r embank |) project ork in the | Te | Corrected SI Value (N _c) | 46 | I | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | ı | ı | 1 | ı | 1 |
| cting geot ges and fo | or (HORC g IR netw | ənlaV | Observed SPT (N) | 100 | 1 | 100 (19cm) | | 100 (21cm) | - | 100 (20cm) | , 100 (23cm) | 100 (20cm) | 100 (22cm) | 100 (24cm) | >100 | >100 | >100 | >100 | 1 |
| Condue of bridg | Corrido existing | (ɯ) " | I.Ə morî diqəU | 0 28.00 | : 29.50 | 1 31.00 | 32.50 | 2 34.00 | , 35.50 | 3 37.00 | 4 38.50 | 5 40.00 | 6 41.50 | 7 43.00 | 8 44.50 | 9 46.00 | 0 47.50 | 1 49.00 | 49.23 |
| Proiec | | ə | qvT əlqmsZ | SPT-1(| UDS* | SPT-1 | UDS* | SPT-1 | UDS* | SPT-1 | SPT-1 | SPT-1: | SPT-1(| SPT-1 | SPT-1 | SPT-19 | SPT-2(| SPT-2 | ı |



| de | 1-22 | S | Compression | | I | ı | ı | 1 | 1 | 1 | I | i. | I | I | 1 | 1 | I | | ı | 1 | 1 | I |
|---|--|---|---|------|--------------------------|-------|-------|-------|-------|-------|-------|-------|---------------|-----------------------------|--------------------------------|-------|-------|-------|-------|-------|-------|-------|
| Ref. Co | -544_2 | rametei | (W ² ,W ²) س ² ،01 | | ı | | , | | | | ı. | ı. | i. | I. | , | | I. | | ı | ı. | | ı |
| - | SR | ion Pa | (cm ² /Sec) C ^x x 10.4 | - | | | | | | | | | 1 | | | | | | | , | | I |
| | 528 m | onsolidat | Pressure Pressure | - | | 1 | 1 | | 1 | | ı | I | I | I | ı | ı | I | ı | | ı | 1 | , |
| R.] | (+)267. |) | Void Ratio (e_) | I | | I | I | | I | | ı | 1 | I | | ı | I | | I | | | I | |
| | m 5 | Â | Permeabilit (cm/sec) | | | 1 | 1 | | ī | 1 | ı | ı | ı | ı | ı | ı | ı | 1 | | ı | 1 | , |
| | 046.953 | nre | Swelling Press (kg/cm ²) | - | ı | ī | ī | | ī | | ı | ı | I | ı | ı | I | ı | ī | | ī | ı | ı |
| : (E,N) | 3123 | хәр | Free Swell Inc (%) | I | ı | T | I | I | I | | I | I | I | I. | I | I | I. | T | I | | T | |
| rdinates | - | h | Angle of Friction (φ°) | ı | 28 | 1 | 27 | ı | T | ı | 28 | I | 30 | I | I | I | I | I | ı | I | ı | |
| Col | 043.901 m | ar Strengt | O noiesion C (kg/em ²) | 1 | 0.00 | | 0.20 | | | | 0.18 | - | 0.18 | 1 | ı | ı | 1 | | | 1 | ı | I |
| | 697 | She | ts9T to 9qvT | | DST | | DST | | | | DST | - | DST | - | ı. | ı | - | ı | | 1 | ı | |
| ation th |) m | ity | verd sific Grav | | 2.62 | | 2.66 | | | | 2.66 | 1 | 2.65 | ı. | ı. | ī | ı. | 1 | | 1 | 1 | |
| Termin Dep | 40.00 | (em3) | Dry Density (g/ | ı | 1.50 | 1 | 1.63 | | 1.63 | 1 | 1.63 | I | 1.65 | I | I | ı | I | ı | ı | I | ı | |
| Table | |) nte | tsioM latutaN %) tnətnoD | | 10.43 | ı | 12.40 | | 13.04 | 1 | 13.78 | ı | 14.76 | ı | ı | ı | ı | ı | | 1 | ı | 1 |
| Water | 4.20 m | (_e wə/ | Bulk Density (g | ı | 1.66 | 1 | 1.83 | 1 | 1.84 | | 1.85 | I | 1.89 | I | I | I | I | ı | 1 | I | ı | |
| Depth o | 3 | | Shrinkage Limit | | | 1 | 1 | | ī | 1 | ı | ı | I | T | ı | ı | T | ı | 1 | ı | 1 | , |
| No. | 12 | imits % | Plasticity Index | ı | ďN | ı | 7 | 1 | 9 | , | 7 | I | 6 | I | I | ٢ | I | 7 | 1 | 6 | ı | 7 |
| В.Н. 1 | BH-/ | terberg I | Plastic Limit | | Nil | | 20 | | 21 | | 19 | | 20 | | 1 | 20 | | 21 | | 21 | | 21 |
| uo | e | AI | timiJ biupiJ | | | 1 | 27 | 1 | 27 | | 26 | I | 26 | I | I | 27 | I | 28 | 1 | 27 | 1 | 28 |
| Jhainage 1.)/Locati | 28+360 ajor Bridg | | Coarse | - | 0 | 1 | 0 | ı | 0 | ı | 2 | I | 0 | I | I | 0 | I | 1 | ı | 2 | 1 | 0 |
| (kn | M | etained | e G | | 0 | ı | 4 | | 9 | | 5 | ı | 8 | I | ı | 9 | I | 7 | 1 | 5 | ı | 10 |
| | -2021 | % wt ro | Coarse | - | 1 | - | 4 | ī | £ | ı | 4 | I | 5 | I | I | 9 | I | 3 | ı | 5 | ı | 8 |
| ing | 13-10 | tribution | Sand Medium | ı | 11 | ı | 5 | | 8 | 1 | 6 | I | 11 | I | I | 6 | I | 4 | 1 | 6 | ı | 14 |
| te of Boı | to | Size Dist | Aine | ı | 56 | ı | 30 | ı | 31 | ı | 28 | I | 23 | I | I | 22 | I | 28 | ı | 26 | ı | 16 |
| Da | -2021 | 46 - 50 - 33 - Silt | | | | | | | | | 48 | i. | 47 | I. | I | 50 | I. | 49 | ı | 46 | - | 4 |
| | 12-10 | · ∞ · · · · · · · · · · · · · · · · | | | | | | | | | | | 7 | ı | ∞ | | | | | | | |
| igning al Rail | | lodmy2 21 | | | | | | | | | | | | | | | | | | | | |
| eport for des aryana Orbit | onnectivity to | uoj | IS Classificati | 1 | SM | ı | ML-CL | ı | ML-CL | 1 | ML-CL | ı | ML-CL | ı | ı | ML-CL | ı | ML-CL | 1 | ML-CL | ı | ML-CL |
| echnical r ction of H | cluding co | | | | | | | | | | | | | Sandy | avel | | | | | | | |
| investigation, preparation of geo kment in connection with constru | from Palwal to Harsana Kalan ir e state of Haryana. | | Soil Description | | Brown, Loose, Silty sand | | | | | | | | | Brown, Dense to very dense, | silt of low plasticity with gr | | | | | | | |
| technical or emban | C) projec /ork in th | Topological Topological <thtopological< th=""> <thtopological< th=""></thtopological<></thtopological<> | | | | | | | | | | | | | | | | | | | | |
| ting geot yes and fc | or (HOR(5 IR netw | Observed SPT Value (N) (1) (21cm) (21cm) (1) | | | | | | | | | | | 100 (20cm) | | | | | | | | | |
| Conduc of bridg | Corride existin£ | (ɯ) " | I.Ə morî diqe | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 |
| Droioot | and the second sec | Э | qvT əlqms2 | DS | UDS-1 | SPT-1 | UDS-2 | SPT-2 | UDS-3 | SPT-3 | UDS-4 | SPT-4 | UDS-5 | SPT-5 | UDS* | SPT-6 | UDS* | 2PT-7 | *SQU | SPT-8 | *SQU | 6-TqS |



| e | -22 | | τ | Compression (,Compression | | ı | ı | ı | ī | ī | ı | ı | ī |
|--|--|--------------------|------------------------|--|--------|----------|--------|------------------|---|------------------|--------|------------------|------------------|
| lef. Cod | -544_21 | ameters. | | (cm ² /Kg) M _{v x} 10 ⁻² | | | | | | | | | |
| I | SR | tion Par | | (cm ² /Sec) C _v x 10.4 | - | ı | I | ı | I | I | ı | ı | I |
| T. | .528 m | Consolida | | (kg/cm ²⁾ | | ı | ı | ' | | | | | |
| R | (+)267 | | (0 | 9) oita Ratio (e | | I | I | ı | ı | ı | ı | ı | ı |
| | В | Â | i) (i | Permeabi (cm/sec | | | | | | | | | |
| | 3046.953 | nre | (₇ Issə | mə\ganilləw2 mə\gan | - | ı | I | 1 | 1 | 1 | ı | ı | 1 |
| s (E,N) | 312 | xəp | pul | [II9w2 997] Free Swell] | | | | | | | | | |
| ordinate | Е | ţth | (| fo slgnA (°φ) noitsirA | ı | ı | ı | ı | ı | ı | ı | ı | ı |
| ŭ | 7043.901 | ear Streng | | Соћезіоп С (kg/cm²) | ' | ' | | | ' | ' | ' | | ' |
| | 69 | She | 1 | lesT to sqvT | ' | | | ' | ' | ' | ' | | ' |
| nination epth | .00 m | ity | IVB. | rÐ sifisəqZ | ı | | | ' | | | ' | | |
| Tern D | 40 | (emo |) /B) | Dry Density | ' | ı | ı | ' | ' | ' | ' | ı | ' |
| r Table | _ |) nre | dsi (%) | oM lstural Mo) tnotno) | ' | ' | | ' | ' | ' | ' | | ' |
| of Wate | 34.20 m | (₂ mə) | /ð) | Tulk Density | ' | , | | ' | ' | ' | ' | | ' |
| Depth | | % | | Shrinkage Jimit | - | ' | | ' | ' | ' | ' | | ' |
| H. No. | H-A2 | g Limits | | Plasticity X9bnI | ' | | | ٢ | | 9 | ' | | |
| B.I | BI | Atterber | 1 | imi.I siterl¶ | ' | ' | · | 20 | ' | 20 | ' | | ' |
| çe tion | lge | | 1 | imiJ biupiJ | ı | ı | ı | 27 | ı | 26 | ı | ı | ı |
| Chainag m.)/Loca | 28+360 1ajor Brio | | avel: | Coarse | ' | ı | ı | 0 | 1 | n | 1 | 1 | 1 |
| (k | ~ | retained | Ū | əniA | ' | ' | ı | 6 | ' | ∞ | ' | ' | ' |
| | 0-2021 | n % wt i | | Coarse | ' | ' | | 7 | ' | 4 | ' | | ' |
| ring | 13-1 | stributio | Sand | muibəM | ' | ı | ı | 10 | ' | 13 | ' | ' | ' |
| ate of Bo | 5 | ı Size Di£ | | əniA | ' | ' | | 20 | ' | 19 | ' | ' | ' |
| ũ | 0-2021 | Grain | | μis | ' | ' | | 47 | ' | 47 | ' | ' | ' |
| | 12-1 | | | VrIJ | • | | - | 7 | 1 | 9 | | - | 1 |
| lesigning bital Rail | y to | | ю | dmy2 2I | | | | | | | | | |
| d report for c Haryana Or | ç connectivit | uo | ite | IS Classific | I | | 1 | ML-CL | | ML-CL | , | | |
| investigation, preparation of geotechnica ment in connection with construction of | from Palwal to Harsana Kalan including : state of Haryana. | | | Soil Description | | | | | Brown, Dense to very dense, Sandy silt of low plasticity with gravel | | | | |
| technical or embank | C) project vork in the | T | (°N dS | Corrected Value (f | | | | - | | - | | - | - |
| ducting geot idges and fo | ting IR netw |), alue | ۱ ۱ ۰۰ | Observed SP (V) | - 00 | 50 >100 | - 00 | 50 100 (19cm) | - 00 | 50 100 (25cm) | - 00 | 50 100 (18cm) | 00 100 (25cm) |
| Conc of br | oject Corr exist | (m) " | 46 1.4 | 1 9iqiniso A mort dta9(] | S* 28. | r-10 29. | S* 31. | ſ-11 32 |)S* 34. | [-12 35 | S* 37. | [-13 38. | -14 40. |
| | Ĕ | | | T .lamo2 | П | LdS | n I | LdS | Ы | SP1 | Б | LdS | SP1 |





| c) | -22 | | Compression (C.) Tadex (C.) | | | | | | | | | | | | | | ı. | | | | | | |
|---|--|------------------------------|--|-------|-------|--------|--|--|--------|--------|---------|----------------------------------|----------------------------|---------|---------|---------|---------------|--------------------------------|------------------------|---------------|---------------|---------------|---------------|
| Ref. Cod | -544_21 | cameters | (cm ² /Kg) M ^{x x} 10 ⁻² | | | ı | | | | | | | 1 | ı | , | | ı | ı | | | | | |
| ſ | SR | ation Pa | (cm ⁵ /Sec) C ^a x 10-4 | | | ı | ı | ı | ı | | 1 | ı | ı. | ı | ı | ī | T | ı | | ' | 1 | ı | ı |
| L. | 2.678 m | Consolid ⁸ | (kg/cm ²⁾ Pressure | | | ı | 1 | | 1 | - | | | I | ı | | ı | I | ı | | | | 1 | |
| H | (+)26 | | Void Ratio (e ₀) | ' | | ı | ı | ' | ' | ' | ' | ' | ı | ı | ı | ı | ı | · | ' | ' | ' | ı | ı |
| | 34 m | Â | Permeabilit; (cm/sec) | , | | ı | ı | ı | ı | ı | ' | ı | ı | ı | ı | ı | ı | ı | , | ' | ' | ı | |
| | 23223.83 | nre | sera gnilləw2 (kg/cm ²) | ' | ' | ' | ' | ' | 1 | ' | ' | ' | ' | ' | ' | ' | 1 | | ' | ' | ' | ' | |
| tes (E,N) | 31 | xəp | Free Swell Inc (%) | ' | ' | ı | ' | ' | ' | ' | ' | ' | ' | ı | ' | ' | 1 | · | ' | ' | ' | ' | ' |
| Ordinat | ш | gth | Angle of Friction (\$°) | ' | | 26 | ' | ' | ' | 27 | ' | 29 | ' | 1 | ' | 5 | ı | ' | ' | ' | ' | ' | |
| 0 | 96531.197 | ear Stren |) noisəho Соhеsion С (kg/cm²) | | , | 0.21 | ' | ' | ' | 0.18 | ' | 0.20 | ' | ' | ' | 3.16 | ' | | | ' | ' | ' | , |
| | 69 | Sh | tsoT to oqYT | ' | , | DST | ı | , | 1 | DST | , | DST | ı | ı | ı | UUT | ı | , | , | , | , | ı | |
| nation pth | 0 m | ity | vraD sifis9q8 | | | 2.66 | | - | - | 2.66 | - | 2.66 | ı. | ı | ı | 2.68 | T | - | | | - | - | , |
| Termi Dej | 40.0 | (_e wə | Dry Density (g/ | | | 1.57 | - | 1.58 | - | 1.58 | | 1.65 | | | | 1.70 | | | | | | - | |
| . Table | |) nre | tsioM IrutrN %) tnotnoD | | | 12.10 | ı | 12.78 | 1 | 13.04 | | 13.90 | ı | ı | ı | 15.47 | I | ı | | | | ı | |
| of Water | 36.90 m | (_e wə) | Bulk Density (g/ | | | 1.76 | | 1.78 | - | 1.79 | - | 1.88 | 1 | 1 | ' | 1.96 | ı. | | | | - | | |
| Depth | | % | Shrinkage Limit | , | | ı | ı | - | | - | - | - | I | ı | ı | ı | I | | , | , | - | ı | |
| . No. | -A1 | Limits 9 | Plasticity Index | ' | | 9 | ı | L | ľ | L | | 9 | I | 10 | ı | 11 | I | 11 | ' | 11 | | 10 | |
| B.H | BH | Atterberg | Plastic Limit | ' | | 20 | ' | 20 | ' | 19 | ' | 21 | 1 | 20 | ' | 22 | ı | 21 | ' | 21 | ' | 20 | |
| e tion | lge | 1 | timiJ biupiJ | | | 26 | ' | 27 | ' | 26 | - | 27 | 1 | 30 | ' | 33 | ı | 32 | , | 32 | - | 30 | |
| Chainag m.)/Loca | 28+900 Aajor Brio | | Coarse | ' | , | 0 | I | 0 | ı | 0 | ' | 0 | ı | 0 | ı | 0 | I | 1 | , | 2 | ' | 0 | |
| (k | N | retained | Pine D | ' | ' | 2 | ' | 3 | ' | 5 | ' | 8 | ' | 4 | ' | 9 | 1 | 11 | ' | 8 | ' | 12 | |
| | 0-2021 | n % wt | Coarse | ' | , | 2 | ı | 5 | 1 | 4 | , | 3 | ı | 9 | ı | 3 | ı | 2 | , | 3 | , | 2 | |
| oring | 21-1 | stributio | Sand MuibəM | , | ' | 10 | ı | 14 | ı | 6 | 1 | 5 | ı | 9 | ı | 4 | I | 3 | , | ٢ | 1 | 3 | |
| ate of Bc | to | ı Size Di | əniA | ' | , | 32 | ı | 27 | ı | 30 | , | 28 | ı | 19 | ı | 15 | ı | 16 | , | 19 | 1 | 20 | |
| D | 0-2021 | Grair | માંડ | ' | ' | 48 | I | 44 | 1 | 45 | ' | 50 | I | 55 | ı | 60 | I | 56 | ' | 49 | ' | 53 | |
| | 18-1 | | Val O | • | | 9 | - | 7 | - | 7 | - | 9 | - | 10 | • | 12 | - | 11 | ' | 12 | | 10 | • |
| designing Abital Rail | ty to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | | |
| al report for f Haryana C | g connectivi | uo | IS Classificati | | , | ML-CL | 1 | ML-CL | - | ML-CL | - | ML-CL | 1 | CL | 1 | CL | | CL | | CL | - | CL | ı |
| nvestigation, preparation of geotechnic ment in connection with construction o | rom Palwal to Harsana Kalan includin. state of Haryana. | | Soil Description | | | | Brown, Medium dense to dense, Canda site of Lana alocition with | bandy sill of row pasticity with gravel | | | | Brown, Very dense, Sandy silt of | low plasticity with gravel | | | | | Brown, Hard, Silty clay of low | plasticity with gravel | | | | |
| technical ii or embankı |) project ork in the | T | Corrected SR Value (N,) | | 43 | ı | 22 | ı | 27 | ı | 26 | ı | 1 | 64 | 68 | ı | 100 (23cm) | 100 (21cm) | 100 (24cm) | 102 (21cm) | 100 (23cm) | 100 (25cm) | 100 (21cm) |
| cting geot ges and fc | or (HORC g IR netw | ənls/ | (N) VDserved SPT V | , | 27 | I | 20 | ı | 29 | ı | 32 | 1 | 100 (30cm) | 64 | 68 | 1 | 100 (23cm) | 100 (21cm) | 100 (24cm) | 102 (21cm) | 100 (23cm) | 100 (25cm) | 100 (21cm) |
| Condue of bridg | corride existing | (w) '' | J.Ə morî diqəU | 00.00 | 1.00 | 1 2.50 | 2 4.00 | 2 5.50 | 3 7.00 | 3 8.50 | 1 10.00 | 4 11.50 | 5 13.00 | 5 14.50 | 7 16.00 | 5 17.50 | 3 19.00 |) 20.50 | 0 22.00 | 1 23.50 | 2 25.00 | 3 26.50 | 4 28.00 |
| Ductor | aforr | ə | qvT əlqms2 | DS | SPT-1 | -SQU | SPT-2 | :-SQU | SPT-3 | -SQU | ≻TqS | ∩DS- | SPT-5 | SPT-6 | SPT-7 | UDS-: | 3-TqS | 5-LdS | SPT-1 | SPT-1 | SPT-1. | SPT-1. | SPT-1 |



urbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated ided Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

| | ndistu | поща | |
|-------|---------|------------|--|
| | U-SC | on Re | |
| | st, Ul | Test | |
| | on Te | Shear | |
| | etrab | irect | |
| | d Per | <u>р-+</u> | |
| | andar | DST. | |
| | PT-St | r Test | |
| | ole, Sl | Shear | |
| л. | Samp | axial | |
| thons | Inbed | d Tri | |
| Tevia | Distu | Iraine | |
| Ab | S | Unc | |

| e a | -22 | | Compression Index (C,) | I | | , | , | , | ı | ī | |
|---|---|--------------------|--|---------------|---------------|--------------------------------|------------------------|---------------|---------------|--------|--------|
| ef. Code | 544_21- | imeters | (گא ^ر شی) ۳.01 x _v M | , | | | , | | 1 | | |
| R | SR- | on Para | (oəs/zmo) | | , | | , | | - | | 1 |
| | 78 m | onsolidati | Lressance | | | | | | | | |
| R.L | (+)262.6 | ŭ | (09) oitsA bioV | | | | | | | , | |
| | в | Â | Permeabilit (598/m2) | | | | | | | | , |
| | 3223.834 | nre | seriling Press (kg/cm ²) | | , | , | , | , | 1 | 1 | 1 |
| s (E,N) | 312 | xəp | Free Swell Inc (%) | | | | | | | | |
| rdinate | | h | Angle of Friction (\$°) | , | T | | | | | | ı |
| Co | 531.197 n | r Strengt | С noisəhoD (kg/cm²) | 1 | | | | | | | , |
| | 6969 | Shea | Type of Test | | | | | | - | - | |
| lation th | m (| ity | Specific Grav | | | | | | | | |
| Termir Dep | 40.0(| (_e mə | Dry Density (g/d | | | | | | | | |
| r Table | |) n.c | tsioM latural Moist (%) tnotnoD | 1 | | ' | ' | | ' | ' | |
| of Wate | 36.90 m | (_e wə, | Bulk Density (g/ | | | | | | | ' | , |
| Depth | | % | Shrinkage Limit | , | | ' | , | | ' | ' | , |
| H. No. | H-A1 | g Limits | Plasticity Index | 11 | ' | 10 | ' | 10 | ' | 11 | , |
| B.I | BI | Atterber | Plastic Limit | 23 | ' | 21 | ' | 20 | ' | 20 | , |
| ge ation | 0 idge | | timi.I biupi.I | 34 | ' | 31 | ' | 30 | ' | 31 | , |
| Chaina; cm.)/Loca | 28+900 Major Bri | | rave Coarse | - | ' | 0 | ' | ŝ | 1 | 0 | ı |
| (k | I | retained | o oniA | 6 | ' | 11 | ' | 6 | ' | 13 | ' |
| | 10-2021 | on % wt | Соягsе | 3 | ' | 1 | ' | 4 | ' | 1 | , |
| oring | 21- | istributi | Man MuibəM | 5 | ' | 7 | ' | 9 | ' | 4 | 1 |
| Date of E | to | in Size D | Fine | 17 | ' | 14 | ' | 20 | ' | 19 | ' |
| | 10-2021 | Gra | માંડ | 52 | ' | 56 | ' | 48 | ' | 53 | ' |
| | 18- | | yr]) | 13 | · | 11 | | 10 | - | 10 | ' |
| designing bital Rail | y to | | lodmy2 21 | | | | | | | | |
| l report for c Haryana Or | connectivit | uo | IS Classificati | CL | | CL | ı | CL | ı | CL | |
| nvestigation, preparation of geotechnica nent in connection with construction of | trom Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | Brown, Hard, Silty clay of low | plasticity with gravel | | | | |
| chnical i embank | project rk in the | T | 9 Corrected SP (₃ N) sulus (_N , | 100 (22cm) | 100 (25cm) | 100 (23cm) | 100 (30cm) | 100 (23cm) | 100 (20cm) | ı | |
| ing geote s and for | ·(HORC) IR netwoi | ən[v/ | V TAS byrysdO (N) | 100 (22cm) | 100 (25cm) | 100 (23cm) | 100 (30cm) | 100 (23cm) | 100 (20cm) | >100 | >100 |
| Conducti of bridge | Corridor existing | (w) " | J.Ə morî diqəQ | 29.50 | 31.00 | 32.50 | 34.00 | 35.50 | 37.00 | 38.50 | 40.00 |
| Ductoot | rroject | ə | qvT slqms2 | SPT-15 | SPT-16 | SPT-17 | SPT-18 | 61-T9S | SPT-20 | SPT-21 | SPT-22 |





| d) | -22 | | Compression (C) x9bn1 | | | , | | | | | | | | | | | | | | | | | |
|---|---|--------------------|---|------|--|--------|--------|--------|--------------------------------|------------------------|---------|---------|---------|---------------|---------|----------------------------------|----------------------------|---------------|---------------|---------------|---------------|--|------------|
| Ref. Cod | -544_21 | rameters | (500 ₇ /KG) W ^a x 10-7 | | , | | | | | | | | | | | | | | | | | | , |
| I | SR | ation Par | (cm ⁵ /Sec) C ^a x 10-4 | - | ı | - | - | - | | | - | | - | ı | ı | ı | - | | - | - | ı. | | |
| .L. | 3.022 m | Consolida | (kg/cm ²⁾ | | 1 | - | - | - | | | - | | 1 | | · | | | | - | | ı. | | , |
| H | (+)263 | | (₀ 9) oit RA bioV | - | I | - | - | - | , | ı | - | | - | I | I | | - | | - | - | I. | I | , |
| | l m | Â | Permeabilit; (cm/sec) | - | ı | - | - | ' | ' | ' | - | ' | 1 | ı | ı | ı | | ' | - | ' | ı | ı | , |
| | 23214.31 | nı.e | Swelling Press (kg/cm ²) | ' | 1 | ' | ' | ' | ' | ' | ' | ' | 1 | ı | ı | ı | ' | ' | ' | ' | ı | ı | , |
| es (E,N) | 31 | xəp | Free Swell Inc (%) | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | , |
| Ordinat | в | gth | Angle of (°°) | ' | 26 | ' | 5 | ' | 5 | ' | 4 | ' | 30 | ' | ' | ' | | ' | ' | ' | ' | ' | , |
| 0 | 6528.146 | ear Stren |) noisənd (^s mə/gx) | ' | 0.20 | ' | 1.75 | ' | 1.52 | ' | 2.43 | ' | 0.19 | ' | ' | ' | ' | ' | ' | ' | ' | ' | , |
| | 69 | Sh | tsoT to oqT | | DST | - | UUT | | UUT | , | UUT | , | DST | ı | ı | , | | | | | ı | ı | , |
| nation pth | 0 m | ţţ | vraÐ sifisəqZ | - | 2.66 | - | 2.67 | - | 2.68 | | 2.68 | | 2.66 | ı | ı | - | - | | - | - | I | ı | , |
| Termi Dej | 50.0 | (_e wə | Dry Density (g/ | | 1.58 | - | 1.64 | - | 1.63 | | 1.68 | - | 1.65 | ı | - | 1.66 | | - | - | - | - | - | , |
| Table | |) nı.c | tsioM Istural %) tnotnoD | - | 12.10 | - | 14.10 | - | 14.85 | | 15.04 | | 14.87 | ı | ı | 15.11 | - | | - | - | I | ı | , |
| of Water | 38.10 m | (_e wə) | Bulk Density (g/ | - | 1.77 | - | 1.87 | - | 1.87 | | 1.93 | | 1.90 | ı | | 1.91 | | | - | - | 1 | | |
| Depth | | • | Shrinkage Limit | - | 1 | - | - | - | | | - | | 1 | | ı | 1 | - | | - | | 1 | | , |
| . No. | -p1 | Limits 9 | Plasticity Index | | 7 | - | 11 | | 11 | | 11 | | L | ı | ı | 7 | | | L | | 11 | ı | 11 |
| B.H | BH | Atterberg | Plastic Limit | | 21 | | 22 | | 21 | , | 20 | | 20 | ı | ı | 21 | | | 19 | | 20 | ı | 21 |
| e tion | lge | V | timiJ biupiJ | - | 28 | - | 33 | - | 32 | , | 31 | | 27 | ı | ı | 28 | - | | 26 | | 31 | ı | 32 |
| Chainag m.)/Loca | 28+900 fajor Brid | | e Coarse | ' | 0 | ' | 1 | ' | 0 | | 0 | ' | 0 | | ' | 0 | | ' | 2 | ' | 2 | ' | 0 |
| (k | 2 | etained | ۲ine ي | ' | 4 | ' | 5 | ' | 7 | ' | 6 | ' | 10 | ı | ı | 12 | | ' | 6 | ' | 6 | ı | 12 |
| | 0-2021 | n % wt i | Coarse | ' | 3 | ' | 3 | ' | 2 | ' | 3 | ' | 2 | ' | ' | 4 | ' | ' | 3 | ' | 3 | ' | |
| oring | 22-1 | stributio | Man ManuibaM | ı | 6 | ı | 4 | ' | 8 | 1 | 4 | , | 8 | , | ı | 3 | 1 | 1 | 2 | 1 | 6 | ' | 6 |
| ate of Bc | to | ı Size Di | əniA | , | 26 | ' | 20 | ' | 17 | ' | 23 | , | 27 | ' | ı | 28 | 1 | , | 30 | ' | 20 | 1 | 18 |
| D | 0-2021 | Grair | HIS | ' | 54 | ' | 55 | ' | 55 | ' | 50 | ' | 46 | ı | ı | 45 | | ' | 47 | ' | 49 | ı | 48 |
| | 19-1 | | Clay | - | 7 | - | 12 | | 11 | ' | 11 | - | 7 | • | | 8 | - | - | 7 | - | 11 | • | 12 |
| designing rebital Rail | ty to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | | |
| al report for f Haryana O | connectivi | uo | IS Classificati | | ML-CL | ı | CL | | CL | , | CL | , | ML-CL | ı | I | ML-CL | | ı | ML-CL | ı | CL | ı | CL |
| nvestigation, preparation of geotechnic ment in connection with construction o | from Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | Brown, Medium dense, Sandy silt of low plasticity with gravel | | | | Brown, Hard, Silty clay of low | plasticity with gravel | | | | | | Brown, Very dense, Sandy silt of | low plasticity with gravel | | | | | Brown, Hard, Silty clay of low plasticity with gravel | |
| technical i | project ork in the | T | AS berected SP Value (N,) | , | 28 | , | 53 | 1 | 46 | , | 76 | ı | 1 | 55 | ı | | - | 1 | , | 100 (25cm) | 100 (27cm) | 100 (25cm) | |
| cting geot ges and fc | or (HORC g IR netw | ənle/ | V TAS bəvrəsdO (N) | , | , | 22 | , | 53 | , | 46 | 1 | 76 | 1 | 100 (22cm) | 82 | I | 100 (23cm) | 100 (21cm) | 100 (22cm) | >100 | 100 (25cm) | 100 (27cm) | 100 (25cm) |
| Condu of brid | Corrid existing | (ɯ) '' | J.Ə morî diqeD | 0.00 | 1 1.00 | 1 2.50 | 2 4.00 | 2 5.50 | 3 7.00 | 3 8.50 | 4 10.00 | 4 11.50 | 5 13.00 | 5 13.50 | 5 14.50 | 6 16.00 | 7 17.50 | 3 19.00 |) 20.50 | 0 22.00 | 1 23.50 | 2 25.00 | 3 26.50 |
| | 2011 | ə | qvT əlqms2 | SQ | UDS- | I-TqS | :-SQU | SPT-2 | -SQU | 5-T-J | -SQU | SPT⊣ | ;-SQU | 3-TqS | SPT-6 |)-SQU | €-TqS | 3-TqS | 5-TqS | SPT-10 | SPT-1 | SPT-1 | SPT-1. |



urbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated ided Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

| | Jndistu | temoul |
|---------|----------------|----------------|
| | 1-SQU | st on R |
| | n Test, | hear Te |
| | etration | irect Sl |
| | ard Pen | T+-D |
| | -Standa | est, DS |
| | e, SPT | hear T |
| | Sampl | axial S |
| ations: | curbed | ed Tri: |
| Abbrev | DS-Dist | Jndrain |

| Ref. Code | -22 | | npression dex (C _c) | oD II | ı | ı | ı | ı | ı | T | ı | ı | ı | T | ı | ı | ı | T | ı | ı | |
|--|--------------------------|--|------------------------------------|----------|-----------|----------------|----------|--|----------------|----------------|----------------|----------|--|----------|--|----------------|----------|----------|----------|------|--|
| | t-544_21 | rameters | (Tangan) 7-01 x 10-2 |) I | I | I | - | - | ı | T | I | I | ı | I | I | I | | I | I | | |
| | SR | ation Pa | (398/ ₂ m3 *-01 x ^2 |) | | I. | | | | T | ı | | | T | 1 | | | T | ı | | |
| . L. 3.022 m | Consolid | k&\cw _{z)} รุ่นธรรม |) [| | ı. | - | - | ı. | T | T | ı | ı. | ı. | ī | ı | | ı. | T | ı | | |
| R | (+)263 | | (09) ottsA (| юЛ | | - | | - | - | - | - | - | - | - | - | - | - | - | - | | |
| | 1 m | Permeability (cm/sec) | | | | ı | | | | Ţ | 1 | ' | | Ţ | ' | ' | | Ţ | 1 | | |
| | 23214.31 | Swelling Pressure (kg/cm ²) | | | 1 | 1 | | ' | ' | 1 | ' | ' | ' | 1 | ' | ' | ' | 1 | ' | | |
| s (E,N) | 312 | Free Swell Index F | | | | I | | 1 | ı | I | ı | I | ı | I | I | I | ı | I | ı | | |
| ordinat | Е | gth | ngle of ction (φ°) | , Fr | ' | ı | ı | ' | ı | | ' | ' | ' | I | ' | ' | | I | ' | , | |
| C | 6528.146 | ear Stren | Cohesion C (kg/cm²) | | | I | | ' | | ı | ı | 1 | 1 | ı | ı | 1 | | ı | ı | 1 | |
| | 69 | She | tesT to sq | ۲ | | ı | | | | 1 | 1 | , | | , | , | , | | , | 1 | , | |
| ination pth | 00 m | ,ity | Specific Gravity | | | ı | | ' | | ı | ı | , | ' | T | ' | , | ' | T | ı | | |
| Term De | 50.(| Dry Density (g/cm ³) | | | | ı | , | ' | ' | 1 | 1 | , | ' | 1 | 1 | , | , | 1 | 1 | ı | |
| r Table | - | Bulk Density (g/cm ³) ^N atural Moisture Content (%) | | | | ı | - | ' | | 1 | ı | ' | ' | , | 1 | ' | ' | , | ı | ı | |
| of Wate | 38.10 m | | | | ' | I | , | ' | ı | ı | ı | ı | ı | I | ı | ı | ' | I | ı | , | |
| Depth | | % | nrinkage Limit | s | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | |
| B.H. No. | Iq-H | g Limits | lasticity Index | I | • | 11 | ' | 11 | ' | 11 | ' | 7 | ' | 6 | 11 | ' | 11 | 1 | 11 | , | |
| | B | Atterber | timiJ site | Ъľ | ' | 23 | ' | 22 | ' | 21 | ' | 20 | ' | 20 | 21 | ' | 22 | ' | 23 | ' | |
| țe tion | 28+900 Major Bridge | | timi.I biu | Г!(| ' | 34 | ' | 33 | | 32 | 1 | 27 | ' | 26 | 32 | ' | 33 | 1 | 34 | , | |
| Chaina tm.)/Loc | | | ravel oarse |) | ' | 0 | ı | 4 | ı | 0 | I | 0 | ı | 1 | 0 | ı | 1 | I | 0 | ı | |
| (k | | retained | 9ni ⁷ | | ' | 11 | ı | 7 | ı | 12 | ı | 12 | ı | 10 | 7 | 1 | 6 | ı | 13 | , | |
| | 22-10-2021 | n % wt | oarse |) | ' | 4 | ı | 3 | ı | 5 | I | 1 | ı | 2 | 1 | ı | 3 | I | 4 | ı | |
| oring | | istributio | Sand muibə | N | ' | 3 | ' | 5 | 1 | 4 | ı | 2 | ' | 4 | 5 | ' | 4 | 1 | 8 | ı | |
| ate of B | to | n Size Di | ənifi | | 1 | 21 | | 18 | ' | 22 | ı | 30 | ' | 29 | 22 | 1 | 17 | ı | 15 | ' | |
| D | 0-2021 | Grai | His | | ' | 48 | ' | 51 | ' | 46 | ' | 48 | ' | 48 | 54 | ' | 55 | ' | 48 | ' | |
| | 19-1 | | VrIJ | | ' | 13 | - | 12 | ' | 11 | - | 7 | - | 6 | 11 | ' | 11 | ' | 12 | • | |
| designing bital Rail | y to | IS Classification | | | | | | | | | | | | | | | | | | | |
| l report for (Haryana Or | connectivit | | | | | CL | ı | CL | ı | CL | ı | ML-CL | ı | ML-CL | CL | 1 | CL | ı | CL | ı | |
| rvestigation, preparation of geotechnical nent in connection with construction of com Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | | | | Brown, Hard, Silty clay of low plasticity with gravel | | | | | Brown, Very dense, Sandy silt of low plasticity with gravel | | Brown, Hard, Silty clay of low plasticity with gravel | | | | | | |
| otechnical for emban | .C) projec work in th | Τć | () () Orrected SI (,V) sulaV |) 001 | 1) (22cm) | 100 (23cm) | 06 | 100 (122cm) | 100 (22cm) | 100 (23cm) | 100 (23cm) | - | - | - | 100 (24cm) | 100 (23cm) | - | - | - | 1 | |
| ucting gec lges and f | dor (HOR 1g IR netv | ənlæV | (N) T T S D S P T T | sqO E | 0 (22cm | 0 100 (23cm | 06 0 | 0 100 (22cm | 0 100 (22cm | 0 100 (23cm | 0 100 (23cm | 0 >100 | 0 >100 | 0 >100 | 0 100 (24cm | 0 100 (23cm | 0 >100 | 0 >100 | 0 >100 | | |
| Condu of brid | corric existir | (m) .J.Ə mort AtqəU | | | 14 28.0 | 15 29.50 | 16 31.00 | 17 32.50 | 18 34.00 | 19 35.50 | 20 37.00 | 21 38.50 | 22 40.00 | 23 41.50 | 24 43.00 | 25 44.50 | 26 46.00 | 27 47.50 | 28 49.00 | 49.2 | |
| Droie | 6 | 9qvT 9lqms2 | | | SPT- | SPT-] | SPT-1 | SPT-1 | SPT-1 | SPT-1 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | SPT-2 | 1 | |



| | | | | | | | | | | | | | | - | | | | | | | | |
|---|--|----------------------------------|--|-------|-------------------------------|------------------------------|-------|--------|---|--------|---------|---------|---------|---------|---------|---------|-------|--|----------|---------|---------------|---------------|
| e | -22 | | Compression (.C) x9bn1 | , | ı | , | , | , | | ı | ı | ı | | | ı | ı | | 0.073 | | ı | T | |
| ef. Cod | 544_21 | ameters | (57/ ² mo) ²⁻ 01 x ₂ M | | | 1 | | ı | | ı | ı | ı | ı | | ı | ı | ı | 1.15 0.84 0.52 0.36 | ı | ı | ı | |
| R | SR- | ion Par | (cm ² /Sec) C ^x x 10 ⁻⁴ | | | | | | | | - | | | | | | | 9.58 8.53 7.59 6.17 | | ı | ı | |
| | R.L. +)263.955 m | | (kg/cm ²⁾ | | | | | | , | ı | ı | | | | | | | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | | | ī | |
| R.I (+)263.5 | 0 | Void Ratio (e_) | | | , | , | | | I | i | | - | | | | | 0.575 | | ı | I | | |
| | ш | Â | נש/גפכ) גפנשפאסווונל | | | , | | , | | ı | ı | | | | ı | , | | 1 | , | ı | ı | |
| | 189.550 | nre | Swelling Pressure (kg/cm²) | | | , | | , | , | ı | ı | 1 | , | | ı | 1 | ı | , | , | ı | ı | |
| s (E,N) | 3123 | хәр | Free Swell Inc (%) | - | | , | , | - | | ı | ı | - | - | - | - | - | | | - | | T | |
| ordinates | υ | th th | Ξ Δ Δ Δ Δ Δ Δ Δ Δ Δ Δ Δ Δ Δ | | | 25 | | 26 | , | ı | ı | 27 | | 28 | ı | 5 | ı | 5 | 1 | ı | I | |
| C | 520.214 n | ar Streng | O noisənoO (kg/cm²) | | | 0.20 | | 0.19 | | | | 0.20 | | 0.19 | | 1.82 | | 3.14 | | | | |
| | 969 | She | Type of Test | | · | DST | | DST | - | - | - | DST | - | DST | - | UUT | | UUT | - | - | - | |
| nation oth | 0 m | ţţ | vrad sifisəq8 | | ı | 2.66 | | 2.66 | | ı | ı | 2.66 | | 2.66 | | 2.68 | | 2.67 | | ı | I | |
| Termi Deț | 50.0 | (_e wə | Dry Density (g/ | , | | 1.52 | , | 1.59 | , | 1.59 | 1 | 1.61 | , | 1.63 | , | 1.65 | , | 1.70 | , | , | 1 | , |
| r Table | |) nıce | tsioM Istural Moist W) tnotent (% | ' | 1 | 12.10 | ' | 12.76 | ' | 13.02 | 1 | 13.46 | ' | 14.28 | ' | 16.34 | ' | 17.20 | ' | ' | 1 | ' |
| Depth of Water 34.55 m | 34.55 m | ulk Density (g/cm ³) | | - | I | 1.70 | 1 | 1.79 | | 1.80 | ı | 1.83 | - | 1.86 | ı | 1.92 | ı | 1.99 | | ı | I | |
| | | % | Shrinkage Limit | - | ı | | , | - | | I | T | - | - | - | | - | | , | - | | I | |
| B.H. No. BH-P2 | g Limits ⁹ | Plasticity Index | • | | 9 | | L | ' | 7 | ' | L | - | 9 | | 11 | | Ξ | | 11 | | 11 | |
| | BF | Atterberg | timid stite Limit | | | 20 | | 20 | ' | 21 | ' | 20 | | 21 | | 22 | | 23 | ' | 20 | 1 | 21 |
| Chainage m.)/Location | 0 idge | | timiJ biupiJ | ' | | 26 | ' | 27 | ' | 28 | ' | 27 | ' | 27 | ' | 33 | | 34 | ' | 31 | 1 | 32 |
| | 28+90 Major Bri | | ra ve Coarse | ' | 1 | 0 | ' | 0 | ' | 3 | ı | 0 | ' | 1 | ' | 0 | ' | 0 | ' | 1 | ı | 0 |
| Ð | | retained | C əniA | ' | | 0 | ' | 5 | ' | 4 | ı | 9 | ' | L | 1 | 7 | 1 | 12 | ' | 10 | I | 11 |
| | 0-2021 | 0n % wt | Coarse | ' | | 1 | ' | 2 | ' | 2 | I | 5 | ' | 4 | ' | 1 | | - | ' | 2 | I | 5 |
| oring | 18- | istributio | Sand muibəM | ' | | 13 | ' | 10 | ' | 9 | I | 3 | ' | 9 | ' | 10 | | 5 | ' | 8 | I | 11 |
|)ate of B | to | n Size D | Fine | ' | 1 | 34 | ' | 28 | ' | 30 | 1 | 26 | ' | 30 | ' | 13 | ' | 16 | ' | 18 | 1 | 21 |
| | 10-2021 | Grai | ¥I!S | ' | 1 | 46 | ' | 48 | ' | 47 | ı | 53 | ' | 46 | ' | 57 | ' | 53 | ' | 51 | ı | 41 |
| | 15- | | Clay | | | 9 | | 7 | | 8 | | 7 | | 9 | | 12 | ' | 13 | - | 10 | - | 11 |
| designing rbital Rail | y to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| ll report for Haryana O | connectivit | uoj | rofficer[] 21 | | • | ML-CL | | ML-CL | | ML-CL | ' | ML-CL | | ML-CL | 1 | CL | | CL | 1 | CL | | CL |
| investigation, preparation of geotechnic cment in connection with construction o | from Palwal to Harsana Kalan including :state of Haryana. | | Soil Description | | Brown, Loose to medium dense, | Sandy silt of low plasticity | | | trown, Dense to very dense, Sandy silt of low plasticity with gravel here a straight bravel bravel brown, Hard, Silty clay of low plasticity with gravel | | | | | | | | | | | | | |
| technical . or embank | project ork in the | Te | Corrected SI (N) sulus | 1 | 14 | ' | 20 | ' | 29 | ı | 28 | ı | 34 | ' | 45 | ' | 55 | , | ' | ı | 100 (23cm) | 100 (17cm) |
| cting geot ges and fo | or (HORC g IR netw | ənlaV | (N) VD\$\$617464 SPT V | , | 6 | | 18 | , | 31 | ı | 34 | 1 | 47 | 1 | 70 | 1 | 55 | - | >100 | >100 | 100 (23cm) | 100 (17cm) |
| Condue of bridg | Corrid existin | (ɯ) " | I.Ə morî diqed | 00.00 | 1.00 | 1 2.50 | 4.00 | 2 5.50 | 3 7.00 | 3 8.50 | 1 10.00 | 4 11.50 | ; 13.00 | 5 14.50 | 5 16.00 | 5 17.50 | 19.00 | 7 20.50 | \$ 22.00 |) 23.50 | 0 25.00 | 1 26.50 |
| Project | | ə | qvT əlqms2 | DS | SPT-1 | UDS-1 | SPT-2 | 5-SQU | SPT-3 | UDS-3 | SPT-4 | -SQU | SPT-5 | S-SQU | SPT-6 | UDS-(| 2-TqS | C-SQU | SPT-8 | SPT-9 | SPT-1(| SPT-1 |



| | 22 | | u | Compression (,C) x9bnI | ı | ı | ı | | | ı | ı | | ı | ı | ı | ı | ı | ı | ı | |
|--|---------------------------|--|---------------------------------|---|-----------------|----------|-----------------|-----------------|-----------------|-----------------|-----------------|--------------------------------|------------------------|----------|-----------|-----------|-----------|-----------|-----------|------|
| Ref. Code | 544_21- | ameters | | (Tay/2mo) 2.01 x M | ı | I | ı | ı | ı | ı | ı | ı | ı | I | ı | ı | ı | I | ı | |
| | SR- | tion Par | | (cm ² /Sec) C ^A X 10-4 | | T | | | | 1 | ı | ı | | I | I | ı | ı | I | ı | |
| R.L. |)55 m | onsolida | | (kg/cm ²⁾ Pressure | 1 | 1 | | | | ı. | | | 1 | 1 | 1 | | | ı. | ı | |
| | (+)263.9 | C | (⁰ , | 9) oitsA bioV | ı | I | ı | , | | 1 | ı | I | ı | I | ı | ı | ı | I | ı | |
| | ш | Â | Permeability (cm/sec) | | | 1 | , | | | | , | | | | 1 | , | , | | 1 | |
| | 3189.550 | Swelling Pressure (kg/cm ²) | | or¶ gnillow2 mo\g¥) | | 1 | | | | | | | | | | , | | 1 | | |
| ss (E,N) | 3123 | Free Swell Index (%) | | | | T | ı | | | ı | | | | ı. | ı | ı | 1 | ı | ı | |
| ordinate | m | gth | Angle of Friction (\$°) | | ı | I | ı | ' | ' | ı | ı | I | ı | I | I | I | ı | I | I | |
| С | 6520.214 | ear Streng | | Cohesion C (kg/cm²) | 1 | I | ı | ' | ' | 1 | ı | ı | 1 | ı | ı | 1 | ' | ı | ı | 1 |
| | 69 | Sh | , | ts9T to 9qT | ' | 1 | | ' | ' | | ' | ' | ' | | ' | ' | ' | 1 | ' | |
| nation pth | 00 m | ity | Specific Gravity | | 1 | ı. | | | | | 1 | | 1 | ı. | ı | 1 | ı | ı | ı | |
| Termi De | 50.(| Dry Density (g/cm ³) | | | | , | , | , | | | | | | 1 | 1 | ' | | | ' | |
| Depth of Water Table | | Natural Moisture Content (%) | | - | T | - | - | - | - | - | - | - | I | ı | ı | 1 | I | ı | | |
| | 34.55 m | (_e wə/ | lk Density (g/cm ³) | | | I | - | - | | - | 1 | ı | | I | I | I | ı | I | I | ı |
| | | • | | Shrinkage Jimit | ı | I | ı | | | | ı | ı | ı | I | ı | ı | ı | T | ı | |
| B.H. No. | -P2 | Limits ⁹ | | Plasticity Index | - | 11 | - | 11 | - | 11 | - | 11 | - | 10 | I | 11 | ı | 11 | ı | |
| | BE | tterberg | 1 | himiJ siterl¶ | | 22 | | 23 | | 20 | | 22 | | 20 | ' | 20 | , | 21 | ' | |
| Chainage 1.)/Location | 28+900 Major Bridge | V | 1 | imiJ biupiJ | | 33 | | 34 | - | 31 | - | 33 | | 30 | ı | 31 | ' | 32 | ı | |
| | | | avel | Coarse | ı | 3 | - | 2 | | 0 | ı | 0 | ı | 2 | I | 3 | ı | 2 | I | ı |
| (kr | | etained | Gr | Sine | ' | 6 | ' | 10 | ' | 14 | ' | 11 | ' | 6 | 1 | 7 | ' | 10 | ı | |
| | 18-10-2021 | n % wt r | | Coarse | ı | 1 | ı | 2 | 1 | 3 | ı | 4 | ı | 5 | ı | 3 | ı | 3 | ı | |
| ring | | stributio | Sand | muibəM | ' | 2 | ' | 3 | ' | 2 | ' | 7 | ' | 3 | ' | 10 | ' | 4 | 1 | ı |
| ate of Bo | to | ı Size Dis | | eniA | ' | 23 | | 20 | ' | 17 | ' | 16 | ' | 20 | ' | 19 | ' | 22 | ' | |
| ũ | 0-2021 | Grain | | HIS | ı | 50 | ı | 50 | ' | 53 | ı | 50 | ı | 51 | ı | 47 | ı | 47 | ı | |
| | 15-1 | | | Clay | - | 12 | | 13 | - | 11 | - | 12 | - | 10 | • | 11 | , | 12 | • | • |
| designing rbital Rail | ty to | lodmy2 21 | | | | | | | | | | | | | | | | | | |
| al report for f Haryana C | g connectivi | uoj | IS Classification | | | CL | 1 | CL | - | CL | - | CL | 1 | CL | I | CL | ı | CL | I | ı |
| estigation, preparation of geotechnica ant in connection with construction of m Palwal to Harsana Kalan including tte of Haryana. | | Soil Description | | | | | | | | | | Brown, Hard, Silty clay of low | plasticity with gravel | | | | | | | |
| technical i or embank | C) project vork in the | Te | (°N dS | Corrected Value (V | 100 (25cm) | I | 100 (22cm) | 100 (26cm) | 100 (17cm) | 100 (22cm) | 100 (23cm) | ı | ı | ı | ı | ı | ' | ı | ı | ' |
| ucting geo dges and fo | dor (HOR) ng IR netw | ənleV | ۲۱ | (N) LAS pərtəsdO | 0 100 (25cm) | 0 >100 | 0 100 (22cm) | 0 100 (26cm) | 0 100 (17cm) | 0 100 (22cm) | 0 100 (23cm) | 0 >100 | 0 >100 | 0 >100 | 0 >100 | 0 >100 | 0 >100 | 0 >100 | 0 >100 | ×. |
| Condi of brid | corric existir | (ɯ) " | т: | Depth from C | .12 28.00 | 13 29.50 | 14 31.00 | .15 32.50 | .16 34.00 | 17 35.50 | .18 37.00 | .19 38.50 | 20 40.00 | 21 41.50 | .22 43.00 | .23 44.50 | .24 46.00 | .25 47.50 | .26 49.00 | 49.0 |
| Proje | | | dA | T slqms2 | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | SPT- | ' |


SOIL CHARACTERISTICS

| | | r | | | 1 | | | | | 1 | 1 | | | | | | | | | | | |
|---|--|--------------------|---|------|--|-------|-----------------------------|------------------------|-------|-------|-------|-------|--|-------|---------------------------|-------|---------|----------------------------|--------------------------|-------|----------------------------|------------------------|
| e | -22 | | Compression (,C) x9bnI | | | | | | | | | ı | 0.093 | | | | I | | I | | | |
| ef. Cod | 544_21 | ameters | (Sy/zmo) z-01 x ^M | | | | ı | | | | | ı | 1.48 1.06 0.63 0.45 | ı | | ı | ī | , | ı | ı | ı | |
| R | SR- | ion Par: | (cm ² /Sec) C ^x x 10 ⁻⁴ | | | | | | | | | | 10.07 8.47 6.84 5.82 | | , | | ī | , | | | 1 | , |
| | 47 m | onsolidat | ر لاور المراجع (لاور المراجع (لاور المراجع | | | | 1 | | | | | | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | , | ı | | ı | ı | | | ı | , |
| R.L | (+)263.8 | Ŭ | (₀ 9) oitsA bioV | | | | 1 | | , | , | | | 0.630 | | 1 | ı | ı | ı | ı | | ı | , |
| | ш | Â | Permeabilit (cm/sec) | , | | , | ı | , | | | | , | 1 | ı | ı | ı | ı | ı | ı | ı | 1 | 1 |
| | 3180.027 | nı.e | serelling Press (kg/cm ²) | | | | I | | 1 | | | ı | ı | 1 | | ı | ī | I | ī | | I | |
| s (E,N) | 312 | xəp | Free Swell Inc (%) | - | - | - | - | - | | | | | - | | - | - | ī | - | - | - | - | |
| ordinate | m | ţth | Angle of Friction (φ°) | | 4 | , | 26 | - | 5 | 1 | 5 | ı | 5 | ı | 24 27 | I | 30 | I | ı | ı | I | |
| Ŭ | 517.163 | ar Streng | Соћезіоп С (^s mɔ\g¥) | - | 0.75 | | 0.20 | - | 1.23 | | 1.35 | ı | 1.66 | - | 0.30 0.23 | ı | 0.18 | I | ı | | T | |
| | 969 | She | rype of Test | | UUT | | DST | - | UUT | | UUT | | UUT | | CUT Total Effective | | DST | , | ı. | | ı. | |
| ation th | Ш | ity | vra Specific Grav | | 2.67 | , | 2.66 | | 2.67 | | 2.68 | , | 2.67 | ı | 2.67 | ı | 2.66 | ı | ı | ı | ı | , |
| Termin Dept | 40.00 | (_e wə | Dry Density (g/ | | 1.56 | , | 1.61 | | 1.61 | , | 1.62 | | 1.64 | , | 1.64 | , | 1.65 | 1 | ı | , | ı | |
| Table | |) n.e | tsioM læutæV (%) tnotnoD | | 13.16 | , | 12.48 | , | 14.19 | | 15.26 | | 15.90 | , | 16.34 | , | 17.00 | , | , | , | , | , |
| f Water] | 4.50 m | (_e wə/ | Bulk Density (g | | 1.77 | , | 1.81 | | 1.84 | | 1.87 | | 1.90 | , | 1.91 | , | 1.93 | 1 | ı | ' | ı | , |
| Depth of | 3 | | Shrinkage Limit | , | | , | ı | , | , | | | , | , | , | , | 1 | 1 | 1 | , | , | ı | , |
| No. | 42 | Limits % | Plasticity Index | | 10 | | 7 | | 11 | | 11 | ı | 11 | ı | 11 | 1 | L | ı | 9 | | 11 | |
| B.H. | BH-, | tterberg] | timid süzelf | | 21 | | 20 | | 21 | | 22 | ı | 23 | | 21 | ı | 21 | ı | 20 | | 20 | , |
| uo | ge | A1 | timiJ biupiJ | | 31 | | 27 | - | 32 | | 33 | ı | 34 | | 32 | 1 | 28 | ı | 26 | | 31 | |
| Chainage 1.)/Locati | 28+900 ajor Bridg | | Coarse | | 0 | , | 0 | | 0 | | 1 | , | 0 | | 0 | ı | 0 | ı | 2 | , | 0 | , |
| (kn) | W | etained | eni F | - | 3 | | 5 | - | 4 | | 5 | ı | 8 | | 5 | ' | 12 | ı | 6 | | 8 | |
| | -2021 | 1 % wt ro | Coarse | - | 2 | | 3 | - | 3 | , | 2 | I | 1 | - | 4 | ı | 1 | ı | 2 | | 1 | , |
| ring | 18-10 | tribution | Zand muibəM | - | 11 | ' | 9 | | 4 | , | 2 | , | 3 | | 9 | ' | 10 | ' | 9 | ' | 4 | |
| tte of Bo | to | Size Dis | əniA | | 16 | ' | 28 | ' | 21 | ' | 20 | , | 17 | ı | 20 | ı | 24 | ı | 29 | ı | 20 | , |
| Da |)-2021 | Grain | HIS | | 58 | ' | 51 | ' | 57 | ' | 58 | | 58 | , | 53 | ' | 46 | ' | 46 | ' | 57 | |
| | 16-1(| | Clay | | 10 | | 7 | • | 11 | | 12 | | 13 | • | 12 | • | 7 | • | 9 | • | 10 | , |
| esigning ital Rail | technical report for designing uction of Haryana Orbital Rail ncluding connectivity to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| eport for de aryana Orb | | | IS Classification | | CL | 1 | ML-CL | ı | CL | , | CL | , | CL | 1 | CL | ı | ML-CL | ı | ML-CL | ı | CL | , |
| technical r action of H | | | | | ow M N N N N N N N N N N N N N N N N N N | | | | | | | | alt of | el | | low | | | | | | |
| investigation, preparation of geo cment in connection with constru | from Palwal to Harsana Kalan i s state of Haryana. | | Soil Description | | Brown, Very stiff, Silty clay plasticity | | Brown, Dense, Sandy silt of | plasticity with gravel | | | | | Brown, Hard, Silty clay of plasticity with gravel | | | | | Brown, Very dense, Sandy s | low plasticity with grav | | Brown, Hard, Silty clay of | plasticity with gravel |
| technical or embank | project ork in the | L | IS bətəərvə Value (N.) | ' | | 22 | ı | 37 | ' | 36 | | 40 | | 77 | ' | 48 | ı | ' | ı | ı | ı | |
| cting geot ses and fo | or (HORC g IR netw | ənleV | (N) VD\$\$\$\$790 (N) | ı | | 22 | ı | 37 | | 36 | | 40 | | 77 | , | 48 | I | >100 | >100 | >100 | >100 | >100 |
| Conduc of bridg | Corride existing | (w) " | I.Ə morî diqeD | 0.00 | 1.00 | 2.50 | 2 4.00 | 5.50 | 1.00 | 8.50 | 10.00 | 11.50 | ; 13.00 | 14.50 | 5 16.00 | 17.50 | 7 19.00 | 20.50 | 22.00 | 23.50 |) 25.00 | 1 26.50 |
| Duction | Luja | ə | qvT əlqms2 | DS | UDS-1 | SPT-1 | UDS-2 | SPT-2 | UDS-3 | SPT-3 | UDS-4 | SPT-4 | UDS-5 | SPT-5 | UDS-6 | SPT-6 | ί-SQU | SPT-7 | SPT-8 | SPT-9 | SPT-1(| SPT-1 |



SOIL CHARACTERISTICS

| | | | 1 | | | | | | | | | | | | | | |
|---|--|--|---------------------------------|---|---------------|------------|---------------|---------------|--|---------|---------------|---------------|---------|---|----|---|---|
| le | -22 | s | ι | 10isesorqmoD Index (C.) | ı | - | - | - | - | - | T | - | I | | | | |
| Ref. Coc | -544_21 | rameter | | (50, x ¹ 0, x 3) W ^{, x} 10, y | ı | | | - | | | ı | - | ı | | | | |
| | SF | ttion Pa | | (cw ₅ /2ec) C ^a x 10-4 | ŗ | | | | | | ı | | | | | | |
| L. | .847 m | Cain Size Distribution % wt retained Atterberg Limits % $\begin{bmatrix} 2 \\ 12 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 $ | | (Kg/cm ²⁾ Pressure | ı | | | ı | | | ı | ı | I | | | | |
| R | (+)263 | $\begin{array}{c c c c c c c c c c c c c c c c c c c $ | (0 | 9) oitaA bioV | ŗ | | | | | | ı | | | | | | |
| | ш | Â | ;) (i | Permeabi 998/mo) | ı | | | | | | ı | | | | | | |
| | 3180.027 | nre | (₇ ssa | Pro ⁵ mo/gal) | ı | - | - | - | - | - | - | - | I | | | | |
| s (E,N) | 312 | xəp | ouj | Free Swell] Free Swell] | ' | | | | | | ŗ | | | | | | |
| ordinate | в | ţth | (| fo slgnA (°φ) noitsirA | ı | | | ı | | | ı | ı | ı | | | | |
| Ċ | 517.163 | r Streng | | С noisэhoD (kg/cm ²) | , | | | | | | , | | | | | | |
| | ;969 | Shea | 1 | rs9T to 9qvT | | | | | | | , | | ı | | | | |
| ation th | Е | ity | AB. | rD sifisəqZ | | | | | | | | | | | | | |
| Termin Dept | 40.00 | (_e wə | /a) | Dry Density (| , | , | , | , | , | , | ı | , | | | | | |
| Table | |) n.c | 1si % | oM lerursl) tastucat (| , | - | - | | | - | | | | | | | |
| of Water | 34.50 m | (_e wə, | (B) | Bulk Density | ı | | | 1 | | | | 1 | ı | | | | |
| Depth (| | ,0 | | Shrinkage Limit | ı | - | - | - | - | - | - | - | ı | | | | |
| No. | -A2 | Limits % | | Plasticity X9bnI | 11 | - | 11 | - | 11 | - | 11 | - | | | | | |
| B.H. | BH | tterberg | 1 | imiJ siterl | 23 | - | 22 | - | 21 | - | 21 | - | | | | | |
| e tion | ge | V | 1 | imiJ biupiJ | 34 | - | 33 | | 32 | - | 32 | | ı | | | | |
| Chainag n.)/Locat | 28+900 Iajor Brid | | avel | Coarse | 0 | ' | 0 | ' | 0 | ' | 4 | ' | | | | | |
| (kı | Date of Boring Chainage (km.)/Location B.H. No. 21 to 18-10-2021 28+900 BH-A2 | etained | tion % wt retained nd Gravel | Gravel | ind Gravel | and Gravel | Gravel | əniA | 11 | ' | 13 | ı | 11 | ' | 10 | ı | ı |
| | | n % wt r | | | | | Coarse | 1 | ' | 2 | ' | 3 | ' | 5 | ' | ı | |
| oring | 18-1 | stributio | Sand | muibəM | 2 | ' | 3 | ' | L | ' | 3 | ' | ı | | | | |
| ate of B(| to | ı Size Di | | əniA | 19 | , | 20 | ı | 19 | , | 17 | ı | , | | | | |
| designing bital Rail bate of Boring Chainage (km.)/Locati | Grain | | માંડ | 54 | ' | 50 | ' | 49 | ' | 49 | ' | , | | | | | |
| | 16-1 | | | Clay | 13 | | 12 | | 11 | | 12 | | ' | | | | |
| lesigning bital Rail | y to | | ю | dmy2 21 | | | | | | | | | | | | | |
| l report for c Haryana Ori | connectivit | uo | its | IS Classific | CL | ı | CL | ı | CL | ı | CL | ı | ı | | | | |
| rvestigation, preparation of geotechnica nent in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | | Soil Description | | | | | Brown, Hard, Silty clay of low plasticity with gravel | | | | | | | | |
| schnical ii r embankı |) project 1 ork in the | T | (°N 48 | Corrected Value (1 | 100 (19cm) | 1 | 100 (22cm) | 100 (19cm) | 100 (21cm) | 1 | 100 (23cm) | 100 (21cm) | I | | | | |
| ting geote es and for | or (HORC) IR netwo | ənla ^v | L / | (N) Opserved SP | 100 (19cm) | >100 | 100 (22cm) | 100 (19cm) | 100 (21cm) | >100 | 100 (23cm) | 100 (21cm) | >100 | | | | |
| Conduc of bridg | Corrido existing | (w) | 1. | D mort dtga | 28.00 | \$ 29.50 | t 31.00 | 5 32.50 | 5 34.00 | 7 35.50 | 37.00 |) 38.50 |) 40.00 | | | | |
| | Projec | ə | dʎ | T slqms2 | SPT-12 | SPT-13 | SPT-14 | SPT-15 | SPT-16 | SPT-17 | SPT-18 | SPT-15 | SPT-20 | | | | |





| Harsana Kalan in the state of Haryana. |
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| I for Haryana |
| GT |

SR-544_21-22 Appendix – B2

| | 'hoinean | Chainago | | Depth of | | Chlorid | es (CI ⁻) | Sulphate (S | (O_3^{2-}) |
|-------|----------|------------------|--------|-------------------------|------|---------|-----------------------|-------------|--------------|
| No ON |)ld (km) | New (km) | BH No. | collected sample (m) | Ηd | (mg/kg) | (%) | (mg/kg) | (%) |
| 1. | 007-20 | Loctoc | BH-A1 | 19.00 | 7.93 | 78.34 | 0.0078 | 30.71 | 0.0031 |
| 2. | 7170ZU | 107107 | BH-P1 | 2.50 | 7.40 | 48.78 | 0.0049 | 25.81 | 0.0026 |
| 3. | 20-075 | 00±713 | BH-A1 | 2.50 | 7.00 | 57.13 | 0.0057 | 30.91 | 0.0031 |
| 4. | C10+07 | C+/+07 | BH-P1 | 25.00 | 8.01 | 61.08 | 0.0061 | 21.95 | 0.0022 |
| 5. | U9670C | $\delta U + U L$ | BH-A1 | 1.00 | 6.85 | 47.45 | 0.0047 | 28.27 | 0.0028 |
| 6. | 006707 | 070167 | BH-P1 | 34.00 | 8.61 | 57.04 | 0.0057 | 34.12 | 0.0034 |
| 7. | | レフラーレレ | BH-A1 | 17.5 | 7.95 | 63.25 | 0.0063 | 34.74 | 0.0035 |
| 8. | 006-07 | 100-17 | BH-P2 | 14.5 | 8.11 | 52.26 | 0.0052 | 31.04 | 0.0031 |

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SR-544_21-22

Appendix -B3

| ld Chainage New BH No. DH Chlorides (Cl) Sulphate (SO3 ²⁻) | (km) (mg/l) (mg/l) | 28+287 BH-A1 7.86 696.25 412.17 | 28+743 BH-A1 7.94 526.14 346.28 | 29+028 BH-P1 7.86 491.25 274.26 | 29+567 BH-A1 7.63 484.16 304.18 |
|--|------------------------|---|---------------------------------|---|---|
| BH No. pH | - | BH-A1 7.86 | BH-A1 7.94 | BH-P1 7.86 | BH-A1 7.63 |
| Chainage New | (km) | 28+287 | 28+743 | 29+028 | 29+567 |
| Chainage Old | (km) | 27+620 | 28+075 | 28+360 | 28+900 |
| Sr. | No | 1. | 2. | 3. | 4. |

RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLE







1.96

9.00

11.00

12.00

11.00

50.00

52.00

49.00

50.00

28.00

21.00

20.00

23.00

4.00

3.00

3.00

4.00

26.50 m

29.50 m

34.00 m

38.50 m

2.00

2.00

5.00

4.00

7.00

11.00

9.00

8.00

0.00

0.00

2.00

0.00

0.0024

0.0192 0.0779

0.0152 0.0675

0.0150 0.0723

0.0160 0.0724





1.79

0.0144 0.0575

0.0139 0.0650 0.0147 0.0651

58.00

52.00

53.00

19.00

20.00

18.00

2.00

4.00

6.00

10.00

12.00

11.00

32.50 m

35.50 m

38.50 m

1.00

3.00

4.00

10.00

7.00

8.00

0.00

2.00

0.00

0.0020





CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.





0.0150 0.0784

0.0174 0.0831

0.0155 0.0829

46.00

47.00

45.00

13.00

11.00

13.00

40.00 m

43.00 m

47.50 m

22.00

22.00

23.00

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12.00

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13.00

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26.50 m

29.50 m

34.00 m

37.00 m

0.00

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9.00

8.00

0.00

0.00

0.00

0.00

0.0177

0.0817

0.0151 0.0784

0.0182 0.1007

0.0193 0.0991





















0.0229 0.0814 18.73

0.0036 0.0242 0.1051 29.01 1.54

52.00

47.00

6.00

7.00

35.50 m

38.50 m

27.00

26.00

2.00

2.00

8.00

11.00

0.00

0.00

0.0043

5.00

7.00





CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.





29.25 1.53

34.24

1.44

0.0029 0.0217 0.0937 31.90 1.71

0.0036 0.0242 0.1060

0.0257 0.1252

0.0037

CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

48.00

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| | | | GRA | AIN SIZE DI | STRIBUTI | ON CURVES | 6 | | | | | |
|-------------------------|--|----------|--|--|---|--|---|-----------------------------|-------------------------|-----------------------|----------------|------|
| | Project Name | | Conducting geoto connection with connectivity to e | echnical investiga construction of Ha xisting IR network | tion, preparatio aryana Orbital F c in the state of | n of geotechnical re Rail Corridor (HOR Haryana. | eport for designin C) project from 1 | ng of bridge Palwal to H | es and for arsana Ka | embankm lan includ | ent in ling | |
| Le | ocation/Chainas | e | 28+900 Major B | ridge | | | | | | | | |
| | B.H. No. | 3 | BH-A1 | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 0.000 | | | | NE SAND | MEDIUM SAND | COARSE FI | | | ARSE AVEL | | |
| | DEPTH: | | | G | irain Size Milli | meters | | | | | | |
| + | 2.50 m 23.50 m | →-5.50 m | 8.5 | 50 m — | — 11.50 m ← 32.50 m | → 14.50 → 35.50 | m 📥 | —17.50 m —38.50 m | - | * 20.5 | 0 m | |
| Denth | | | Grain Size | Distribution % v | wt retained | C. | avel | D10 | D30 | D60 | C" | Ce |
| Deptii | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | 510 | 150 | 100 | Cu | Ce |
| 2.50 m | 6.00 | 48.00 | 32.00 | 10.00 | 2.00 | 2.00 | 0.00 | 0.0045 | 0.0258 | 0.0992 | 22.25 | 1.50 |
| 5.50 m | 7.00 | 44.00 | 27.00 | 14.00 | 5.00 | 3.00 | 0.00 | 0.0037 | 0.0267 | 0.1310 | 35.59 | 1.47 |
| 8.50 m | 6.00 | 45.00 | 28.00 | 9.00 5.00 | 4.00 | 5.00 | 0.00 | 0.003/ | 0.0260 | 0.1144 | 20.55 | 1.01 |
| 14.50 m | 10.00 | 55.00 | 19.00 | 6.00 | 6.00 | 4 00 | 0.00 | 0.0044 | 0.0242 | 0.0632 | 31.61 | 1.47 |
| 17.50 m | 12.00 | 60.00 | 15.00 | 4.00 | 3.00 | 6.00 | 0.00 | - | 0.0116 | 0.0502 | - | - |
| 20.50 m | 11.00 | 56.00 | 16.00 | 3.00 | 2.00 | 11.00 | 1.00 | - | 0.0137 | 0.0589 | - | - |
| 23.50 m | 12.00 | 49.00 | 19.00 | 7.00 | 3.00 | 8.00 | 2.00 | - | 0.0149 | 0.0723 | - | - |
| 26.50 m | 10.00 | 53.00 | 20.00 | 3.00 | 2.00 | 12.00 | 0.00 | 0.0020 | 0.0160 | 0.0676 | 33.78 | 1.91 |
| 29.50 m | 13.00 | 52.00 | 17.00 | 5.00 | 3.00 | 9.00 | 1.00 | - | 0.0126 | 0.0625 | - | - |
| 32.50 m | 11.00 | 56.00 | 14.00 | 7.00 | 1.00 | 11.00 | 0.00 | - | 0.0136 | 0.0588 | - | - |
| 35.50 m | 10.00 | 48.00 | 20.00 | 6.00 | 4.00 | 9.00 | 3.00 | 0.0020 | 0.0183 | 0.0834 | 41.71 | 2.00 |
| 38.50 m | 10.00 | 53.00 | 19.00 | 4.00 | 1.00 | 13.00 | 0.00 | 0.0020 | 0.0160 | 0.0675 | 33.77 | 1.90 |



| | | | GR | AIN SIZE DI | ISTRIBUTI | ON CURVES | 5 | | | | | |
|-------------------------|--|---|---|--|---|--|--|---------------------------|-------------------------|-----------------------|---------------|------|
| | Project Name | | Conducting geot connection with connectivity to e | technical investiga construction of H existing IR networ | ation, preparation aryana Orbital R k in the state of 1 | n of geotechnical r ail Corridor (HOR Haryana. | eport for designing C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm lan includ | ent in ing | |
| L | ocation/Chaina | ge | 28+900 Maior B | ridge | | | | | | | | |
| | B.H. No. | .8. | BH-P1 | | | | | | | | | |
| | CLAY | | SILT | FI | INE SAND | MEDIUM SAND | COARSE FIN | E GRAVEL | | ARSE AVEL > | | |
| Percent Finer By Weight | 100 90 80 70 60 50 40 30 20 10 | | | | | | | | | | | |
| | 0 0.001 0.001 | 02 | 0.01 | 0.075 0.1 | 0.42 | 5 2 1 | 4.75 | 2 10 | 20 | 80 | 100 | |
| | 00 m ▲ | 4.00 m - ≭ 32.50 m - ↓ | -7.00 m → | — 10.00 m — | | | → 20.50 m → 46.00 m | <u> </u> | 3.50 m 9.00 m | ~ 26 | 5.50 m | |
| Depth | Clay | Silt | Grain Size | e Distribution % Sand | wt retained | Gr | avel | D10 | D30 | D60 | Cu | Ce |
| 1.00 m | 7.00 | 54.00 | Fine 26.00 | Medium 6.00 | Coarse 3.00 | Fine 4.00 | Coarse 0.00 | 0.0035 | 0.0202 | 0.0726 | 20.58 | 1.60 |
| 4.00 m | 12.00 | 55.00 | 20.00 | 4.00 | 3.00 | 5.00 | 1.00 | - | 0.0130 | 0.0588 | - | - |
| 7.00 m | 11.00 | 55.00 | 17.00 | 8.00 | 2.00 | 7.00 | 0.00 | - | 0.0140 | 0.0609 | - | - |
| 10.00 m | 11.00 | 50.00 | 23.00 | 4.00 | 3.00 | 9.00 | 0.00 | - | 0.0160 | 0.0724 | - | - |
| 13.00 m | 7.00 | 46.00 | 27.00 | 8.00 | 2.00 | 10.00 | 0.00 | 0.0036 | 0.0250 | 0.1115 | 30.62 | 1.54 |
| 20.50 m | 8.00 7.00 | 45.00 | 28.00 | 2.00 | 4.00 | 9.00 | 2.00 | 0.0030 | 0.0240 | 0.1089 | 27 49 | 1.78 |
| 23.50 m | 11.00 | 49.00 | 20.00 | 6.00 | 3.00 | 9.00 | 2.00 | - | 0.0243 | 0.0750 | - | - |
| 26.50 m | 12.00 | 48.00 | 18.00 | 9.00 | 1.00 | 12.00 | 0.00 | - | 0.0153 | 0.0750 | - | - |
| 29.50 m | 13.00 | 48.00 | 21.00 | 3.00 | 4.00 | 11.00 | 0.00 | - | 0.0141 | 0.0722 | - | - |
| 32.50 m | 12.00 | 51.00 | 18.00 | 5.00 | 3.00 | 7.00 | 4.00 | - | 0.0142 | 0.0672 | - | - |
| 35.50 m | 11.00 | 46.00 | 22.00 | 4.00 | 5.00 | 12.00 | 0.00 | - | 0.0179 | 0.0884 | - | - |
| 38.50 m | 7.00 | 48.00 | 30.00 | 2.00 | 1.00 | 12.00 | 0.00 | 0.0036 | 0.0238 | 0.0943 | 26.08 | 1.66 |
| 41.50 m | 6.00 | 48.00 | 29.00 | 4.00 | 2.00 | 10.00 | 1.00 | 0.0044 | 0.0256 | 0.1009 | 22.68 | 1.46 |
| 45.00 m | 11.00 | 55.00 | 17.00 | 3.00 | 3.00 | 9.00 | 1.00 | - | 0.0145 | 0.0609 | - | - |
| 10.00 m | 12.00 | 48.00 | 15.00 | 8.00 | 4.00 | 13.00 | 0.00 | - | 0.0152 | 0.0750 | | - |



| | | | GRA | AIN SIZE DI | STRIBUTI | ON CURVES | | | | | | |
|-------------------------|---|------------------|--|---|---|--|---|-----------------------------|---|-----------------------|---------------|-------|
| | Project Name | | Conducting geoto connection with connectivity to ex- | echnical investigat construction of Ha xisting IR network | tion, preparatio aryana Orbital F c in the state of | n of geotechnical re Rail Corridor (HOR Haryana. | eport for designin C) project from 1 | ng of bridge Palwal to H | es and for arsana Ka | embankm lan includ | ent in ing | |
| L | ocation/Chaina | ge | 28+900 Major B | ridge | | | | | | | | |
| | B.H. No. | - | BH-P2 | · | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: 50 m | 5.50 m | SILT | Fill | NE SAND | MEDIUM SAND | COARSE FI SAND | NE GRAVEL | CO, GR. I I I I I I I I I I I I I I I I I I I | ARSE AVEL | 100 | |
| 2 | 6.50 m 🛁 | — 29.50 m | →— 32.50 m | 35.50 r | m <u> </u> | 8.50 m 🔶 | - 41.50 m | —— 44.5 | 0 m | — 47. | 50 m | |
| | | I | Grain Size | Distribution % v | wt retained | | _ | | | | ~ | - |
| Depth | Clay | Silt | Fine | Sand Medium | Coarse | Gr | avel Coarse | D10 | D30 | D60 | Cu | Ce |
| 2.50 m | 6.00 | 46.00 | 34.00 | 13.00 | 1.00 | 0.00 | 0.00 | 0.0045 | 0.0274 | 0.1096 | 24.22 | 1.52 |
| 5.50 m | 7.00 | 48.00 | 28.00 | 10.00 | 2.00 | 5.00 | 0.00 | 0.0036 | 0.0237 | 0.0967 | 26.76 | 1.60 |
| 8.50 m | 8.00 | 47.00 | 30.00 | 6.00 | 2.00 | 4.00 | 3.00 | 0.0030 | 0.0227 | 0.0949 | 32.16 | 1.83 |
| 11.50 m 14.50 m | 6.00 | 55.00 46.00 | 20.00 | 5.00 | 5.00 | 7.00 | 1.00 | 0.0035 | 0.0207 | 0.0750 | 25.16 | 1.01 |
| 17.50 m | 12.00 | 57.00 | 13.00 | 10.00 | 1.00 | 7.00 | 0.00 | - | 0.0122 | 0.0549 | - | - |
| 20.50 m | 13.00 | 53.00 | 16.00 | 5.00 | 1.00 | 12.00 | 0.00 | - | 0.0123 | 0.0603 | - | - |
| 23.50 m | 10.00 | 51.00 | 18.00 | 8.00 | 2.00 | 10.00 | 1.00 | 0.0020 | 0.0168 | 0.0724 | 36.18 | 1.94 |
| 26.50 m | 11.00 | 41.00 | 21.00 | 11.00 | 5.00 | 11.00 | 0.00 | - | 0.0211 | 0.1422 | - | - |
| 29.50 m | 12.00 | 50.00 | 23.00 | 2.00 | 1.00 | 9.00 | 3.00 | | 0.0147 | 0.0698 | - | - |
| 32.50 m | 13.00 | 50.00 | 20.00 | 3.00 | 2.00 | 10.00 | 2.00 | - | 0.0134 | 0.0671 | - | - |
| 38.50 m | 12.00 | 50.00 | 17.00 | 2.00 | 3.00 | 14.00 | 0.00 | - | 0.0146 | 0.0696 | - | - |
| 41 50 m | 12.00 | 51.00 | 20.00 | 3.00 | 4.00 | 9.00 | 2.00 | 0.0020 | 0.0144 | 0.0090 | 36.19 | - 196 |
| 44.50 m | 11.00 | 47.00 | 19.00 | 10.00 | 3.00 | 7.00 | 3.00 | - | 0.0172 | 0.0842 | - | - |
| 47.50 m | 12.00 | 47.00 | 22.00 | 4.00 | 3.00 | 10.00 | 2.00 | - | 0.0159 | 0.0784 | | - |
| | | | 22.00 | | 5.00 | 10.00 | 2.00 | | | | L | |



| | | | GRA | AIN SIZE DI | STRIBUT | ION CURVES | | | | | | |
|-------------------------|--|--------|--|--|-------------------------------------|---|--------------------------------------|------------------------------|-------------------------|-----------------------|---------------|------|
| | Project Name | | Conducting geoto connection with connectivity to e | echnical investiga construction of Ha xisting IR network | tion, preparation aryana Orbital | on of geotechnical re Rail Corridor (HOR Haryana. | eport for designi C) project from | ing of bridge Palwal to H | es and for arsana Ka | embankm lan includ | ent in ing | |
| Lo | cation/Chaina | ze | 28+900 Major B | ridge | | | | | | | | |
| | B.H. No. | 2 | BH-A2 | č | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0.001 DEPTH: | 2 | SILT | Fit 0.075 0.1 G | NE SAND | MEDIUM SAND | COARSE F | INE GRAVEL | | ARSE AVEL | 100 | |
| | 1.00 m 22.00 m | 4.00 m | | 00 m — | - 10.00 m - 31.00 m | | m —∎ m → | — 16.00 m —37.00 m | - | →~− 19.0 | 0 m | |
| | | | Grain Size | Distribution % | vt retained | 1 | | _ | _ | _ | _ | _ |
| Depth | Clay | Silt | Fina | Sand Modium | Coores | Gr | avel | D10 | D30 | D60 | Cu | Cc |
| 1.00 m | 10.00 | 58.00 | 16.00 | 11.00 | 2.00 | 3.00 | 0.00 | 0.0020 | 0.0143 | 0.0574 | 28.70 | 1.77 |
| 4.00 m | 7.00 | 51.00 | 28.00 | 6.00 | 3.00 | 5.00 | 0.00 | 0.0036 | 0.0218 | 0.0814 | 22.81 | 1.64 |
| 7.00 m | 11.00 | 57.00 | 21.00 | 4.00 | 3.00 | 4.00 | 0.00 | - | 0.0136 | 0.0573 | - | - |
| 10.00 m | 12.00 | 58.00 | 20.00 | 2.00 | 2.00 | 5.00 | 1.00 | - | 0.0122 | 0.0536 | - | - |
| 13.00 m | 13.00 | 58.00 | 17.00 | 3.00 | 1.00 | 8.00 | 0.00 | - | 0.0111 | 0.0514 | - | - |
| 16.00 m | 12.00 | 53.00 | 20.00 | 6.00 | 4.00 | 5.00 | 0.00 | - | 0.0136 | 0.0628 | - | - |
| 19.00 m | 7.00 | 46.00 | 24.00 | 10.00 | 1.00 | 12.00 | 0.00 | 0.0036 | 0.0248 | 0.1184 | 32.56 | 1.43 |
| 22.00 m | 0.00 | 40.00 | 29.00 | 6.00 | 2.00 | 9.00 | 2.00 | 0.0045 | 0.0271 | 0.1151 | 25.54 | 1.42 |
| 25.00 m | 13.00 | 57.00 | 20.00 | 4.00 | 1.00 | 8.00 | 0.00 | 0.0020 | 0.014/ | 0.0594 | 29.69 | 1.82 |
| 20.00 m 31.00 m | 12.00 | 50.00 | 20.00 | 2.00 | 2.00 | 11.00 | 0.00 | - | 0.0121 | 0.0585 | - | - |
| 34.00 m | 11.00 | 49.00 | 19.00 | 7.00 | 3.00 | 11.00 | 0.00 | - | 0.0140 | 0.0097 | - | - |
| 37.00 m | 12.00 | 49.00 | 17.00 | 3.00 | 5.00 | 10.00 | 4.00 | - | 0.0149 | 0.0722 | - | - |
| 37.00 m | 12.00 | 49.00 | 17.00 | 5.00 | 3.00 | 10.00 | 4.00 | - | 0.0149 | 0.0722 | - | - |







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BORE HOLE NO: BH-P-3 CHAINAGE : 27+620 KM SAMPLE NO.: UDS-1 DEPTH: 2.50 m COHESION(C)= 0.37 kg/sq.cm ANGLE OF FRICTION(Phi): 5 deg TYPE OF THE TEST: UUT



















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BORE HOLE NO: BH-A1 Chainage:- 28+075 km SAMPLE NO.: UDS-5 DEPTH: 14.50m COHESION(C)= 1.39 kg/sq.cm ANGLE OF FRICTION(Phi): 5 deg TYPE OF THE TEST: UUT








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BORE HOLE NO: BH-P1 Chainage: 28+900 SAMPLE NO.: UDS-2 DEPTH: 4.00 m COHESION(C)= 1.75 kg/sq.cm ANGLE OF FRICTION(Phi): 5 deg TYPE OF THE TEST: UUT



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BORE HOLE NO: BH-A2 Chainage: 28+900 SAMPLE NO.: UDS-1 DEPTH: 1.00 m COHESION(C)= 0.75 kg/sq.cm ANGLE OF FRICTION(Phi): 4 deg TYPE OF THE TEST: UUT



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CHAINAGE: 27+620

INITIAL WATER CONTENT = 13.46 %

COMPRESSION INDEX (C_c) = 0.126

DRY DENSITY = 1.58 gm/cm³

VOID RATIO $(e_o) = 0.695$

SAMPLE NO. = UDS-2

BORE HOLE NO. = BH-P1

DEPTH = 5.50 M

TYPE OF SOIL = CL

FIGURE NO.

PRESSURE Vs VOID RATIO CURVE (e-log p)



Figure No. -



Figure No. -



CHAINAGE = 28+075

INITIAL WATER CONTENT = 14.30 %

COMPRESSION INDEX (C_c) = 0.126

BORE HOLE NO. = BH-P1

DRY DENSITY = 1.57 gm/cm³

VOID RATIO $(e_o) = 0.705$

SAMPLE NO. = UDS-3

DEPTH = 7.00 M

TYPE OF SOIL = CL

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)



Figure No. -



Figure No. -



CHAINAGE = 28+075

SAMPLE NO. = UDS-1

DEPTH = 1.00 M

INITIAL WATER CONTENT = 12.64 %

COMPRESSION INDEX $(C_c) = 0.159$

PRESSURE Vs VOID RATIO CURVE (e-log p)

DRY DENSITY = 1.50 gm/cm³

BORE HOLE NO. = BH-A2

FIGURE NO.

TYPE OF SOIL = CL



Figure No. -



Figure No. -

216 of 222



BORE HOLE NO. = BH-P2

INITIAL WATER CONTENT = 17.20 %

SAMPLE NO. = UDS-7

DEPTH = 20.50 M

TYPY OF SOIL = CL

DRY DENSITY = 1.70 gm/cm³

VOID RATIO $(e_0) = 0.575$

COMPRESIVE INDEX (C_c) = 0.073

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)



Figure No. -



Figure No. -



BORE HOLE NO. = BH-A2

SAMPLE NO. = UDS-5

INITIAL WATER CONTENT = 15.90 %

DRY DENSITY = 1.64 gm/cm³

VOID RATIO (e_0) = 0.630

TYPE OF SOIL = CL

DEPTH = 13.00 M

COMPRESSION INDEX (C_c) = 0.093

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)



Figure No. -


Figure No. -

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Geotechnical Investigation Report

Old Ch. 11+523 to Old Ch. 16+815 (New CH: 12+208 to 17+500)

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

AUGUST - 2022

| SR. No. | Report No. | Revision No. | Date |
|-----------|---|--------------|------------|
| 544_21-22 | CEGTH/HRIDCL/SR-544/2022-23/1030_(21 BHs) | 02 | 31.10.2022 |
| 544_21-22 | CEGTH/HRIDCL/SR-544/2022-23/740_(21 BHs) | 01 | 19.08.2022 |
| 544_21-22 | CEGTH/HRIDCL/SR-544/2022-23/717_(21 BHs) | 00 | 10.08.2022 |



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-544/2022-23/1030

Date:- 31.10.2022

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 21 borehole carried out at Old Ch. 11+523 to Old Ch. 16+815 (New CH 12+208 to 17+500) 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.

Prepared By:-

Nyor

Nehal Jain General Manager - Geotechnical Authorized Signatory

Brothit

Ankur Mudgal Sr. Manager

| SR. No. | Report Ref. No. | Revision No. | Date |
|-----------|---|--------------|------------|
| 544_21-22 | CEGTH/HRIDCL/SR-544/2022-23/1030_(21 BHs) | 02 | 31.10.2022 |
| 544_21-22 | CEGTH/HRIDCL/SR-544/2022-23/740_(21 BHs) | 01 | 19.08.2022 |
| 544_21-22 | CEGTH/HRIDCL/SR-544/2022-23/717_(21 BHs) | 00 | 10.08.2022 |



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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 of soil, field test results, laboratory test results, analysis of results and recommendations for proposed structure carried out at Old Ch. 11+523 to Old Ch. 16+815 (New CH 12+208 to 17+500) based on soil sample collected from the locations of 21 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:-

<u>Panipat</u>: 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.

<u>Rohtak</u>: 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.

<u>Rewari:</u> 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.

<u>Mewat:</u> 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.

On soil Samples

- Dry density test
- o Bulk Density and Moisture Content.
- o Sieve Analysis
- Hydrometer Analysis
- o Liquid Limit and Plastic Limit
- Specific gravity
- $\circ~$ Shrinkage Limit





- Free Swell Index
- Direct Shear Test
- o Triaxial Shear Test
- o 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

On Rock Samples

- Moisture content, porosity & Density
- Specific gravity
- o 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 three 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. 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 21 boreholes carried out at Old Ch. 11+523 to Old Ch. 16+815 (New CH 12+208 to 17+500) 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:

| . No. | nage Old (km) | nage New (km) | ucture | H.No. | of Water below EGL (m) | Co-ordinates (m) (m) EGL (m) (+) (+) | | (+) R.L. (m) | |
|-------|------------------|------------------|--------|-------|------------------------------|---|------------|-----------------|---------|
| S | Chaii (| Chair (| Str | B | Depth Table h | Table b Depth o below | Е | Ν | (11) |
| 1. | 11+523 | 12+208 | | BH-CL | 4.22 | 10.00 | 709040.651 | 3123968.349 | 195.402 |
| 2. | 11+614 | 12+299 | | BH-CL | 4.60 | 10.00 | 708954.798 | 3123947.903 | 195.557 |
| 3. | 11+657 | 12+342 | MND | BH-CL | 4.70 | 10.00 | 708910.733 | 3123935.677 | 195.027 |
| 4. | 12+125 | 12+808 | WIND | BH-CL | 1.56 | 10.00 | 708479.897 | 3123758.290 | 194.849 |
| 5. | 12+431 | 13+115 | | BH-CL | 1.50 | 10.00 | 708224.151 | 3123592.675 | 195.631 |
| 6. | 13+218 | 13+903 | | BH-CL | 3.10 | 10.00 | 707594.763 | 3123118.176 | 195.027 |
| 7. | | | | BH-A1 | 2.53 | 40.00 | 707152.851 | 3122785.015 | 194.731 |
| 8. | 13+787 | 14+472 | MJB | BH-P1 | 2.55 | 40.00 | 707140.474 | 3122775.684 | 194.755 |
| 9. | | | | BH-A2 | 2.50 | 40.00 | 707128.097 | 3122766.353 | 194.784 |
| 10. | 13+917 | 14+601 | | BH-CL | 2.90 | 10.00 | 707035.822 | 3122696.787 | 194.850 |
| 11. | 14+072 | 14+756 | | BH-CL | 3.10 | 10.00 | 706910.449 | 3122602.267 | 194.471 |
| 12. | 14+415 | 15+100 | MNB | BH-CL | 3.00 | 10.00 | 706638.160 | 3122396.987 | 194.541 |
| 13. | 15+259 | 15+944 | | BH-CL | 2.90 | 10.00 | 705971.993 | 3121873.019 | 193.786 |
| 14. | 15+416 | 16+101 | | BH-CL | 3.20 | 10.00 | 705861.877 | 3121764.321 | 194.416 |
| 15. | 15-441 | 16+127 | | BH-A1 | 3.00 | 30.00 | 705851.853 | 3121753.862 | 194.160 |
| 16. | 13+441 | 10+127 | | BH-A2 | 3.10 | 30.00 | 705838.108 | 3121739.334 | 193.216 |
| 17. | 16±042 | 16+727 | MID | BH-A1 | 3.65 | 30.00 | 705482.626 | 3121279.064 | 194.075 |
| 18. | 10+042 | 10+727 | IVIJD | BH-A2 | 3.68 | 30.00 | 705472.020 | 3121262.045 | 194.105 |
| 19. | 16+221 | 16+017 | | BH-A1 | 3.13 | 30.00 | 705386.344 | 3121114.308 | 192.968 |
| 20. | 10+231 | 10+91/ | | BH-A2 | 3.10 | 30.00 | 705376.865 | 3121096.697 | 193.065 |
| 21. | 16+815 | 17+500 | MNB | BH-CL | 4.10 | 10.00 | 705153.768 | 3120569.349 | 194.981 |

Table 1.1: Details of Borehole Locations

*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.



The Ground Water Table was met at depths of from 1.5m to 4.7m below EGL in the boreholes. 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:-

| Correlation for C | 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 | | | | |

 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)

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 +
$$\frac{1}{2}$$
 (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.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

| Description of Test | Reference | Undisturbed (UDS) Soil Samples | Disturbed (DS/SPT) Soil Samples |
|--|---------------------------|--------------------------------------|---------------------------------------|
| Grain Size Analysis / Hydrometer | IS: 2720 (Part - 4) | \checkmark | - |
| Natural Moisture Content / Bulk / Dry density | IS : 2720 (Part – 2) | \checkmark | - |
| Atterberg Limits | | | |
| Liquid Limit | IS: 2720 (Part - 5) | | |
| Plastic Limit | IS: 2720 (Part - 5) | | \checkmark |
| Specific Gravity | IS : 2720 (Part – 3) | \checkmark | - |
| Direct Shear Test | IS : 2720 (Part – 13) | \checkmark | - |
| | IS : 2720 | . | |
| I riaxial compressive shear test | (Part – 11 & 12) | N | - |
| Chemical Analysis of Soil Samples | IS : 2720 (Part – 26, 27) | \checkmark | - |

 Table 1.3: Description of Tests

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 $(\gamma_b) = W/V$

Dry density $(\gamma_d) = \gamma_b / (1+Wn)$

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 75 micron. 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; $\mu = \text{co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;}$

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

$$M = \sqrt{\frac{30\mu}{980(G-1)}} = \text{a constant factor for given values of } \mu \text{ and } G \text{ at the temperature of the}$$

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 $30^{\circ} \pm 1/2^{\circ}$. The weight of the cone, together with its associated shaft is $80g \pm 0.5g$. 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 (\pm 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. (WP)



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 $(30 \pm 0.1g)$ 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 borehole carried out at Old Ch. 11+523 to Old Ch. 16+815 (New CH 12+208 to 17+500) it is revealed that the strata consisit of Coarse grained soil i.e. Silty Sand (SM), Silty Sand with Clay (SM-SC), Clayey Silt with low Plasticity (MLCL), Fine grained Soil i.e. Silty Clay of low Plasticity (CL), Silty Clay of Medium Plasticity (CI).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table was met at depths of from 1.50 m to 4.6 m below EGL in 21 boreholes and not encountered in the remaining boreholes as given in Table 2.1, 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 2 to 3.0m at the locations of boreholes.

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 :-

| Chemical Property | Findings (Min. to Max.) | Remarks (Required limits as per IS 456-2000) |
|----------------------------------|--------------------------|--|
| pН | 7.41 to 8.91 | > 6.0 |
| Sulphite as SO_3^{2-} (%) | 0.0021 (%) to 0.0036 (%) | < 0.2% (Class I) |
| Chlorides as Cl ⁻ (%) | 0.0065 (%) to 0.0077 (%) | No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31) |

Summary of chemical analysis of soil samples

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

6.3 COMPUTATION OF LIQUEFACTION POTENTIAL

The site falls under seismic zone- IV. 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 cohesionless strata encountered in the boreholes at site, the IS: 1893 (Part-1)-2016 should be referred for the analysis of Liquefaction Potential and for the cohesive strata, RDSO BS-118 should be referred.

As per the RDSO guidelines:

a)Cohesive soils should be considered liquefiable if wl \leq 37 %, Ip \leq 12 % and wn>0.80 wl, where Ip is the Plasticity Index.

b)Liquefaction susceptibility of soils should be considered marginal if wl \leq 47 %, Ip \leq 20 % and wn \geq 0.85 wl, where Ip is the Plasticity Index.

c)Cohesive soils should be considered non-liquefiable if wl>47 % or Ip>20 % or wn<0.85 wl, where Ip is the Plasticity Index.

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 met at depths of from 1.50 m to 4.70m below EGL in the boreholes. For the analysis of liquefaction potential, the water table is generally considered to rise all boreholes. However, a sample analysis sheet is provided for reference.

The strata in the boreholes are not likely to liquefy as mentioned above and the same is tabulated below:-

| S. No. | Chainage Old | Chainage New | Structure | BH.No. | Water Table depth considered for analysis (m) | Liquefiable upto(m) |
|-----------|-----------------|-----------------|-----------|--------|---|------------------------|
| 1. | 11+523 | 12+208 | | BH-CL | 0.00 | 3.00 |
| 2. | 11+614 | 12+299 | | BH-CL | 0.00 | 3.00 |
| 3. | 11+657 | 12+342 | MNB | BH-CL | 0.00 | 3.00 |
| 4. | 12+125 | 12+808 | | BH-CL | 0.00 | Non-Liquefiable |
| 5. | 12+431 | 13+115 | | BH-CL | 0.00 | Non-Liquefiable |
| 6. | 13+218 | 13+903 | | BH-CL | 0.00 | 3.00 |
| 7. | | | | BH-A1 | 0.00 | Non-Liquefiable |
| 8. | 13+787 | 14+472 | MJB | BH-P1 | 0.00 | 11.50 |
| 9. | | | | BH-A2 | 0.00 | 7.00 |
| 10. | 13+917 | 14+601 | | BH-CL | 0.00 | 1.50 |
| 11. | 14+072 | 14+756 | MNB | BH-CL | 0.00 | 1.50 |
| 12. | 14+415 | 15+100 | | BH-CL | 0.00 | 3.00 |
| 13. | 15+259 | 15+944 | MNID | BH-CL | 0.00 | 6.00 |
| 14. | 15+416 | 16+101 | IVIIND | BH-CL | 0.00 | 6.00 |

Table 2.1: Liquefaction Analysis



| S. No. | Chainage Old | Chainage New | Structure | BH.No. | Water Table depth considered for analysis (m) | Liquefiable upto(m) |
|-----------|-----------------|-----------------|-----------|--------|---|------------------------|
| 15. | 15+441 | 16+127 | | BH-A1 | 0.00 | 5.50 |
| 16. | 13+441 | 10+127 | | BH-A2 | 0.00 | Non-Liquefiable |
| 17. | 16+042 | 16+727 | MID | BH-A1 | 0.00 | 4.00 |
| 18. | 10+042 | 10+/2/ | MJD | BH-A2 | 0.00 | Non-Liquefiable |
| 19. | 16+221 | 16+017 | | BH-A1 | 0.00 | Non-Liquefiable |
| 20. | 10+231 | 10+917 | | BH-A2 | 0.00 | 4.00 |
| 21. | 16+815 | 17+500 | MNB | BH-CL | 0.00 | Non-Liquefiable |

6.4 INTERPRETATION OF LAB TEST RESULTS

Grain Size Analysis

- Clay content: It generally varies from 3 to 12%.
- Silt content: It generally varies from 22 to 64%.
- Sand content: It generally varies from 23 to 88%.
- **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 25 to 27% in ML-CL type of soil, 32 to 36% in CL type of soil.
- **Plastic Limit:** The plastic limit of the soil sample varies from 20 to 23% in ML-CL type of soil, 20 to 24% 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, 09 to 12% 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 1.64 gm/cc to 1.98gm/cc whereas natural moisture content varies from 9.51% to 25.3%.

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 31° , whereas cohesion varies from 0.00 kg/cm² to 0.11 kg/cm².

For Silty strata (ML-CL), the value of angle of internal friction varies from 22° to 27° , whereas cohesion varies from 0.19 kg/cm² to 0.22 kg/cm².



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/cm² to 2.24kg/cm².



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:

| Type of foundation | Depth of Foundation below E.G.L. (m) | Size of Foundation (m x m) |
|-----------------------|---|----------------------------|
| | 1.0, 1.5, 2.0 | 2.7 x 27 |
| | 1.0, 1.5, 2.0 | 5.5 x 5.5 |
| Shallow Foundation | 1.0, 1.5, 2.0 | 2.5 x 2.5 |
| | 1.0, 1.5, 2.0 | 3.7 x 3.7 |
| | 1.0, 1.5, 2.0 | 6 x 6 |
| | 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 | 20.0, 22.0, 24.0, 26.0, 28.0, 30.0 | 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 $0.5*B*Tan (45+\emptyset/2)$ (where B = Width of the Foundation, \emptyset = 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, $q_d = c N_c s_c d_c i_c + q (N_q-1) s_q d_q i_q + (1/2) B \gamma N_\gamma s_\gamma d_\gamma i_\gamma W'$ The ultimate net bearing capacity in case of local shear failure is given by following expression, $q'_d = (2/3) c N'_c s_c d_c i_c + q (N'_q-1) s_q d_q i_q + (1/2) B \gamma N'_\gamma s_\gamma d_\gamma i_\gamma W'$ Where, $d_c = 1 + 0.2 (D_f/B)^*SQRT(N_{\phi})$ $d_q = d_\gamma = 1 \text{ for } \phi < 10^{\circ}$ $d_q = d_\gamma = 1 + 0.1 (D_f/B)^*SQRT(N_{\phi}) \text{ for } \phi > 10^{\circ}$ $N_{\phi} = \tan^2(\pi/4 + \phi/2)$ $\phi' \text{ for local shear failure = tan^{-1} (0.67 tan \phi)$

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, cm²/kg

 ΔP = Pressure increment, kg/cm²

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] :-

| Plasticity | Conversion | $m_v (10^{-3} \text{ kPa}^{-1})$ based on N-Value: $m_v = 1/(f_2N)$ | | | | | | | | |
|------------|--------------------------|---|------|------|------|------|--|--|--|--|
| Index (%) | Factor (f ₂) | 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 | | | | |
| 30 | 475 | 0.21 | 0.10 | 0.07 | 0.05 | 0.04 | | | | |
| 40 | 450 | 0.22 | 0.11 | 0.07 | 0.06 | 0.04 | | | | |

Coefficient of Volume Compressibility derived from SPT N-Value (after Stroud and Butler, 1975)



 $Mv = 1/(f_2N_{corr.})$

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 construction be constructed.

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)

$\mathbf{Q}_{u} = (\mathbf{0.5}^{*}\mathbf{D}^{*}\gamma^{*}\mathbf{N}_{\gamma} + \mathbf{P}_{D}^{*}\mathbf{N}_{q})^{*}\mathbf{A}_{p} + (\Sigma\mathbf{K}_{i}^{*}\mathbf{P}_{Di}^{*}\tan\delta_{i})^{*}\mathbf{A}_{si}$

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/m³

 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/m² 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/m² 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 m²

b) For piles in cohesive soils (using the static formula)

$$\mathbf{Q}_{u} = \mathbf{c}\mathbf{p}^{*}\mathbf{N}\mathbf{c}^{*}\mathbf{A}_{p} + \boldsymbol{\Sigma}\boldsymbol{\alpha}_{i}^{*}\mathbf{c}_{i}^{*}\mathbf{A}_{si}$$

Where,

 Q_u = Ultimate load capacity of pile in KN

 A_p = cross-sectional area of pile tip in m²

 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 m²

c) For computation of safe load carrying capacity of pile in lateral, the following equation has been used:

i. <u>Fixed Head Condition</u>

 $Q = (12 * E * I * Y) / (L_1 + L_f)^3$

ii. <u>Free Head Condition</u> $Q = (3 * E * I * Y) / (L_1 + L_f)^3$

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:-

| ge Old ;e New | | Vo. | Layer depth below EGL (m) | | of strata) | cription | N. LdS | | y (gm/cc) | n (C) n2) | nternal (Ф) (°) |
|------------------|---|---------|---------------------------------------|------------|----------------|------------|-------------|-------------------|------------------------|--------------|--------------------|
| Chainag | Chainag Chainag From To Thickness | | Thickness (m) | Strata des | Observed | Corrected | Bulk Densit | Cohesio (kg/cr | Angle of i Friction | | |
| | | | 0.00 | 3.00 | 3.00 | Silty Sand | 5 | 8 | 1.65 | 0.00 | 30 |
| 11+523 | 12+208 | BH-CL | 3.00 | 8.25 | 5.25 | Silty Sand | 18 | 18 | 1.78 | 0.00 | 31 |
| | | | 8.25 | 10.00 | 1.75 | Silty Sand | - | - | 1.82 | 0.10 | 31 |
| | | | 0.00 | 2.25 | 2.25 | Sandy Silt | 8 | 13 | 1.69 | 0.19 | 28 |
| 11+614 | 12+299 | BH-CI | 2.25 | 5.25 | 3.00 | Sandy Silt | 17 | 20 | 1.78 | 0.21 | 28 |
| 11,014 | 12+277 | DII-CL | 5.25 | 8.25 | 3.00 | Sandy Silt | 19 | 17 | 1.83 | 0.21 | 28 |
| | | | 8.25 | 10.00 | 1.75 | Sandy Silt | - | - | 1.84 | 0.21 | 28 |
| | | | 0.00 | 5.25 | 5.25 | Sandy Silt | 12 | 16 | 1.73 | 0.18 | 28 |
| 11+657 | 12+342 | BH-CL | 5.25 | 8.25 | 3.00 | Sandy Silt | 22 | 19 | 1.83 | 0.20 | 29 |
| | | | 8.25 | 10.00 | 1.75 | Silty Clay | - | - | 1.93 | 0.56 | 5 |
| 12+125 | 12+808 | BH-CI | 0.00 | 5.50 | 5.50 | Silty Sand | 16 | 19 | 1.76 | 0.00 | 31 |
| 12+125 | 12+000 | DII-CL | 5.50 | 10.00 | 4.50 | Sandy Silt | 34 | 27 | 1.86 | 0.21 | 27 |
| | | BH-CL | 0.00 | 4.00 | 4.00 | Silty Sand | 16 | 19 | 1.74 | 0.00 | 31 |
| 12+431 | 13+115 | | 4.00 | 7.00 | 3.00 | Silty Sand | 64 | 46 | 1.88 | 0.00 | 32 |
| | | | 7.00 | 10.00 | 3.00 | Silty Sand | - | - | 1.84 | 0.00 | 31 |
| | | | 0.00 | 2.25 | 2.25 | Silty Sand | 5 | 8 | 1.67 | 0.00 | 30 |
| 13+218 | 13+903 | BH-CI | 2.25 | 5.25 | 3.00 | Silty Clay | 15 | 15 | 1.83 | 0.53 | 5 |
| 15+210 | 15+705 | DII-CL | 5.25 | 8.25 | 3.00 | Silty Clay | 23 | 23 | 1.96 | 0.75 | 6 |
| | | | 8.25 | 10.00 | 1.75 | Sandy Silt | - | - | 1.84 | 0.21 | 30 |
| | | | 0.00 | 2.50 | 2.50 | Silty Clay | 6 | 6 | 1.65 | 0.23 | 4 |
| | | | 2.50 | 8.50 | 6.00 | Silty Clay | 15 | 15 | 1.93 | 0.49 | 4 |
| 13+787 | 14+472 | BH-A1 | 8.50 | 11.50 | 3.00 | Silty Clay | 20 | 20 | 1.95 | 0.70 | 5 |
| 15+707 | 17,7/2 | D11-711 | 11.50 | 14.50 | 3.00 | Silty Clay | 26 | 26 | 1.97 | 0.88 | 5 |
| | | | 14.50 | 20.50 | 6.00 | Silty Clay | 33 | 33 | 1.98 | 1.02 | 6 |
| | | | 20.50 | 24.00 | 3.50 | Silty Clay | 32 | 32 | 1.98 | 1.02 | 6 |
| | | | 24.00 | 29.50 | 5.50 | Silty Clay | 40 | 40 | 2.01 | 1.42 | 5 |
| | | BH-A1 | 29.50 | 35.50 | 6.00 | Silty Clay | 83 | 83 | 2.04 | 2.56 | 5 |
| 13+787 | 14+472 | | 35.50 | 40.00 | 4.50 | Silty Clay | 73 | 73 | 2.05 | 2.56 | 5 |
| | | BH-D1 | 0.00 | 7.00 | 7.00 | Silty Sand | 6 | 7 | 1.69 | 0.09 | 29 |
| | | D11-1 1 | 7.00 | 10.00 | 3.00 | Silty Sand | 9 | 10 | 1.71 | 0.09 | 29 |

Table 3.3 : Design Soil Parameter



| Chainage Old Chainage New | | e New Vo. | | Layer depth below EGL (m) | | cription | | N. LAS | y (gm/cc) | n (C) n2) | nternal (Φ) (°) |
|------------------------------|--------|--------------|-------|---------------------------------------|------------------|------------|----------|-----------|-------------|-------------------|------------------------|
| | | BH.N | From | To | Thickness (m) | Strata des | Observed | Corrected | Bulk Densit | Cohesio (kg/cr | Angle of i Friction |
| | | | 10.00 | 13.00 | 3.00 | Silty Clay | 24 | 24 | 1.97 | 0.82 | 5 |
| | | | 13.00 | 16.00 | 3.00 | Silty Clay | 29 | 29 | 1.98 | 0.95 | 6 |
| | | | 16.00 | 19.00 | 3.00 | Silty Clay | 56 | 56 | 2.01 | 1.85 | 5 |
| | | | 19.00 | 22.00 | 3.00 | Silty Clay | 65 | 65 | 2.02 | 2.03 | 6 |
| | | | 22.00 | 25.00 | 3.00 | Silty Clay | 43 | 43 | 2.00 | 1.42 | 5 |
| | | | 25.00 | 28.00 | 3.00 | Silty Clay | 64 | 64 | 2.03 | 2.08 | 5 |
| | | | 28.00 | 34.00 | 6.00 | Silty Clay | 67 | 67 | 2.04 | 2.50 | 6 |
| | | | 34.00 | 37.00 | 3.00 | Silty Clay | 75 | 75 | 2.03 | 2.37 | 6 |
| | | | 37.00 | 40.00 | 3.00 | Silty Clay | - | - | 2.03 | 2.37 | 6 |
| | | | 0.00 | 5.50 | 5.50 | Silty Sand | 9 | 13 | 1.73 | 0.11 | 29 |
| | | | 5.50 | 7.00 | 1.50 | Silty Sand | - | - | 1.75 | 0.11 | 29 |
| | | | 7.00 | 11.50 | 4.50 | Silty Clay | 22 | 22 | 1.95 | 0.75 | 5 |
| | | | 11.50 | 14.50 | 3.00 | Silty Clay | 30 | 30 | 1.98 | 1.02 | 6 |
| | | | 14.50 | 20.50 | 6.00 | Silty Clay | 34 | 34 | 1.98 | 1.02 | 6 |
| | | BH-A2 | 20.50 | 23.50 | 3.00 | Silty Clay | 43 | 43 | 2.00 | 1.40 | 6 |
| | | | 23.50 | 26.50 | 3.00 | Silty Clay | 44 | 44 | 2.01 | 1.40 | 6 |
| | | | 26.50 | 29.50 | 3.00 | Silty Clay | 63 | 63 | 2.03 | 2.18 | 5 |
| | | | 29.50 | 32.50 | 3.00 | Silty Clay | 72 | 72 | 2.03 | 2.18 | 5 |
| | | | 32.50 | 35.50 | 3.00 | Silty Clay | 79 | 79 | 2.05 | 2.56 | 5 |
| | | | 35.50 | 40.00 | 4.50 | Silty Clay | 81 | 81 | 2.04 | 2.56 | 5 |
| | | | 0.00 | 2.25 | 2.25 | Sandy Silt | 7 | 11 | 1.69 | 0.20 | 28 |
| 13+917 | 14+601 | BH-CI | 2.25 | 5.25 | 3.00 | Silty Clay | 14 | 14 | 1.91 | 0.44 | 4 |
| 15-717 | 14,001 | DII-CL | 5.25 | 8.25 | 3.00 | Sandy Silt | 32 | 25 | 1.89 | 0.21 | 29 |
| | | | 8.25 | 10.00 | 1.75 | Silty Clay | - | - | 1.99 | 1.03 | 5 |
| | | | 0.00 | 2.25 | 2.25 | Silty Sand | 8 | 12 | 1.69 | 0.09 | 29 |
| 14:070 | 14.756 | | 2.25 | 5.25 | 3.00 | Silty Clay | 14 | 14 | 1.89 | 0.51 | 4 |
| 14+072 | 14+756 | BH-CL | 5.25 | 8.25 | 3.00 | Silty Clay | 32 | 32 | 1.99 | 1.02 | 5 |
| | | | 8.25 | 10.00 | 1.75 | Silty Clay | - | - | 1.99 | 1.02 | 5 |
| | | | 0.00 | 2.25 | 2.25 | Sandy Silt | 7 | 11 | 1.67 | 0.19 | 28 |
| 14,417 | 15,100 | | 2.25 | 5.25 | 3.00 | Silty Clay | 20 | 20 | 1.86 | 0.71 | 4 |
| 14+415 | 15+100 | BH-CL | 5.25 | 8.25 | 3.00 | Sandy Silt | 22 | 20 | 1.86 | 0.22 | 29 |
| | | | 8.25 | 10.00 | 1.75 | Sandy Silt | - | - | 1.86 | 0.22 | 29 |
| 15+259 | 15+944 | BH-CL | 0.00 | 5.25 | 5.25 | Sandy Silt | 9 | 13 | 1.76 | 0.19 | 28 |



| ge Old | ge New | No. | Layer depth | below EGL (m) | of strata) | cription | | N. LdS | ty (gm/cc) | iion (C) cm2) | internal (Φ) (°) | |
|--------|---------|--------|----------------|---------------------|-----------------|------------|----------|-----------------------|------------|-------------------|----------------------|--|
| Chaina | Chainag | BH. | From | To | Thickness (m | Strata des | Observed | Observed Corrected | | Cohesic (kg/c) | Angle of Friction | |
| | | | 5.25 | 8.25 | 3.00 | Silty Clay | 31 | 31 | 1.99 | 1.05 | 5 | |
| | | | 8.25 | 10.00 | 1.75 | Silty Clay | - | - | 2.00 | 1.05 | 5 | |
| | | | 0.00 | 2.25 | 2.25 | Sandy Silt | 8 | 12 | - | 0.21 | 28 | |
| 15-416 | 16+101 | | 2.25 | 5.25 | 3.00 | Sandy Silt | 17 | 19 | 1.78 | 0.21 | 28 | |
| 137410 | 10+101 | DII-CL | 5.25 | 8.25 | 3.00 | Sandy Silt | 19 | 17 | 1.83 | 0.21 | 28 | |
| | | | 8.25 | 10.00 | 1.75 | Sandy Silt | - | - | 1.84 | 0.21 | 28 | |
| | | | 0.00 | 4.00 | 4.00 | Silty Sand | 5 | 6 | 1.64 | 0.10 | 28 | |
| | | | 4.00 | 7.00 | 3.00 | Silty Clay | 36 | 36 | 1.99 | 1.13 | 6 | |
| | | | 7.00 | 10.00 | 3.00 | Silty Clay | 39 | 39 | 2.00 | 1.13 | 6 | |
| | | BH-A1 | 10.00 | 13.00 | 3.00 | Silty Clay | 33 | 33 | 1.99 | 1.13 | 6 | |
| | | | 13.00 | 16.00 | 3.00 | Silty Clay | 28 | 28 | 1.98 | 1.13 | 6 | |
| | | | 16.00 | 19.00 | 3.00 | Silty Clay | 42 | 42 | 2.00 | 1.38 | 6 | |
| | | | 19.00 | 22.00 | 3.00 | Silty Clay | 41 | 41 | 1.99 | 1.38 | 6 | |
| | | | 22.00 | 25.00 | 3.00 | Silty Clay | 45 | 45 | 2.00 | 1.38 | 6 | |
| 15+441 | 16+127 | | 25.00 | 30.00 | 4.95 | Silty Clay | 75 | 75 | 2.03 | 2.35 | 6 | |
| 15 111 | 10 127 | | 0.00 | 5.50 | 5.50 | Silty Clay | 11 | 11 | 1.72 | 0.39 | 4 | |
| | | | 5.50 | 8.50 | 3.00 | Silty Clay | 25 | 25 | 1.97 | 0.85 | 5 | |
| | | | 8.50 | 11.50 | 3.00 | Silty Clay | 35 | 35 | 1.99 | 1.19 | 4 | |
| | | | 11.50 | 14.50 | 3.00 | Silty Clay | 39 | 39 | 2.00 | 1.36 | 5 | |
| | | BH-A2 | 14.50 | 17.50 | 3.00 | Silty Clay | 43 | 43 | 2.00 | 1.36 | 5 | |
| | | | 17.50 | 20.50 | 3.00 | Silty Clay | 42 | 42 | 1.99 | 1.36 | 5 | |
| | | | 20.50 | 23.50 | 3.00 | Silty Clay | 52 | 52 | 2.01 | 1.79 | 5 | |
| | | | 23.50 | 26.50 | 3.00 | Silty Clay | 56 | 56 | 2.03 | 1.79 | 5 | |
| | | | 26.50 | 30.00 | 3.50 | Silty Clay | 55 | 55 | 2.03 | 1.79 | 5 | |
| | | | 0.00 | 6.00 | 6.00 | Silty Sand | 10 | 13 | 1.71 | 0.10 | 28 | |
| | | | 6.00 | 10.00 | 4.00 | Silty Sand | 19 | 18 | 1.77 | 0.11 | 30 | |
| 16+042 | 16+727 | BH-A1 | 10.00 | 14.50 | 4.50 | Sandy Silt | 22 | 18 | 1.86 | 0.20 | 29 | |
| | | | 14.50 | 17.50 | 3.00 | Silty Clay | 31 | 31 | 1.98 | 1.06 | 5 | |
| | | | 17.50 | 20.50 | 3.00 | Silty Clay | 36 | 36 | 1.99 | 1.23 | 4 | |
| | | BH-A1 | 20.50 | 23.50 | 3.00 | Silty Clay | 42 | 42 | 2.00 | 1.40 | 4 | |
| | | | 23.50 | 30.00 | 6.45 | Silty Clay | 77 | 77 | 2.04 | 2.74 | 4 | |
| 16+042 | 16+727 | | 0.00 | 4.00 | 4.00 | Silty Sand | 9 | 12 | 1.69 | 0.11 | 28 | |
| | | BH-A2 | 4.00 | 7.00 | 3.00 | Silty Sand | 16 | 17 | 1.75 | 0.12 | 29 | |
| | | | 7.00 | 8.50 | 1.50 | Silty Sand | 19 | 18 | 1.76 | 0.12 | 29 | |



| | 1 | | | | | | | | 1 | | |
|---------|----------------|--------|----------------|---------------------------------------|-----------------|------------|----------|-----------|------------|-------------------|------------------------|
| ge Old | ge New | Vo. | Layer depth | Layer depth below EGL (m) | | cription | N. LdS | | ty (gm/cc) | on (C) :m2) | internal (Ф) (°) |
| Chainag | Chaina; BH. | | From | To | Thickness (m | Strata des | Observed | Corrected | Bulk Densi | Cohesic (kg/ci | Angle of i Friction |
| | | | 8.50 | 13.00 | 4.50 | Silty Clay | 27 | 23 | 1.96 | 0.85 | 4 |
| | | | 13.00 | 16.00 | 3.00 | Silty Clay | 27 | 27 | 1.96 | 0.85 | 4 |
| | | | 16.00 | 19.00 | 3.00 | Silty Clay | 42 | 42 | 1.99 | 1.40 | 4 |
| | | | 19.00 | 22.00 | 3.00 | Silty Clay | 56 | 56 | 2.02 | 1.83 | 5 |
| | | | 22.00 | 25.00 | 3.00 | Silty Clay | 62 | 62 | 2.02 | 1.98 | 4 |
| | | | 25.00 | 30.00 | 4.95 | Silty Clay | 78 | 78 | 2.04 | 2.50 | 4 |
| | | | 0.00 | 4.00 | 4.00 | Silty Sand | 11 | 14 | 1.71 | 0.11 | 28 |
| | | | 4.00 | 7.00 | 3.00 | Silty Sand | 27 | 23 | 1.80 | 0.10 | 29 |
| | | | 7.00 | 10.00 | 3.00 | Sandy Silt | 48 | 32 | 1.88 | 0.22 | 29 |
| | | BH A1 | 10.00 | 13.00 | 3.00 | Silty Clay | 39 | 39 | 1.99 | 1.19 | 5 |
| | | DII-AI | 13.00 | 16.00 | 3.00 | Silty Clay | 32 | 32 | 1.99 | 1.19 | 5 |
| | | | 16.00 | 19.00 | 3.00 | Silty Clay | 45 | 45 | 2.00 | 1.48 | 6 |
| | | | 19.00 | 22.50 | 3.50 | Silty Clay | 47 | 47 | 1.99 | 1.48 | 6 |
| | | | 22.50 | 30.00 | 7.50 | Sandy Silt | 85 | 36 | 1.95 | 0.18 | 29 |
| 16+231 | 16+917 | | 0.00 | 5.50 | 5.50 | Sandy Silt | 10 | 14 | 1.74 | 0.20 | 27 |
| | | | 5.50 | 8.50 | 3.00 | Sandy Silt | 23 | 20 | 1.82 | 0.19 | 28 |
| | | | 8.50 | 11.50 | 3.00 | Sandy Silt | 33 | 24 | 1.87 | 0.20 | 28 |
| | | | 11.50 | 14.50 | 3.00 | Silty Clay | 28 | 28 | 1.98 | 0.95 | 5 |
| | | BH-A2 | 14.50 | 17.50 | 3.00 | Silty Clay | 40 | 40 | 1.99 | 1.31 | 6 |
| | | | 17.50 | 20.50 | 3.00 | Silty Clay | 39 | 39 | 1.99 | 1.31 | 6 |
| | | | 20.50 | 23.50 | 3.00 | Silty Clay | 46 | 46 | 2.02 | 1.65 | 5 |
| | | | 23.50 | 26.50 | 3.00 | Silty Clay | 53 | 53 | 2.01 | 1.65 | 5 |
| | | | 26.50 | 30.00 | 3.50 | Sandy Silt | 47 | 23 | 1.91 | 0.18 | 30 |
| 16+915 | 17+500 | BH CI | 0.00 | 5.50 | 5.50 | Sandy Silt | 21 | 26 | 1.81 | 0.20 | 27 |
| 10-013 | 17:500 | DII-CL | 5.50 | 10.00 | 4.50 | Sandy Silt | 19 | 17 | 1.88 | 0.19 | 28 |

Design parameter have been obtain 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-insitu 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

| Chainage Old | Chainage New | BH. No. | Foundation Size (m x m) | Depth of foundation below EGL (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) |
|--------------|--------------|---------|----------------------------|--------------------------------------|--|---|--|
| | | | 2.7 X 2.7 | 1.00 | 8.34 | 7.46 | 7.46 |
| 11+523 | 12+208 | BH-CL | 2.7 X 2.7 | 1.50 | 10.56 | 8.02 | 8.02 |
| | | | 2.7 X 2.7 | 2.00 | 12.90 | 8.55 | 8.55 |
| | | | 5.5 X 5.5 | 1.00 | 16.83 | 5.92 | 5.92 |
| 11+614 | 12+299 | BH-CL | 5.5 X 5.5 | 1.50 | 18.12 | 6.11 | 6.11 |
| | | | 5.5 X 5.5 | 2.00 | 19.43 | 6.32 | 6.32 |
| | | | 2.5 X 2.5 | 1.00 | 14.04 | 8.06 | 8.06 |
| 11+657 | 12+342 | BH-CL | 2.5 X 2.5 | 1.50 | 15.75 | 8.71 | 8.71 |
| | | | 2.5 X 2.5 | 2.00 | 17.52 | 9.30 | 9.30 |
| | | | 2.7 X 2.7 | 1.00 | 8.58 | 10.08 | 8.58 |
| 12+125 | 12+808 | BH-CL | 2.7 X 2.7 | 1.50 | 10.83 | 10.84 | 10.83 |
| | | | 2.7 X 2.7 | 2.00 | 13.19 | 11.56 | 11.56 |
| | | | 3.7 X 3.7 | 1.00 | 10.01 | 14.37 | 10.01 |
| 12+431 | 13+115 | BH-CL | 3.7 X 3.7 | 1.50 | 12.13 | 15.12 | 12.13 |
| | | | 3.7 X 3.7 | 2.00 | 14.34 | 15.95 | 14.34 |
| | | | 3.7 X 3.7 | 1.00 | 11.96 | 3.98 | 3.98 |
| 13+218 | 13+903 | BH-CL | 3.7 X 3.7 | 1.50 | 12.36 | 5.99 | 5.99 |
| | | | 3.7 X 3.7 | 2.00 | 12.75 | 12.05 | 12.05 |
| | | | 7.2 X 7.2 | 2.00 | 10.94 | 6.40 | 6.40 |
| | | BH-A1 | 7.2 X 7.2 | 3.00 | 11.36 | 6.75 | 6.75 |
| | | | 7.2 X 7.2 | 4.00 | 11.77 | 7.13 | 7.13 |
| | | | 7.2 X 7.2 | 2.00 | 14.90 | 1.77 | NR |
| 13+787 | 14+472 | BH-P1 | 7.2 X 7.2 | 3.00 | 17.35 | 1.96 | NR |
| | | | 7.2 X 7.2 | 4.00 | 19.89 | 2.23 | NR |
| | | | 7.2 X 7.2 | 2.00 | 16.41 | 5.18 | NR |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 19.04 | 5.88 | NR |
| | | | 7.2 X 7.2 | 4.00 | 21.75 | 6.70 | NR |



| Chainage Old | Chainage New | BH. No. | Foundation Size (m x m) | Depth of foundation below EGL (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) |
|--------------|--------------|------------|----------------------------|--------------------------------------|--|---|--|
| | | | 3.7 X 3.7 | 1.00 | 9.62 | 7.15 | 7.15 |
| 13+917 | 14+601 | BH-CL | 3.7 X 3.7 | 1.50 | 9.94 | 9.49 | 9.49 |
| | | | 3.7 X 3.7 | 2.00 | 10.25 | 13.82 | 10.25 |
| | | | 6 X 6 | 1.00 | 10.95 | 5.33 | 5.33 |
| 14+072 | 14+756 | BH-CL | 6 X 6 | 1.50 | 11.20 | 5.75 | 5.75 |
| | | | 6 X 6 | 2.00 | 11.44 | 7.01 | 7.01 |
| | | | 2.7 X 2.7 | 1.00 | 14.40 | 7.37 | 7.37 |
| 14+415 | 15 + 100 | BH-CL | 2.7 X 2.7 | 1.50 | 16.00 | 10.87 | 10.87 |
| | | | 2.7 X 2.7 | 2.00 | 17.64 | 19.93 | 17.64 |
| | | | 6 X 6 | 1.00 | 16.41 | 5.13 | NR |
| 15+259 | 15+944 | BH-CL | 6 X 6 | 1.50 | 17.73 | 5.53 | NR |
| | | | 6 X 6 | 2.00 | 19.08 | 6.02 | NR |
| | | | 6 X 6 | 1.00 | 14.84 | 6.30 | NR |
| 15+416 | 16+101 | BH-CL | 6 X 6 | 1.50 | 16.05 | 6.47 | NR |
| | | | 6 X 6 | 2.00 | 17.28 | 6.67 | NR |
| | | | 7.2 X 7.2 | 2.00 | 34.48 | 4.41 | NR |
| | | BH-A1 | 7.2 X 7.2 | 3.00 | 35.72 | 4.19 | NR |
| 15+441 | 16+127 | | 7.2 X 7.2 | 4.00 | 36.96 | 10.82 | NR |
| 10 111 | 10 127 | | 7.2 X 7.2 | 2.00 | 8.73 | 8.30 | 8.30 |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 9.05 | 8.75 | 8.75 |
| | | | 7.2 X 7.2 | 4.00 | 9.38 | 9.24 | 9.24 |
| | | | 7.2 X 7.2 | 2.00 | 21.70 | 7.05 | 7.05 |
| | | BH-A1 | 7.2 X 7.2 | 3.00 | 25.23 | 7.43 | 7.43 |
| 16+042 | 16+727 | | 7.2 X 7.2 | 4.00 | 28.88 | 7.74 | 7.74 |
| | | | 7.2 X 7.2 | 2.00 | 22.09 | 6.89 | 6.89 |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 25.54 | 7.67 | 7.67 |
| | | | 7.2 X 7.2 | 4.00 | 29.12 | 8.71 | 8.71 |
| | | | 7.2 X 7.2 | 2.00 | 29.28 | 9.73 | 9.73 |
| | | BH-A1 | 7.2 X 7.2 | 3.00 | 33.19 | 10.26 | 10.26 |
| 16+231 | 16+917 | | 7.2 X 7.2 | 4.00 | 37.22 | 10.97 | 10.97 |
| | / - / | _ : | 7.2 X 7.2 | 2.00 | 23.30 | 7.31 | 7.31 |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 26.45 | 7.69 | 7.69 |
| | | | 7.2 X 7.2 | 4.00 | 29.70 | 8.20 | 8.20 |
| | | | 7.2 X 7.2 | 1.00 | 23.42 | 10.55 | 10.55 |
| 16+815 | 17+500 | BH-CL | 7.2 X 7.2 | 1.50 | 25.11 | 10.77 | 10.77 |
| | | | 7.2 X 7.2 | 2.00 | 26.83 | 11.04 | 11.04 |

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m2.



| Chainage Old | Chainage New | BH. No. | Foundation Size (m x m) | Depth of foundation below EGL (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) |
|--------------|--------------|---------|----------------------------|--------------------------------------|--|--|--|
| | | | 2.7 X 2.7 | 1.00 | 8.34 | 14.91 | 8.34 |
| 11+523 | 12+208 | BH-CL | 2.7 X 2.7 | 1.50 | 10.56 | 16.04 | 10.56 |
| | | | 2.7 X 2.7 | 2.00 | 12.90 | 17.10 | 12.90 |
| | | | 5.5 X 5.5 | 1.00 | 16.83 | 11.84 | 11.84 |
| 11+614 | 12+299 | BH-CL | 5.5 X 5.5 | 1.50 | 18.12 | 12.22 | 12.22 |
| | | | 5.5 X 5.5 | 2.00 | 19.43 | 12.64 | 12.64 |
| | | | 2.5 X 2.5 | 1.00 | 14.04 | 16.12 | 14.04 |
| 11+657 | 12+342 | BH-CL | 2.5 X 2.5 | 1.50 | 15.75 | 17.41 | 15.75 |
| | | | 2.5 X 2.5 | 2.00 | 17.52 | 18.60 | 17.52 |
| | | | 2.7 X 2.7 | 1.00 | 8.58 | 20.16 | 8.58 |
| 12+125 | 12+808 | BH-CL | 2.7 X 2.7 | 1.50 | 10.83 | 21.69 | 10.83 |
| | | | 2.7 X 2.7 | 2.00 | 13.19 | 23.13 | 13.19 |
| | | | 3.7 X 3.7 | 1.00 | 10.01 | 28.73 | 10.01 |
| 12+431 | 13+115 | BH-CL | 3.7 X 3.7 | 1.50 | 12.13 | 30.23 | 12.13 |
| | | | 3.7 X 3.7 | 2.00 | 14.34 | 31.91 | 14.34 |
| | | | 3.7 X 3.7 | 1.00 | 11.96 | 7.96 | 7.96 |
| 13+218 | 13+903 | BH-CL | 3.7 X 3.7 | 1.50 | 12.36 | 11.97 | 11.97 |
| | | | 3.7 X 3.7 | 2.00 | 12.75 | 24.10 | 12.75 |
| | | | 7.2 X 7.2 | 2.00 | 10.94 | 12.80 | 10.94 |
| | | BH-A1 | 7.2 X 7.2 | 3.00 | 11.36 | 13.49 | 11.36 |
| | | | 7.2 X 7.2 | 4.00 | 11.77 | 14.25 | 11.77 |
| | | | 7.2 X 7.2 | 2.00 | 14.90 | 3.53 | NR |
| 13+787 | 14+472 | BH-P1 | 7.2 X 7.2 | 3.00 | 17.35 | 3.92 | NR |
| | | | 7.2 X 7.2 | 4.00 | 19.89 | 4.46 | NR |
| | | | 7.2 X 7.2 | 2.00 | 16.41 | 10.36 | NR |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 19.04 | 11.75 | NR |
| | | | 7.2 X 7.2 | 4.00 | 21.75 | 13.40 | NR |
| | | | 3.7 X 3.7 | 1.00 | 9.62 | 14.29 | 9.62 |
| 13+917 | 14+601 | BH-CL | 3.7 X 3.7 | 1.50 | 9.94 | 18.97 | 9.94 |
| | | | 3.7 X 3.7 | 2.00 | 10.25 | 27.65 | 10.25 |
| | | | 6 X 6 | 1.00 | 10.95 | 10.67 | 10.67 |
| 14+072 | 14+756 | BH-CL | 6 X 6 | 1.50 | 11.20 | 11.50 | 11.20 |
| | | | 6 X 6 | 2.00 | 11.44 | 14.02 | 11.44 |
| | | | 2.7 X 2.7 | 1.00 | 14.40 | 14.74 | 14.40 |
| 14+415 | 15+100 | BH-CL | 2.7 X 2.7 | 1.50 | 16.00 | 21.75 | 16.00 |
| | | | 2.7 X 2.7 | 2.00 | 17.64 | 39.85 | 17.64 |

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm



| Chainage Old | Chainage New | BH. No. | Foundation Size (m x m) | Depth of foundation below EGL (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) |
|--------------|--------------|---------|----------------------------|--------------------------------------|--|--|--|
| | | | 6 X 6 | 1.00 | 16.41 | 10.26 | NR |
| 15+259 | 15+944 | BH-CL | 6 X 6 | 1.50 | 17.73 | 11.05 | NR |
| | | | 6 X 6 | 2.00 | 19.08 | 12.04 | NR |
| | | | 6 X 6 | 1.00 | 14.84 | 12.59 | NR |
| 15+416 | 16+101 | BH-CL | 6 X 6 | 1.50 | 16.05 | 12.94 | NR |
| | | | 6 X 6 | 2.00 | 17.28 | 13.35 | NR |
| | | | 7.2 X 7.2 | 2.00 | 34.48 | 8.83 | NR |
| | | BH-A1 | 7.2 X 7.2 | 3.00 | 35.72 | 17.42 | NR |
| 15+441 | 16+127 | | 7.2 X 7.2 | 4.00 | 36.96 | 21.64 | NR |
| 15 + + 1 | 10+127 | | 7.2 X 7.2 | 2.00 | 8.73 | 16.60 | 8.73 |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 9.05 | 17.50 | 9.05 |
| | | | 7.2 X 7.2 | 4.00 | 9.38 | 18.48 | 9.38 |
| | | | 7.2 X 7.2 | 2.00 | 21.70 | 14.10 | 14.10 |
| | | BH-A1 | 7.2 X 7.2 | 3.00 | 25.23 | 14.87 | 14.87 |
| 16+042 | 16+727 | | 7.2 X 7.2 | 4.00 | 28.88 | 15.48 | 15.48 |
| 10+042 | 10+727 | | 7.2 X 7.2 | 2.00 | 22.09 | 13.77 | 13.77 |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 25.54 | 15.34 | 15.34 |
| | | | 7.2 X 7.2 | 4.00 | 29.12 | 17.42 | 17.42 |
| | | | 7.2 X 7.2 | 2.00 | 29.28 | 19.47 | 19.47 |
| | | BH-A1 | 7.2 X 7.2 | 3.00 | 33.19 | 20.53 | 20.53 |
| 16+231 | 16+017 | | 7.2 X 7.2 | 4.00 | 37.22 | 21.94 | 21.94 |
| 10+231 | 10+917 | | 7.2 X 7.2 | 2.00 | 23.30 | 14.62 | 14.62 |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 26.45 | 15.38 | 15.38 |
| | | | 7.2 X 7.2 | 4.00 | 29.70 | 16.39 | 16.39 |
| | | | 7.2 X 7.2 | 1.00 | 23.42 | 21.10 | 21.10 |
| 16+815 | 17+500 | BH-CL | 7.2 X 7.2 | 1.50 | 25.11 | 21.53 | 21.53 |
| | | | 7.2 X 7.2 | 2.00 | 26.83 | 22.08 | 22.08 |

Note:-

• The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2 .

<u>Notes:</u> -

From Table 2.1: Liquefaction Analysis, it has been observed that Liquefaction depth varies from 3.0 to 11.5 m below EGL in all the boreholes. Therefore before laying the open foundation at 1.0 to 4.0 m depth it is recommended to replace & compact the soil up to depth of Liquefaction below the foundation level.



1. The design parameters may be considered for replaced/compacted Soil for calculating the SBC from shear and settlement criteria are as follows;

 $C=0, Phi = 32 degree, Sp. Gravity = 2.63 Bulk density = 1.85 t/m^2, N = 25...$

• Bore holes which are liquefied greater than 4m depth, Some other suitable ground improvement methods may be adopted.

| Table 4.3: Recommended Net Allowable Bearing Capacity for s | hallow foundation for |
|---|-----------------------|
| allowable settlement 25mm (Replaced / Compacted | 1 Soil) |

| Chainage Old | Chainage New | BH. No. | Foundation Size (m x m) | Depth of foundation below EGL (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+523 | 12+208 | BH-CL | 2.7 X 2.7 | 1.00 | 16.5 | 10.8 | 10.8 |
| | | | 2.7 X 2.7 | 1.50 | 20.8 | 11.6 | 11.6 |
| | | | 2.7 X 2.7 | 2.00 | 25.2 | 12.3 | 12.3 |
| 11+614 | 12+299 | BH-CL | 5.5 X 5.5 | 1.00 | 25.2 | 8.7 | 8.7 |
| | | | 5.5 X 5.5 | 1.50 | 29.1 | 9.0 | 9.0 |
| | | | 5.5 X 5.5 | 2.00 | 33.1 | 9.3 | 9.3 |
| 11+657 | 12+342 | BH-CL | 2.5 X 2.5 | 1.00 | 17.6 | 11.0 | 11.0 |
| | | | 2.5 X 2.5 | 1.50 | 22.4 | 11.9 | 11.9 |
| | | | 2.5 X 2.5 | 2.00 | 27.3 | 12.7 | 12.7 |
| 13+218 | 13+903 | BH-CL | 3.7 X 3.7 | 1.00 | 17.5 | 14.2 | 14.2 |
| | | | 3.7 X 3.7 | 1.50 | 21.2 | 16.1 | 16.1 |
| | | | 3.7 X 3.7 | 2.00 | 25.0 | 18.5 | 18.5 |
| 13+787 | 14+472 | BH-P1 | 7.2 X 7.2 | 2.00 | 40.9 | 10.9 | NR |
| | | | 7.2 X 7.2 | 3.00 | 49.5 | 11.4 | NR |
| | | | 7.2 X 7.2 | 4.00 | 58.5 | 12.2 | NR |
| | | BH-A2 | 7.2 X 7.2 | 2.00 | 40.9 | 9.9 | NR |
| | | | 7.2 X 7.2 | 3.00 | 49.5 | 10.4 | NR |
| | | | 7.2 X 7.2 | 4.00 | 58.5 | 10.7 | NR |
| 13+917 | 14+601 | | 3.7 X 3.7 | 1.00 | 19.9 | 14.1 | 14.1 |
| | | BH-CL | 3.7 X 3.7 | 1.50 | 24.0 | 15.6 | 15.6 |
| | | | 3.7 X 3.7 | 2.00 | 28.4 | 17.1 | 17.1 |
| 14+072 | 14+756 | BH-CL | 6 X 6 | 1.00 | 24.3 | 8.7 | 8.7 |
| | | | 6 X 6 | 1.50 | 27.9 | 8.7 | 8.7 |
| | | | 6 X 6 | 2.00 | 31.5 | 8.6 | 8.6 |
| 14+415 | 15+100 | BH-CL | 2.7 X 2.7 | 1.00 | 16.4 | 17.9 | 16.4 |
| | | | 2.7 X 2.7 | 1.50 | 20.6 | 22.6 | 20.6 |
| | | | 2.7 X 2.7 | 2.00 | 25.0 | 29.2 | 25.0 |
| 15+259 | 15+944 | BH-CL | 6 X 6 | 1.00 | 27.3 | 10.2 | NR |
| | | | 6 X 6 | 1.50 | 31.3 | 10.6 | NR |
| | | | 6 X 6 | 2.00 | 35.4 | 11.0 | NR |


| Chainage Old | Chainage New | BH. No. | Foundation Size (m x m) | Depth of foundation below EGL (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) |
|--------------|--------------|---------|----------------------------|--------------------------------------|--|---|--|
| | | | 6 X 6 | 1.00 | 24.3 | 8.7 | NR |
| 15+416 | 16+101 | BH-CL | 6 X 6 | 1.50 | 27.9 | 8.9 | NR |
| | | | 6 X 6 | 2.00 | 31.6 | 9.2 | NR |
| | | | 7.2 X 7.2 | 2.00 | 40.9 | 14.5 | NR |
| 15+441 | 16+127 | BH-A1 | 7.2 X 7.2 | 3.00 | 49.5 | 11.2 | NR |
| | | | 7.2 X 7.2 | 4.00 | 58.5 | 17.4 | NR |
| | | | 7.2 X 7.2 | 2.00 | 40.9 | 9.0 | 9.0 |
| 16+042 | 16+727 | BH-A1 | 7.2 X 7.2 | 3.00 | 49.5 | 9.5 | 9.5 |
| | | | 7.2 X 7.2 | 4.00 | 58.5 | 9.9 | 9.9 |
| | | | 7.2 X 7.2 | 2.00 | 38.9 | 9.8 | 9.8 |
| 16+231 | 16+917 | BH-A2 | 7.2 X 7.2 | 3.00 | 47.1 | 10.2 | 10.2 |
| | | | 7.2 X 7.2 | 4.00 | 55.7 | 10.6 | 10.6 |

 Table 4.4: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm (Replaced / Compacted Soil)

| Chainage Old | Chainage New | BH. No. | Foundation Size (m x m) | Depth of foundation below EGL (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) |
|--------------|--------------|---------|----------------------------|---|---|---|---|
| | | | 2.7 X 2.7 | 1.00 | 16.5 | 21.5 | 16.5 |
| 11+523 | 12 + 208 | BH-CL | 2.7 X 2.7 | 1.50 | 20.8 | 23.1 | 20.8 |
| | | | 2.7 X 2.7 | 2.00 | 25.2 | 24.7 | 24.7 |
| | | | 5.5 X 5.5 | 1.00 | 25.2 | 17.5 | 17.5 |
| 11+614 | 12+299 | BH-CL | 5.5 X 5.5 | 1.50 | 29.1 | 18.0 | 18.0 |
| | | | 5.5 X 5.5 | 2.00 | 33.1 | 18.7 | 18.7 |
| | | BH-CL | 2.5 X 2.5 | 1.00 | 17.6 | 22.0 | 17.6 |
| 11+657 | 12+342 | | 2.5 X 2.5 | 1.50 | 22.4 | 23.8 | 22.4 |
| | | | 2.5 X 2.5 | 2.00 | 27.3 | 25.4 | 25.4 |
| | | | 3.7 X 3.7 | 1.00 | 17.5 | 28.4 | 17.5 |
| 13+218 | 13+903 | BH-CL | 3.7 X 3.7 | 1.50 | 21.2 | 32.1 | 21.2 |
| | | | 3.7 X 3.7 | 2.00 | 25.0 | 37.1 | 25.0 |
| | | | 7.2 X 7.2 | 2.00 | 40.9 | 21.8 | NR |
| | | BH-P1 | 7.2 X 7.2 | 3.00 | 49.5 | 22.9 | NR |
| 12 1707 | 14 472 | | 7.2 X 7.2 | 4.00 | 58.5 | 24.3 | NR |
| 13+/8/ | 14+472 | | 7.2 X 7.2 | 2.00 | 40.9 | 19.9 | NR |
| | | BH-A2 | 7.2 X 7.2 | 3.00 | 49.5 | 20.9 | NR |
| | | | 7.2 X 7.2 | 4.00 | 58.5 | 21.4 | NR |



| GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state | SR-544_21-22 |
|--|--------------|
| of Haryana. | _ |

| Chainage Old | Chainage New | BH. No. | Foundation Size (m x m) | Depth of foundation below EGL (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) |
|--------------|--------------|---------|---|--|---|---|---|
| 13+917 | 14+601 | BH-CL | 3.7 X 3.7 3.7 X 3.7 3.7 X 3.7 | 1.00 1.50 2.00 | 19.9 24.0 28.4 | 28.2 31.2 34.1 | 19.9 24.0 28.4 |
| 14+072 | 14+756 | BH-CL | 6 X 6 6 X 6 | 1.00 1.50 2.00 | 24.3 27.9 21.5 | 17.4 17.3 | 17.4 17.3 |
| 14+415 | 15+100 | BH-CL | 2.7 X 2.7 2.7 X 2.7 2.7 X 2.7 | 1.00 1.50 2.00 | 16.4 20.6 25.0 | 35.8 45.3 58.4 | 17.2 16.4 20.6 25.0 |
| 15+259 | 15+944 | BH-CL | $ \begin{array}{r} 2.7 \times 2.7 \\ 6 \times 6 \\ 6 \times 6 \\ 6 \times 6 \end{array} $ | $ \begin{array}{r} 2.00 \\ 1.00 \\ 1.50 \\ 2.00 \end{array} $ | 27.3 31.3 35.4 | 20.5 21.2 22.0 | NR NR NR |
| 15+416 | 16+101 | BH-CL | 6 X 6 6 X 6 6 X 6 | $ \begin{array}{r} 2.00 \\ 1.00 \\ 1.50 \\ 2.00 \\ \end{array} $ | 24.3 27.9 31.6 | 17.4 17.9 18.5 | NR NR NR |
| 15+441 | 16+127 | BH-A1 | 7.2 X 7.2 7.2 X 7.2 7.2 X 7.2 7.2 X 7.2 | 2.00 3.00 4.00 | 40.9 49.5 58.5 | 29.0 20.1 34.9 | NR NR NR |
| 16+042 | 16+727 | BH-A1 | 7.2 X 7.2 7.2 X 7.2 7.2 X 7.2 | 2.00 3.00 4.00 | 40.9 49.5 58.5 | 18.1 19.1 19.8 | 18.1 19.1 19.8 |
| 16+231 | 16+917 | BH-A2 | 7.2 X 7.2 7.2 X 7.2 7.2 X 7.2 | 2.00 3.00 4.00 | 38.9 47.1 55.7 | 19.7 20.3 21.2 | 19.7 20.3 21.2 |

Note:-

The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2 .

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:-



| : Old New | | | Pile | iles (m) | elow | Safe loa | d carrying ca single pile (T | apacity of [) | | |
|--------------|--------|---------------|---------------|--------------------|------------------|---------------|----------------------------------|-------------------|--|--|
| age () | age N | . No. | er of] m) | ı of pi ut-off | evel b L (m) | sion | ĮĮ | In Lateral | | |
| Chain | Chains | BH | Diamet | Length below cı | Cut-off l EGI | In compres | In upli | Fixed Head | | |
| | | | | 20.0 | | 168.0 | 149.0 | | | |
| | | | | 22.0 | | 182.0 | 165.0 | | | |
| | | | 1.0 | 24.0 | | 197.0 | 181.0 | 15.4 | | |
| | | | 1.0 | 26.0 | | 222.0 | 197.0 | | | |
| | | | | 28.0 | | 238.0 | 214.0 | | | |
| | | | | 30.0 | 2.0 | 290.0 | 235.0 | | | |
| | | DП- АТ | | 20.0 | 2.0 | 215.0 | 190.0 | | | |
| | | | | 22.0 | | 233.0 | 211.0 | | | |
| | | | 1.2 | 24.0 | | 252.0 | 232.0 | 18.5 | | |
| | | | 1.2 | 26.0 | | 285.0 | 253.0 | | | |
| | | | | 28.0 | | 305.0 | 275.0 | | | |
| | | | | 30.0 | | 376.0 | 301.0 | | | |
| | | | | 20.0 | | 123.0 | 104.0 | | | |
| | | | 1.0 | 22.0 | | 138.0 | 119.0 | | | |
| | | | | 24.0 | | 153.0 | 136.0 | 5.3 | | |
| | | | | 26.0 | | 188.0 | 153.0 | | | |
| 13+787 | 14+472 | | | 28.0 | | 220.0 | 174.0 | | | |
| | | BH-P1 | | 30.0 | | 235.0 | 194.0 | | | |
| | | | 1.2 | 20.0 | 2.0 | 164.0 | 136.0 | | | |
| | | | | 22.0 | | 182.0 | 156.0 | | | |
| | | | | 24.0 | | 201.0 | 178.0 | | | |
| | | | | 26.0 | | 248.0 | 200.0 | 0.4 | | |
| | | | | 28.0 | | 272.0 | 226.0 | | | |
| | | | | 30.0 | | 309.0 | 252.0 | | | |
| | | | | 20.0 | | 152.0 | 127.0 | | | |
| | | | | 22.0 | | 167.0 | 143.0 | | | |
| | | | 1.0 | 24.0 | | 182.0 | 160.0 | 5.0 | | |
| | | | 1.0 | 26.0 | | 198.0 | 178.0 | 5.9 | | |
| | | BH-A2 | | 28.0 | 2.0 | 237.0 | 196.0 | | | |
| | | | - | 30.0 | 1 | 254.0 | 214.0 | | | |
| | | | 1.2 | 20.0 | | 198.0 | 164.0 | | | |
| | | | | 22.0 | | 217.0 | 185.0 | 8.7 | | |
| | | | | 24.0 | | 236.0 | 207.0 | | | |

Table 4.5: Safe Load Carrying Capacity of normal bored cast in-situ RCC Pile in Soil



| bld | ew | | Pile | iles (m) | elow | Safe loa s | d carrying c | apacity of [] |
|---------|--------|----------|-----------------|---------------------------|-------------------|---------------|---|-------------------|
| nage () | lage N | H. No. | ter of] (m) | h of pi cut-off | level b iL (m) | ssion | lift | In Lateral |
| Chair | Chain | BI | Diame | Diame Lengt below e | Cut-off EC | In compres | In up | Fixed Head |
| | | | | 26.0 | | 257.0 | 230.0 | 8.7 |
| 13+787 | 14+472 | BH-A2 | 1.2 | 28.0 | 2.0 | 309.0 | 253.0 | |
| | | | | 30.0 | | 330.0 | 276.0 | |
| | | | | 20.0 | | 158.0 | 134.0 | |
| | | | | 22.0 | | 185.0 | 150.0 | |
| | | | 1.0 | 24.0 | | 200.0 | 166.0 | 96 |
| | | | 1.0 | 26.0 | | 214.0 | 182.0 | 7.0 |
| | | | | 28.0 | | 229.0 | 198.0 | |
| | | BH-A1 | | 30.0 | | 244.0 | 214.0 | |
| | | DII-AI | 1.2 | 20.0 | | 205.0 | 172.0 | 13.4 |
| | | | | 22.0 | | 241.0 | 193.0 | |
| | | | | 24.0 | | 260.0 | 214.0 | |
| | | | 1.2 | 26.0 | | 278.0 | 234.0 | |
| | | | | 28.0 | | 296.0 | 255.0 | |
| 15+441 | 16+127 | | | 30.0 | | 315.0 | 276.0 | |
| 10 111 | 10 127 | | 1.0 | 20.0 | 2.0 | 163.0 | 136.0 | 13.2 |
| | | | | 22.0 | | 178.0 | 153.0 | |
| | | | | 24.0 | | 195.0 | 171.0 | |
| | | | | 26.0 | | 242.0 | 191.0 | |
| | | | | 28.0 | | 261.0 | 210.0 | |
| | | BH-A2 | | 30.0 | | 286.0 | 231.0 | |
| | | D11 112 | | 20.0 | | 212.0 | 175.0 | |
| | | | | 22.0 | | 231.0 | 197.0 | |
| | | | 12 | 24.0 | | 252.0 | 220.0 | 17.2 |
| | | | 1.2 | 26.0 | | 315.0 | 246.0 | 17.2 |
| | | | | 28.0 | | 339.0 | 271.0 | |
| | | | | 30.0 | | 364.0 | 297.0 | |
| | | | | 20.0 | | 161.0 | 140.0 | |
| | | | | 22.0 | | 181.0 | 156.0 | |
| | | | 1.0 | 24.0 | | 239.0 | 177.0 | - 13.3 |
| 16+042 | 16+727 | 27 BH-A1 | 1.0 | 26.0 | 2.0 | 259.0 | 198.0 | |
| | | | | 28.0 | | 279.0 | 218.0 | |
| | | | | 30.0 |) | 299.0 | 239.0 | |
| | | | 1.2 | 20.0 | | 206.0 | 179.0 | 19.3 |



| ld | ew | | Pile | les (m) | elow | Safe loa | d carrying cannot be a carrying cannot be a carrying be | apacity of Γ) | |
|---------------|---------|--------|------------------|---------------------|-------------------|--------------|---|------------------|--|
| nage O | nage N | H. No. | eter of] (m) | th of pi cut-off | level b GL (m) | ssion | lift | In Lateral | |
| Chai | Chai | B | Diamo | Leng | Cut-off E(| In compre | In up | Fixed Head | |
| | | | | 22.0 | | 232.0 | 200.0 | | |
| | | | | 24.0 | | 312.0 | 226.0 | | |
| | | | | 26.0 | | 336.0 | 252.0 | | |
| | | | | 28.0 | | 361.0 | 279.0 | | |
| | | | | 30.0 | | 385.0 | 305.0 | | |
| | | | | 20.0 | | 164.0 | 128.0 | | |
| | | | | 22.0 | | 183.0 | 144.0 | | |
| 16±042 16±727 | | BH-A2 | 1.0 | 24.0 | | 198.0 | 161.0 | 0.4 | |
| | | | 1.0 | 26.0 | | 213.0 | 177.0 | 9.4 | |
| | | | | 28.0 | | 228.0 | 194.0 | | |
| | 16 1727 | | | 30.0 | 2.0 | 243.0 | 210.0 | - | |
| 10+042 | 10+/2/ | | | 20.0 | | 215.0 | 164.0 | | |
| | | | | 22.0 | | 234.0 | 185.0 | | |
| | | | 1.2 | 24.0 | | 257.0 | 207.0 | 14.0 | |
| | | | 1.2 | 26.0 | | 276.0 | 228.0 | 14.0 | |
| | | | | 28.0 | | 295.0 | 249.0 | | |
| | | | | 30.0 | | 314.0 | 271.0 | | |
| | | | | 20.0 | | 163.0 | 134.0 | | |
| | | | | 22.0 | | 184.0 | 155.0 | 10.9 | |
| | | | 1.0 | 24.0 | | 237.0 | 178.0 | | |
| | | | 1.0 | 26.0 | | 260.0 | 201.0 | 10.8 | |
| | | | | 28.0 | | 282.0 | 223.0 | | |
| | | | | 30.0 | 2.0 | 305.0 | 246.0 | | |
| | | DII-AI | | 20.0 | 2.0 | 212.0 | 173.0 | | |
| | | | | 22.0 | | 241.0 | 202.0 | | |
| 16+231 | 16+917 | | 1.2 | 24.0 | | 341.0 | 235.0 | 16.6 | |
| | | | 1.2 | 26.0 | | 373.0 | 267.0 | 10.0 | |
| | | | | 28.0 | | 405.0 | 299.0 | 1 | |
| | | | | 30.0 | | 437.0 | 331.0 | 1 | |
| | | | | 20.0 | | 160.0 | 136.0 | | |
| | | | | 22.0 | 2.0 | 183.0 | 151.0 | 15.1 | |
| | | BH-A2 | 1.0 | 24.0 | | 197.0 | 167.0 | | |
| | | | | 26.0 |] | 218.0 | 188.0 | | |
| | | | | 28.0 | | 278.0 | 211.0 | | |



| pl | ew | | Pile | les (m) | elow | Safe load carrying capacity of single pile (T) | | | |
|--------|-------|--------|-----------------|-------------------|------------------|--|-------|---------------|--|
| lage O | age N | I. No. | ter of] (m) | h of pi ut-off | level b L (m) | ssion | ift | In Lateral | |
| Chair | Chain | BI | Diame | Lengt below c | Cut-off] EG | In compre | In up | Fixed Head | |
| | | | | 30.0 | | 301.0 | 234.0 | | |
| | | | | 20.0 | | 207.0 | 175.0 | | |
| | | | | 22.0 | | 238.0 | 195.0 | | |
| | | | 1.2 | 24.0 | | 255.0 | 215.0 | 21.0 | |
| | | | 1.2 | 26.0 | | 284.0 | 245.0 | 21.7 | |
| | | | | 28.0 | | 397.0 | 278.0 | | |
| | | | | 30.0 | | 430.0 | 311.0 | | |

<u>Notes :</u> -

- 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.

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

- 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.
- 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.
- 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.
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- **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.
- 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 |
| NR N | Not Recommended |



APPENDIX – A (FIELD DATA RESULTS)

| Appendix No. | ITEMS | | | | |
|--------------|--------------------------|--|--|--|--|
| A-1 | LOCATION PLAN | | | | |
| A-2 | FIELD BORE HOLE LOGS | | | | |
| A-3 | SUB SOIL PROFILE DIAGRAM | | | | |





SR-544_21-22

CEG TEST HOUSE



CEO TEST HOUSE

| Ca | CANILL THE CANADA | | | | FIE | ELD | BOREHOLE L | , OG | | | | |
|--------------|-------------------------------|----------------|-------------------|----------------------|------------|-------------------|--|-------------------|---------------------|---------------------------------------|----------------------|--|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Cli | ent :HRIDCL | | | |
| BH Loc | ation/Ch | ainage :1 | 1+523 | | | | Northing :3123968.349 m | Eas | sting :709040.651 | m | | |
| Reduced | d Level (i | n):(+)195 | .402 | | | | BH. No. :BH-CL BH Termination Depth (m):10 | | | | | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Min | or Bridge | ; | | Water Table (m):4.22 | Inc | lination : Vertical | | | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing (m) | Not Used | | |
| Date of | Start :30 | -10-2021 | | | | | Date of Completion :30-10-2021 | | | | | |
| | Ê | | В | low cour per 15cn | nts n | | | ion | | | suc | |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS classificat | Graphic Log | (Depth v/s SPT N Value) | Special bservatio | |
| 0.0 | | DS | | | | | | 0 | 0 10 2 | <u>) 30 40 50 60 70 80 90 100</u> | | |
| 0.5 | 0.5 | SPT-1 | 2 | 2 | 2 | 4 | | | | | | |
| 1.5 | . 1.5 | SPT-2 | 2 | 3 | 3 | 6 | Brown, Loose, Silty sand | SM | | | | |
| 2.0 | - | | | | | | | | | | | |
| 2.5 | 2.25 | UDS-1 | | | | | | | | | _ | |
| 3.0 | 3 | SPT-3 | 4 | 6 | 8 | 14 | | | | | | |
| 3.5 | | | | | | | | | | | _ | |
| 4.0 4.5 | 4.5 | SPT-4 | 6 | 7 | 10 | 17 | | | ¥4.22m | | - | |
| 5.0 | 5.25 | UDS-2 | | | | | | | | | _ | |
| 6.0 | . 6 | SPT-5 | 4 | 8 | 9 | 17 | Brown, Medium dense, Silty sand | SM | | | _ | |
| 6.5 | | | | | | | | | | | - | |
| 7.0 | | | | | | | | | | | - | |
| 7.5 | 7.5 | SPT-6 | 6 | 10 | 12 | 22 | | | | | _ | |
| 8.0 | | | | | | | | | | | | |
| | 8.25 | UDS-3 | | | | | | | | | | |
| 8.5 | - | | | | | | | | | ++++++++ | 4 | |
| 9.0 | . 9 | SPT-7 | 8 | 11 | 14 | 25 | Brown, Medium dense, Silty sand | SM-SC | | ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ | _ | |
| 9.5 | | | | | | | with clay 5 | | | | | |
| | | | | | | | | | | | 1 | |
| _10.0_ | 10 | SPT-8 | 10 | 13 | 16 | 29 | | | | | | |

| Ch | JAHI NI LANAN | | | | FIE | ELD | BOREHOLE L | OG | |
|-------------------|-------------------------------|----------------|-----------------|----------------------|------------|-------------------|--|-------------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL |
| BH Loce | ation/Ch | ainage :1 | 1+614 | | | | Northing :3123947.903 m | East | <i>ting</i> :708954.798 m |
| Reduced | d Level (r | n):(+)195 | .557 | | | | BH. No. :BH-CL | BHT | Termination Depth (m):10 |
| Propose | ed / Exist | ing Struct | <i>ure</i> :Min | or Bridge | ; | | Water Table (m):4.60 | Incli | ination : Vertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing (m) :Not Used |
| Date of | Start :30 | -10-2021 | | | | | Date of Completion :30-10-2021 | | |
| | Ê | | В | low cour per 15cn | nts า | | | ion | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic (Depth V/S Constraints of the constraints o |
| 0.0 | | DS | | | | | | | |
| 0.5 | 0.5 | SPT-1 | 3 | 3 | 5 | 8 | | | |
| 1.0 | 1.5 | SPT-2 | 2 | 3 | 4 | 7 | Brown, Loose, Sandy silt of low plasticity | ML-CL | |
| 2.0 | 2.25 | UDS-1 | | | | | | | |
| 3.03.5 | 3 | SPT-3 | 5 | 7 | 8 | 15 | | | |
| 4.0 4.5 5.0 | 4.5 | SPT-4 | 5 | 8 | 11 | 19 | | 2 | 4.60m |
| 5.56.06.5 | 6 | UDS-2 SPT-5 | 6 | 8 | 13 | 21 | Brown, Medium dense, Sandy silt of low plasticity | ML-CL | |
| 7.0 7.5 | 7.5 | SPT-6 | 5 | 7 | 9 | 16 | | | |
| 8.0 | 8.25 | UDS-3 | | | | | | | |
| 9.0 | 9 | SPT-7 | 4 | 6 | 8 | 14 | | | |
| 9.5 | 10 | _SPT-8_ | 4 | 7 | 9 | | | | |

| C | DANI I | | | | FIE | ELD | BOREHOLE L | ,OG | | |
|--------------|-------------------------------|----------------|----------|----------------------|------------|-------------------|---|-------------------|----------------|-----------------|
| Project | Name :C | GTI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDC | L |
| BH Loc | ation/Ch | ainage :1 | 1+657 | | | | Northing :3123935.677 m | East | ing :70891 | 0.733 m |
| Reduced | d Level (i | m):(+)195 | .027 | | | | BH. No. :BH-CL | BH T | Termination | n Depth (m):10 |
| Propose | ed / Exist | ing Struct | ure :Min | or Bridge | e | | Water Table (m):4.70 | Incli | nation : Ve | ertical |
| Boring | type :Rot | tary | | | | | Dia. of Boring :150 mm | Dept | th of Casin | g (m) :Not Used |
| Date of | Start :30 | 0-10-2021 | | | | | Date of Completion :30-10-2021 | | | |
| | Ê | | В | low cour per 15cn | nts n | | | ion | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth |
| | | DS | | | | | | | | |
| 0.5 | . 0.5 | SPT-1 | 3 | 3 | 4 | 7 | | | | • |
| 1.5 | . 1.5 | SPT-2 | 2 | 3 | 5 | 8 | | | | |
| 2.0 | 2 25 | UDS-1 | | | | | | | | |
| 2.5 | | 0201 | | | | | | | | |
| 3.0 | . 3 | SPT-3 | 4 | 6 | 8 | 14 | | | | |
| 3.5 | | | | | | | | | | |
| 4.0 | 4.5 | SPT-4 | 5 | 9 | 11 | 20 | Brown, Loose to medium dense, Sandy silt of low plasticity | ML-CL | | |
| 5.0 | | | | | | | | - | 4 .70m | |
| 5.5 | 5.25 | UDS-2 | | | | | | | | |
| 6.0 | 6 | SPT-5 | 6 | 8 | 12 | 20 | | | | + + |
| 6.5 | | | | | | | | | | |
| 7.0 | 75 | SDT 6 | 7 | 10 | 14 | 24 | | | | |
| 8.0 | 1.0 | 0-1-0 | 1 | | 14 | 24 | | | | |
| 8.5 | 8.25 | UDS-3 | | | | | | | | |
| 9.0 | 9 | SPT-7 | 5 | 6 | 10 | 16 | Brown, Medium stiff to stiff, Silty clay of low plasticity | CL | | |
| 9.5 | | | | | | | | | | |
| _10.0_ | 10 | SPT-8 | 4 | 7 | 9 | | | | | |

| CHIT | THE LOCAL | | | | | | DOREITOLE L | | | | |
|-------------------|-----------------------------|----------------|------------------|------------|------------|------------|---|-----------------|----------------------|---------------------------|-------------------|
| Project | Name :C | fTI for (H | ORC) pro | oject fron | n Palwal t | to Harsana | Kalan in the state of Haryana. | Clie | ent :HRIDCI | | |
| BH Loc | ation/Ch | ainage :1 | 2+125 | | | | <i>Northing</i> :3123758.29 m | Eas | ting :708479 | 9.897 m | |
| Reduced | d Level (1 | n):(+)194 | .849 | | | | BH. No. :BH-CL | BH | Termination | <i>Depth (m)</i> :10 | |
| Propose | ed / Exist | ing Struct | <i>ture</i> :Min | or Bridge | • | | Water Table (m):1.56 | Inc | <i>lination</i> : Ve | rtical | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing | g (m) :Not Used | |
| Date of | <i>Start</i> :06 | -10-2021 | D | | ato | | Date of Completion :06-10-2021 | _ | | | |
| | n e E | | | per 15cn | n | ерт | | ation | | (Donth | al |
| Depth (m) | In-Siti Sampl Depth (| Sample Type | N1 | N2 | N3 | N Value | Strata Description | IS lassifica | Graphic Log | v/s SPT N Value) | Specia bservat |
| 0.0 | | DS | | | | | | C | 0 | 10 20 30 40 50 60 70 80 5 | ao 100 O |
| 0.5 1.0 1.5 | . 1 | SPT-1 | 4 | 5 | 6 | 11 | | | Y1 56m | | |
| 2.0 | | | | | | | | | | | |
| 2.5 | 2.5 | UDS-1 | | | | | Brown Medium dense. Silty sand | SM | | | |
| 3.0 | | | | | | | | SM | | | |
| 3.5 | | | | | | | | | | | |
| 4.0 | 4 | SPT-2 | 7 | 9 | 11 | 20 | | | | | |
| 4.5 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 5.5 | 5.5 | UDS-2 | | | | | | | | | |
| 6.0 | | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 8 | 15 | 19 | 34 | | | | | |
| 7.5 | | | | | | | | | | | |
| 8.0 | | | | | | | Brown, Medium dense to dense, Sandy silt of low plasticity | ML-CL | | | |
| 8.5 | 8.5 | UDS-3 | | | | | | | | | |
| 9.0 | | | | | | | | | | | |
| 9.5 | | | | | | | | | | | |
| 10.0 | 10 | | 6 | | 11 | 20 | | | | | |

| C | LANI THE CASE AND | | | | FIE | ELD | BOREHOLE L | OG | | |
|------------|------------------------|------------|------------------|------------|------------|-----------|---------------------------------|---------------|-----------------------------|--------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Cli | ent :HRIDCL | |
| BH Loc | ation/Ch | ainage :1 | 2+431 | | | | Northing :3123592.675 m | Eas | <i>ting</i> :708224.151 m | |
| Reduce | d Level (1 | n):(+)195 | 5.631 | | | | BH. No. :BH-CL | BH | Termination Depth (m):10 | |
| Propose | ed / Exist | ing Struct | <i>ture</i> :Min | or Bridge | ; | | Water Table (m):1.50 | Inc | lination : Vertical | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing (m) :Not used | |
| Date of | <i>Start</i> :06 | -10-2021 | B | | ite | | Date of Completion :06-10-2021 | | | |
| Depth | Situ nple th (m) | Sample | | per 15cn | n | SPT | Strata | S ficatior | Graphic (Depth | ecial vations |
| (m) | Lept Sar Dept | Туре | N1 | N2 | N3 | Value | Description | l Classi | Log SPT N Value) | Obser 00 |
| 0.0 | | DS | | | | | | | | |
| 0.5 | - | | | | | | | | | |
| 1.0 | 1 | UDS-1 | | | | | | | | |
| 1.5 | - | | | | | | | | 1.50m | |
| 2.0 | - | | | | | | Brown, Medium dense, Silty sand | SM | | |
| 2.5 | 2.5 | SPT-1 | 3 | 8 | 8 | 16 | | | | |
| 3.0 | - | | | | | | | | | |
| 3.5 | - | | | | | | | | | |
| 4.0 | 4 | UDS-2 | | | | | | | | |
| 4.5 | | | | | | | | | | |
| 5.0 | | | | | | | | | | |
| <u>5.0</u> | 5.5 | edt o | 12 | 21 | 22 | 64 | | | | |
| | . 5.5 | 3F 1-2 | 15 | 51 | | 04 | | | | |
| 0.0 | | | | | | | | | | |
| 0.5 | - | | | | | | Brown Donce to your donce Silty | | | |
| | | 005-3 | | | | | sand with gravel | SM | | |
| 7.5 | - | | | | | | | | | |
| 8.0 | - | | | | | | | | | |
| 8.5 | 8.5 | SPT-3 | 6 | 13 | 21 | 34 | | | | |
| 9.0 | | | | | | | | | | $\left - \right $ |
| 9.5 | | | | | | | | | | |
| 10.0 | 10 | | | | | | | | | |

| Project | Name ·C | TI for (H | ORC) pro | oiect fron | n Palwal t | o Harsana | Kalan in the state of Harvana. | Clie | ent HRIDCL | | |
|--------------|--------------------------------|----------------|----------|------------|------------|-------------------|--|--------------------|--------------------------|-------------------------------|-----------------------|
| BHLoc | ation/Ch | ainage ·1 | 3+218 | | | | Northing :3123118 176 m | Eas | ting :707594.7 | 63 m | |
| Reduced | d Level (i | n):(+)195 | .027 | | | | BH No BH-CL | BH | Termination D | epth (m)·10 | |
| Propose | ed / Exist | ing Struct | ure ·Min | or Bridge | , | | Water Table (m):3.10 | Inci | <i>lination</i> : Vertic | cal | |
| Boring | tvpe :Rot | arv | | ior bridge | | | Dia. of Boring :150 mm | Der | oth of Casing (n | n) :Not used | |
| Date of | Start :31 | -10-2021 | | | | | Date of Completion :31-10-2021 | | | <i>y</i> | |
| | | | В | low cour | nts | | | Ľ | | | S |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | N2 | n N3 | SPT N Value | Strata Description | IS Iassificatio | Graphic Log | (Depth v/s SPT N Value) | Special bservatior |
| 0.0 | | DS | | | | | | 0 | 0 10 | 20 30 40 50 60 70 80 96 | 3 100 U |
| 0.5 | 0.5 | SPT-1 | 2 | 2 | 2 | 4 | | | | | |
| 1.0 | . 1.5 | SPT-2 | 2 | 3 | 3 | 6 | Brown, Loose, Silty sand | SM | | | |
| 2.0 | | | | | | | | | | | |
| 2.5 | 2.25 | UDS-1 | | | | | | | | | |
| 3.0 | . 3 | SPT-3 | 4 | 5 | 7 | 12 | | | ¥3.10m | | |
| 3.5 | | | | | | | | | | | |
| 4.5 | 4.5 | SPT-4 | 5 | 8 | 10 | 18 | | | | | |
| 5.0 | 5.25 | UDS-2 | | | | | Brown, Very stiff, Silty clay of low | CL | | | |
| 5.5 | 6 | SPT-5 | 6 | 9 | 12 | 21 | placedary | | | | |
| 6.5 | | | | | | | | | | | |
| 7.0 | | | | | | | | | | | |
| 7.5 | 7.5 | SPT-6 | 8 | 10 | 14 | 24 | | | | + | |
| 8.0 | 8.25 | UDS-3 | | | | | | | | | |
| 8.5 | | | | | | | | | | | |
| 9.0 9.5 | 9 | SPT-7 | 5 | 7 | 10 | 17 | Brown, Medium dense, Sandy silt of low plasticity | ML-CL | | | |
| 10.0 | 10 | SPT-8 | 6 | ۵ ۵ | 11 | 20 | | | | | |

| Ca | APRIL TE CARDONNE | | | | FIE | CLD | BOREHOLE L | OG | | | | | | | |
|--------------|-------------------------------|----------------|----------|----------------------|-----------|-------------------|---|-------------------|-----------------|---------|---------|---------------------|-------------|-------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDO | Ľ | | | | | |
| BH Loca | ation/Ch | ainage :1 | 3+787 kn | n | | | Northing :3122785.015 m | East | ing :7071: | 52.851 | m | | | | |
| Reduced | l Level (n | n):(+)194 | .731 | | | | BH. No. :BH-A1 | BH | Terminatio | n Dep | th (m): | 40 | | | |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):2.53 | Incli | nation : V | ertical | | | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casir | ng (m) | Not U | sed | | | |
| Date of | Start :09 | -11-2021 | | | | | Date of Completion :10-11-2021 | | | | | | | | |
| | . 6 | | В | low coun per 15cm | its 1 | | | ion | | | | | | | suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | | SP | (Dept v/s FNV | :h alue) | | Special Dbservatio |
| 0.0 | | DS | | | | | | 0 | | 0 10 2 | J 3U 4 | 0 50 | 60 70 | 80 90 | |
| 0.5 | 1 | SPT-1 | 2 | 3 | 3 | 6 | | | | | | | | | _ |
| 1.5 | • | | L | 0 | 0 | | Greyish brown, Medium stiff, Silty clay of medium plasticity | CI | | | | | | | _ |
| 2.0 | | | | | | | | | | | - | | | | _ |
| 2.5 | 2.5 | UDS-1 | | | | | | | ¥ 2.53m□ | | | | | | |
| 3.0 | | | | | | | | | | | | | | | _ |
| 3.5 | | | | | | | | | | | | | | | _ |
| 4.0 | 4 | SPT-2 | 6 | 6 | 8 | 14 | | | | | | | | | - |
| 4.5 | | | | | | | | | | | | | | | |
| 5.5 | 5.5 | UDS* | | | | | | | | | | | | | |
| 6.0 | 6 | SPT-3 | 5 | 7 | 9 | 16 | | | | | | | | | _ |
| 6.5 | | | | | | | Greyish brown, Stiff to very stiff, Silty clay of low plasticity | CL | | | _ | | | | - |
| 7.0 | 7 | SPT-4 | 4 | 5 | 9 | 14 | | | | | + | | | | - |
| 7.5 | | | | | | | | | | | | | | | - |
| 8.0 | 85 | UDS-2 | | | | | | | | | | | | | |
| 9.0 | 0.0 | | | | | | | | | | | | | | |
| 9.5 | | | | | | | | | | | | | | | |
| 10.0 | 10 | _SPT-5_ | 6 | 8 | 12 | 20 | | | | | | | | | |

| Ca | JANI UTE LANA ME | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--|--------------------------------|--|-------------------|------------|----------------|-------------------|---|-------------------|----------------|-----------------|------------|
| Project . | <i>Name</i> :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | \neg |
| BH Loca | ation/Ch | ainage :1 | 3+787 kr | n | | | Northing :3122785.015 m | East | ing :70715 | 2.851 m | |
| Reduced | l Level (r | n):(+)194 | .731 | | | | BH. No. :BH-A1 | BH | Termination | n Depth (m):40 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):2.53 | Incli | ination : Ve | rtical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used | |
| Date of | Start :09 | -11-2021 | | | | | Date of Completion :10-11-2021 | I | | | |
| | (| | В | low coun | its າ | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth | Observatio |
| 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 | 11.5 | UDS-3 SPT-6 | 8 | 10 | 16 | 26 | Greyish brown, Stiff to very stiff, Silty clay of low plasticity | CL | | | |
| _14.5_ _15.0_ _15.5_ _16.0_ _16.5_ _17.0_ _17.5_ _18.0_ _18.5_ _19.0_ | 14.5 16 17.5 18 19 | UDS-4 SPT-7 UDS* SPT-8 SPT-9 | 13 | 15 | 16 24 16 | 31 36 31 | Greyish brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| 19.5 | | | | | | | | | | | |

| Ca | JANII ITT CANA MI | | | | FIE | ELD | BOREHOLE L | OG | | |
|---------------|-------------------------------|----------------|------------------|----------------------|------------|-------------------|---|-------------------|----------------|--|
| Project | Name :C | GTI for (H | ORC) pro | oject fron | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loce | ation/Ch | ainage :1 | 3+787 kr | n | | | Northing :3122785.015 m | Eas | ting :70715 | 2.851 m |
| Reduced | d Level (i | m):(+)194 | .731 | | | | BH. No. :BH-A1 | BH | Termination | n Depth (m):40 |
| Propose | ed / Exist | ting Struct | <i>ure :</i> Maj | or Bridge | ; | | Water Table (m):2.53 | Incl | ination : Ve | ertical |
| Boring i | type :Rot | tary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :09 | 9-11-2021 | | | | | Date of Completion :10-11-2021 | | | |
| | Ê | | В | low cour per 15cn | nts n | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS classificat | Graphic Log | Depth (Depth sky sky SPT N Value) SPT N Value |
| _20.0_ | | | | | | | | 0 | | |
| 20.5_ 21.0 | 20.5 | UDS-5 | | | | | | | | |
| _21.5_ | | | | | | | | | | |
| _22.0_ | 22 | SPT-10 | 12 | 14 | 18 | 32 | | | | |
| _22.5_ | | | | | | | | | | |
| _23.0_ | | | | | | | | | | |
| _23.5_ | 23.5 | UDS* | | 40 | 40 | | | | | |
| 24.0 | 24 | SP1-11 | 14 | 16 | 18 | 34 | | | | |
| 25.0 | | | | | | | Greyish brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _25.5_ | 25.5 | SPT-12 | 13 | 17 | 20 | 37 | | | | |
| _26.0_ | | | | | | | | | | |
| _26.5_ | 26.5 | UDS-6 | | | | | | | | |
| _27.0_ | | | | | | | | | | |
| _27.5_ | | | | | | | | | | |
| _28.0_ | 28 | SPT-13 | 19 | 21 | 27 | 48 | | | | |
| 29.0 | | | | | | | | | | |
| _29.5_ | 29.5 | UDS-7 | | | | | | | | |
| 30.0 | | | | | | | Greyish brown, Hard, Silty clay of medium plasticity with gravel | CI | | |

| Ca | JAHI NET ANA M | | | | FIE | ELD | BOREHOLE L | OG | | | |
|-------------------------|--|------------------------------------|----------------------|----------------------|-------------|-------------------|--|-------------------|----------------|-------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | |
| BH Loca | ation/Ch | ainage :1 | 3+787 kr | n | | | Northing :3122785.015 m | East | ing :70715 | 2.851 m | |
| Reduced | l Level (r | n):(+)194 | .731 | | | | BH. No. :BH-A1 | BH | Terminatio | n Depth (m):40 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):2.53 | Incli | ination : V | ertical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used | |
| Date of | Start :09 | -11-2021 | | | | | Date of Completion :10-11-2021 | | | | |
| | <u>ہ</u> و | | В | low cour per 15cm | its 1 | | | tion | | | suo |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| | 31 32.5 34 35.5 37 38.5 | SPT-14 SPT-15 UDS-8 UDS-9 | 21 24 27 21 | 31 39 42 28 | 40 46 51 45 | 71 85 93 73 | Greyish brown, Hard, Silty clay of medium plasticity with gravel | CI | | | |
| 39.0_ 39.5_ 40.0_ | 40 | _SPT-18 | 24 | 34 | 49 | 83 | | | | | |

| Ducies | Name | TI for (II | | -: 6 | ΓIC . Delvelt | | | | | | |
|--|-------------------------------|----------------------|------------------|----------------|------------------|-------------------|----------------------------------|------------------|-------------------|-------------------------------|----------------------|
| Project | Name :C | 111 IOF (H | ORC) pr | oject fron | n Palwal t | o Harsana | Kalan in the state of Haryana. | | ient :HRIDCL | 7.4 | |
| BH Loc | ation/Ch | ainage: I | 3+/8/ kr | n | | | Northing :31227/5.684 m | Ea | sting : /0/140.4 | /4 m | |
| Reauce | $\frac{1}{1}$ | $\frac{n}{(+)}$ | +./55 | D 1 | | | BH. No. :BH-P1 | BF | Termination D | <i>epth (m)</i> :40 | |
| Propose | ed / Exist | ing Struci | <i>ture</i> :Maj | or Bridge | • | | Water Table (m):2.55 | | | | |
| Boring | | ary | | | | | Date of Completion (00.11.2021 | De | epth of Casing (n | n) :Not Used | |
| Date of | Start :08 | -11-2021 | B | low cour | nts | | Date of Completion :09-11-2021 | | | | <i>w</i> |
| Depth (m) | In-Situ Sample epth (m) | Sample Type | N1 | per 15cn N2 | n N3 | SPT N Value | Strata Description | IS ssificatio | Graphic Log | (Depth v/s SPT N Value) | Special servation |
| _0.0_ | | | | | | | | Cla | 0 10 | 20 30 40 50 60 70 80 | 90 100 Q |
| 0.5 1.0 1.5 2.0 2.5 3.0 | 2.5 | DS UDS-1 SPT-1 | 2 | 2 | 2 | 4 | | | ¥2.55m | | |
| 3.5 4.0 4.5 5.0 | 4 | UDS-2 | | | | | | | | | |
| 5.5 | 5.5 | SPT-2 | 2 | 3 | 4 | 7 | Grey, Loose, Silly sand with day | 5M-50 | | | |
| 6.5 7.0 7.5 | . 7 | UDS-3 | | | | | | | | | |
| 8.0 8.5 9.0 | . 8.5 | SPT-3 | 2 | 4 | 5 | 9 | | | | | |
| 9.5 | 10 | | | | | | | | | | |

| C | A CONTRACTOR OF A CONTRACT OF A CONTRACTACT OF A CONTRACTACTACTACTACTACT | | | | FIE | ELD | BOREHOLE L | OG | | |
|--|--|----------------|-------------------|----------------------|------------|-------------------|--|-------------------|----------------|---|
| Project | Name :C | ïTI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | Ľ |
| BH Loc | ation/Ch | ainage :1 | 3+787 kr | n | | | Northing :3122775.684 m | East | ting :70714 | 0.474 m |
| Reduce | d Level (i | n):(+)194 | .755 | | | | BH. No. :BH-P1 | BH | Terminatio | n Depth (m):40 |
| Propos | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | ; | | Water Table (m):2.55 | Incl | ination : Ve | ertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :08 | 3-11-2021 | | | | | Date of Completion :09-11-2021 | | | |
| | Ē | | В | low cour per 15cn | nts n | | | ion | | Suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | ic (Depth (Depth v/s v/s SPT N Value) SPT N Value |
| 10.5_ 11.0_ 11.5_ 12.0_ 12.5_ 13.0_ 13.5_ 14.0_ | 11.5 | SPT-4 UDS-5 | 6 | 10 | 14 | 24 | Greyish brown, Very stiff, Silty clay of low plasticity | CL | | |
| 14.5_ 15.0_ 15.5_ 16.0_ | 14.5 | SPT-5 UDS-6 | 7 | 12 | 17 | 29 | | | | |
| 10.0_ 16.5_ 17.0_ 17.5_ 18.0_ 18.5_ 19.0_ 19.5_ | 17.5 | SPT-6 | 12 | 22 | 34 | 56 | Greyish brown, Hard, Silty clay of low plasticity with gravel | CL | | |

| Ca | JAHI DECAMINE | | | | FIE | ELD | BOREHOLE L | OG | | |
|--|-----------------------------------|--|----------|----------------------|-------------|-------------------|--|-------------------|----------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal te | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCI | _ |
| BH Loce | ation/Ch | ainage :1 | 3+787 kn | n | | | Northing :3122775.684 m | East | ing :707140 |).474 m |
| Reduced | d Level (r | n):(+)194 | .755 | | | | BH. No. :BH-P1 | BH | Termination | <i>Depth (m)</i> :40 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):2.55 | Incli | nation : Ve | rtical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used |
| Date of | Start :08 | -11-2021 | | | | | Date of Completion :09-11-2021 | | | |
| | Ê | | В | low coun per 15cm | its າ | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Opepth v/s SPT N Value) Opsolve qp |
| _20.0_ _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ _23.0_ _23.5_ _23.0_ _23.5_ _24.0_ _24.5_ _25.0_ _25.5_ _26.0_ _25.5_ _26.0_ _26.5_ _26.0_ _27.0_ _27.5_ _28.0_ _28.0_ | 20.5 222 23.5 25 26.5 | SPT-7 UDS-8 UDS-9 SPT-9 UDS-10 | 14 | 27 | 38 | 65 | Greyish brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _29.0_ _29.5_ _30.0_ | 29.5 | SPT-10 | 17 | 32 | 54 | 86 | | | | |

| Ca | Safet The El Acid, No. | | | | FIE | ELD | BOREHOLE L | OG | | |
|--|--------------------------------|--------------------------|----------|------------|-------------|-------------------|--|--------------------|----------------|---|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal te | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loce | ation/Ch | ainage :1 | 3+787 kr | n | | | Northing :3122775.684 m | East | ing :70714 | .0.474 m |
| Reduced | l Level (1 | n):(+)194 | .755 | | | | BH. No. :BH-P1 | BH | Terminatio | n Depth (m):40 |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):2.55 | Incli | ination : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :08 | -11-2021 | | | | | Date of Completion :09-11-2021 | 1 | 5 | |
| | | | В | low cour | its | | | u u | | u |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificati | Graphic Log | (Depth v/s V/s SPT N Value) 0.00 00000000000000000000000000000000 |
| 30.5 31.0 31.5 32.0 32.5 33.0 33.5 34.0 | 31 32.5 | UDS* SPT-11 UDS-11 | 12 | 19 | 28 | 47 | | | | |
| _34.5_ _35.0_ _35.5_ _36.0_ _36.5_ _37.0_ | 35.5 | SPT-12 UDS-12 | 14 | 32 | 43 | 75 | Greyish brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _37.5_ _38.0_ _38.5_ _39.0_ _39.5_ _40.0 | 38.5 | SPT-14 | 20 | 34 | 47 | 81 | | | | |

| Ca | LANI L | | | | FIE | CLD | BOREHOLE L | ,OG | | | |
|--|----------------------------|---|----------|------------|------------|-----------|--|------------------|------------------|---|----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL | | |
| BH Loca | ation/Ch | ainage :1. | 3+787 kn | n | | | Northing :3122766.353 m | East | ing :707128.09 | 7 m | |
| Reduced | l Level (n | n):(+)194 | .784 | | | | BH. No. :BH-A2 | BHT | Termination De | epth (m):40 | |
| Propose | d / Existi | ing Struct | ure :Maj | or Bridge | : | | Water Table (m):2.50 | Incli | nation : Vertica | al | |
| Boring t | <i>ype</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing (m) |) :Not Used | |
| Date of | Start :08 | -11-2021 | | | 4- | | Date of Completion :09-11-2021 | | | | |
| Depth (m) | n-Situ ample pth (m) | Sample Type | B | per 15cm | 1 | SPT N | Strata Description | IS sification | Graphic Log | (Depth v/s | pecial ervations |
| 0.0 | La Se La Del | .,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | N1 | N2 | N3 | Value | p | Class | 0 1p | SPT N Value) 20 30 40 50 60 70 80 901 | [∞] Obse |
| 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 4.5 5.0 5.5 | 1 2.5 4 5.5 | DS SPT-1 UDS-1 SPT-2 UDS-2 | 8 | 4 | 6 | 10 | Grey, Loose, Silty sand with clay | SM-SC | 2.50m | | |
| 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 | 7 | SPT-3 UDS-3 | 5 | 7 | 12 | 19 | Greyish brown, Very stiff to hard, Silty clay of low plasticity | CL | | | |
| _10.0_ | 10 | SPT-4 | 7 | 9 | 15 | 24 | | | | | |

| Ca | (CAPIT) THE E AND A THE | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--|--|---|----------|----------------------|----------|-------------------|--|-------------------|----------------|--|-----------------------|
| Project | <i>Name</i> :G | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | |
| BH Loc | ation/Ch | ainage :1 | 3+787 kn | n | | | Northing :3122766.353 m | East | ing :70712 | 8.097 m | |
| Reduced | d Level (r | n):(+)194 | .784 | | | | BH. No. :BH-A2 | BH | Termination | n Depth (m):40 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):2.50 | Incl | ination : Ve | rtical | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used | |
| Date of | Start :08 | -11-2021 | | | | | Date of Completion :09-11-2021 | | | | |
| | (| | В | low coun per 15cm | its 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth V/s SPT N Value) 10 20 30 40 50 60 70 80 90100 | Special Observatic |
| -10.0 -10.5 -11.0 -11.5 -11.5 -12.0 -12.5 -12.5 -13.0 -13.5 -13.5 -14.0 -14.5 -14.0 -14.5 -15.5 -15.5 -15.5 -15.5 -16.0 -15.5 -16.0 -16.5 -17.0 -17.5 -18.0 -18.5 -19.0 | 11.5 13 14.5 16 17.5 18 | UDS-4 SPT-5 UDS-5 SPT-6 UDS* SPT-7 | 9 | 12 | 18 | 30 | Greyish brown, Very stiff to hard, Silty clay of low plasticity | CL | | | Ob |
| _19.5_ | 19.5 | SPT-8 | 11 | 15 | 24 | 39 | | | | | |

| Ca | ATT CARDON | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--|-------------------------------|----------------|----------|----------------------------|----------------|-------------------|--|-------------------|----------------|--------------------------------|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loce | ation/Ch | ainage :1. | 3+787 kr | n | | | Northing :3122766.353 m | East | ing :707128 | .097 m | |
| Reduced | l Level (i | n):(+)194 | .784 | | | | BH. No. :BH-A2 | BH | Termination | Depth (m):40 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | : | | Water Table (m):2.50 | Incli | ination : Ver | tical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | (m) :Not Used | |
| Date of | Start :08 | -11-2021 | | | | | Date of Completion :09-11-2021 | | | | |
| Depth (m) | In-Situ Sample epth (m) | Sample Type | N1 | low coun per 15cm N2 | nts n N3 | SPT N Value | Strata Description | IS ssification | Graphic Log | (Depth v/s SPT N Value) | Special servations |
| _20.0_ | - ° č | | | | _ | | | Clas | 0 | 10 20 30 40 50 60 70 80 90 100 | sq0 |
| _20.5_ _21.0_ _21.5_ _22.0_ _22.5_ | 20.5 | UDS-6 SPT-9 | 12 | 14 | 29 | 43 | | | | | |
| 23.0_ 23.5_ 24.0_ | 23.5 | UDS-7 | | | | | Greyish brown, Very stiff to hard, Silty clay of low plasticity | CL | | | |
| 24.5 25.0 25.5 26.0 | 25 | SPT-10 | 13 | 20 | 24 | 44 | | | | | |
| _26.5_ | 26.5 | UDS-8 | | | | | | | | | |
| _27.5_ | | | | | | | | | | | |
| _28.0_ _28.5_ | 28 | SPT-11 | 12 | 25 | 38 | 63 | Greyish brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| _29.0_ | 29.5 | UDS-9 | | | | | | | | | |
| | | | | | | | | | | | |

| Ca | ANI I CARANA | | | | FIE | ELD | BOREHOLE L | OG | | |
|------------------|-------------------------------|----------------|----------|----------------------|-----------|-------------------|--|-------------------|----------------|--|
| Project . | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | Ľ |
| BH Loca | ation/Ch | ainage :13 | 3+787 kn | n | | | Northing :3122766.353 m | East | ing :70712 | 28.097 m |
| Reduced | l Level (r | n):(+)194 | .784 | | | | BH. No. :BH-A2 | BH | Terminatio | n Depth (m):40 |
| Propose | d / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):2.50 | Incli | ination : V | ertical |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :08 | -11-2021 | | | | | Date of Completion :09-11-2021 | ŀ | | |
| | ب (n | | В | low coun per 15cm | its 1 | | | tion | | |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth العنية) v/s SPT N Value) על אין אין אין אין אין אין אין אין אין אין אין |
| _30.0_ | | | | | | | | 0 | | |
| _30.5_ | | | | | | | | | | |
| _31.0_ | 31 | SPT-12 | 18 | 30 | 42 | 72 | | | | |
| _32.0_ | | | | | | | | | | |
| 32.5 | 32.5 | UDS-10 | | | | | | | | |
| _33.0_ | | | | | | | | | | |
| _33.5_ | | 007.40 | 00 | | 45 | | | | | |
| 34.0 | 34 | 5P1-13 | 20 | 34 | 45 | 79 | | | | |
| 35.0 | | | | | | | Greyish brown, Hard, Silty clay of low plasticity with gravel | CL | | |
| _35.5_ | 35.5 | UDS-11 | | | | | | | | |
| _36.0_ | | | | | | | | | | |
| _36.5_ _37.0_ | 37 | SPT-14 | 23 | 37 | 44 | 81 | | | | |
| _37.5_ | | | | | | | | | | |
| _38.0_ | | | | | | | | | | |
| _38.5_ | 38.5 | SPT-15 | 22 | 36 | 46 | 82 | | | | |
| 39.0 39.5 | | | | | | | | | | |
| | | | | | | | | | | |
| _40.0_ | 40 | SPT-16 | 24 | 33 | 44 | 77 | | | | |

| Ca | APRIL TO F AND A DE | | | | FIE | ELD | BOREHOLE L | OG | | |
|--------------|-------------------------------|----------------|----------|----------------------|-------------|-------------------|--|-------------------|---------------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal te | o Harsana | Kalan in the state of Haryana. | Clie | ent :HRIDCL | |
| BH Loca | ation/Ch | ainage :1 | 3+917 | | | | Northing :3122696.787 m | Eas | <i>ting</i> :707035.822 m | |
| Reduced | l Level (r | n):(+)194 | .850 | | | | BH. No. :BH-CL | BH | Termination Depth (m):10 | |
| Propose | d / Exist | ing Struct | ure :Min | or Bridge | ; | | Water Table (m):2.90 | Incl | ination : Vertical | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing (m) : Not used | |
| Date of | Start :31 | -10-2021 | | | | | Date of Completion :31-10-2021 | | | |
| | . 6 | | В | low cour per 15cm | nts 1 | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic (Depth V/s SPT N Value) | Special Dbservati |
| 0.0 | | DS | | | | | | <u> </u> | | |
| 0.5 | 0.5 | SPT-1 | 2 | 2 | 3 | 5 | | | • | |
| 1.0 | | | | | | | Grey, Loose, Sandy silt of low plasticity | ML-CL | | |
| 1.5 | 1.5 | SPT-2 | 3 | 4 | 5 | 9 | | | | |
| 2.0 | | | | | | | | | | |
| | 2.25 | UDS-1 | | | | | | | | |
| 2.5 | | | | | | | | | | |
| 3.0 | 3 | SPT-3 | 5 | 6 | 10 | 16 | | | ¥2.90m | |
| 3.5 | | | | | | | | | | |
| 4.0 | | | | | | | Grey, Very stiff, Silty clay of medium plasticity | CI | | |
| 4.5 | 4.5 | SPT-4 | 4 | 5 | 7 | 12 | | | | |
| 5.0 | | | | | | | | | | |
| | 5.25 | UDS-2 | | | | | | | | |
| 5.5 | | | | | | | | | | |
| 6.0 | 6 | SPT-5 | 8 | 12 | 18 | 30 | | | | |
| 6.5 | | | | | | | Com Dance Conductive of law | | | |
| 7.0 | | | | | | | Grey, Dense, Sandy slit of low plasticity | ML-CL | | |
| | | | | | | | | | | |
| 7.5 | 7.5 | SPT-6 | 7 | 10 | 24 | 34 | | | | |
| 8.0 | | | | | | | | | | $\mid \mid \mid \mid$ |
| | 8.25 | UDS-3 | | | | | | | | |
| 8.5 | | | | | | | | | | +++ |
| 9.0 | 9 | SPT-7 | 7 | 13 | 19 | 32 | Grey, Very stiff to hard, Silty clay of | CL | | |
| 9.5 | | | | | | | iow plasticity | | | |
| | | | | | | | | | | |
| _10.0_ | 10 | SPT-8 | 5 | 12 | 17 | 29 | | | | |

| Ca | JANI UTE LANA ME | | | | FIE | ELD | BOREHOLE L | OG | | | | | |
|--------------|-------------------------------|----------------|----------|----------------------|----------|-------------------|---|-------------------|------------------|--------------------|------------------------------|------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | <i>ıt :</i> HRID | CL | | | |
| BH Loca | ation/Ch | ainage :14 | 4+072 | | | | Northing :3122602.267 m | East | ing :7069 | 10.449 m | | | |
| Reduced | l Level (r | n):(+)194 | .471 | | | | BH. No. :BH-CL | BHT | Terminati | on Depth (| m):10 | | |
| Propose | ed / Exist | ing Struct | ure :Min | or Bridge | | | Water Table (m):3.10 | Incli | nation : N | rtical | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casi | <i>ng (m) :</i> No | ot used | | |
| Date of | Start :31 | -10-2021 | | | | | Date of Completion :31-10-2021 | | | | | | |
| | (| | В | low coun per 15cm | its 1 | | | ion | | | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | \$ | (Deptivy) v/s SPT N Va | n Ilue) | Special Dbservatic |
| 0.0 | | DS | | | | | | 0 | | 0 10 20 3 | 0 40 50 | 60 70 80 | 90 100 |
| 0.5 | 0.5 | SPT-1 | 2 | 2 | 3 | 5 | | | | • | | | |
| 1.0 | 1.5 | SPT-2 | 3 | 4 | 6 | 10 | Brownish grey, Loose, Silty sand with clay | SM-SC | | | | | |
| 2.0 | | | | | | | | | | | | | |
| 2.5 | 2.25 | UDS-1 | | | | | | | | | | | |
| 3.0 | 3 | SPT-3 | 4 | 6 | 9 | 15 | | 2 | 3.10m | • | | | |
| 3.5 | | | | | | | Brownish grey, Very stiff, Silty clay of medium plasticity | CI | | | | | |
| 4.5 | 4.5 | SPT-4 | 3 | 5 | 8 | 13 | | | | • | | | |
| 5.0 | 5.25 | UDS-2 | | | | | | | | | | | |
| 5.5 6.0 | 6 | SPT-5 | 9 | 12 | 20 | 32 | | | | | | | |
| 6.5 | 0 | | 0 | 12 | 20 | | | | | | | | |
| 7.0 | | | | | | | | | | | | | |
| 7.5 | 7.5 | SPT-6 | 11 | 13 | 18 | 31 | Brownish grey, Hard, Silty clay of low plasticity | CL | | | | | |
| 8.0 8.5 | 8.25 | UDS-3 | | | | | | | | | | | |
| 9.0 | 9 | SPT-7 | 7 | 12 | 18 | 30 | | | | | | | |
| 9.5 | | | | | | | | | | | | | |
| _10.0_ | 10 | SPT-8 | 6 | 13 | 20 | | | | | | | | |

| Ca | JAHI TE CANANA | | | | FIE | ELD | BOREHOLE L | OG | |
|--------------|-------------------------------|----------------|-------------------|------------|------------|-------------------|--|--------------------|--|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | a Kalan in the state of Haryana. | Clier | nt :HRIDCL |
| BH Loc | ation/Ch | ainage :1 | 4+415 | | | | Northing :3122396.987 m | East | <i>ing</i> :706638.16 m |
| Reduced | d Level (i | n):(+)194 | .541 | | | | BH. No. :BH-CL | BHT | Termination Depth (m):10 |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Min | or Bridge | ; | | Water Table (m):3.00 | Incli | ination : Vertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing (m) :Not Used |
| Date of | Start :31 | -10-2021 | | | | | Date of Completion :31-10-2021 | | |
| | _ | | В | low cour | nts | | | u | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificati | Graphic (Depth 55 V/s 20 SPT N Value) 00 |
| 0.0 | | DS | | | | | | | |
| 0.5 | 0.5 | SPT-1 | 2 | 3 | 3 | 6 | | | |
| 1.5 | 1.5 | SPT-2 | 2 | 3 | 4 | 7 | Brown, Loose, Sandy silt of low plasticity | ML-CL | |
| 2.0 | 2.25 | UDS-1 | | | | | | | |
| 2.5 | | | | | | | | | |
| 3.0 | 3 | SPT-3 | 5 | 7 | 12 | 19 | | - | -3.00m |
| 3.5 | | | | | | | Brown, Very stiff, Silty clay of low | CL | |
| 4.0 | | | | | | | plasticity | | |
| 4.5 | 4.5 | SPT-4 | 4 | 8 | 13 | 21 | | | |
| 5.0 | 5.25 | UDS-2 | | | | | | | |
| 5.5 | | | | | | | | | |
| 6.0 | 6 | SPT-5 | 7 | 9 | 11 | 20 | | | |
| 6.5 | | | | | | | | | |
| 7.0 | | | | | | | | | |
| 7.5 | 7.5 | SPT-6 | 8 | 11 | 13 | 24 | Brown, Medium dense, Sandy silt of low plasticity | ML-CL | |
| 8.0 | 8.25 | UDS-3 | | | | | | | |
| 8.5 | | | | | | | | | |
| 9.0 | 9 | SPT-7 | 5 | 8 | 10 | 18 | | | |
| 9.5 | | | | | | | | | |
| _10.0_ | 10 | SPT-8 | 7 | 10 | 12 | 22 | | | |

| Ca | JANI UTE LANA M | | | | FIE | ELD | BOREHOLE L | ,OG | | | |
|--------------|-------------------------------|----------------|----------|------------|------------|-------------------|---|--------------------|------------------|-------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | t:HRIDCL | | |
| BH Loce | ation/Ch | ainage :1: | 5+259 | | | | Northing :3121873.019 m | East | ing :705971.993 | 3 m | |
| Reduced | l Level (1 | n):(+)193 | .786 | | | | BH. No. :BH-CL | BH | Fermination Dep | <i>pth (m)</i> :10 | |
| Propose | ed / Exist | ing Struct | ure :Min | or Bridge | | | Water Table (m):2.90 | Incli | nation : Vertica | ıl | |
| Boring | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casing (m) |) :Not Used | |
| Date of | Start :31 | -10-2021 | | | | | Date of Completion :31-10-2021 | 1 | | | |
| | _ | | В | low cour | its | | | u | | | su |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificati | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| 0.0 | | DS | | | | | | | | 20 30 40 50 60 70 80 90 100 | |
| 0.5 | 0.5 | SPT-1 | 2 | 4 | 5 | 9 | | | | | |
| 1.0 | 1.5 | SPT-2 | 3 | 5 | 7 | 12 | | | | | |
| 2.0 | 2.25 | UDS-1 | | | | | | | | | |
| 2.5 | 0 | | 0 | | | _ | Brown, Loose to medium dense, Sandy silt of low plasticity | ML-CL | 2.90m | | |
| 3.0 | 3 | 5P1-3 | 2 | 3 | 4 | | | | ↓ | | |
| 4.0 | | | | | | | | | | | |
| 4.5 | 4.5 | SPT-4 | 3 | 3 | 5 | 8 | | | | | |
| 5.5 | 5.25 | UDS-2 | | | | | | | | | |
| 6.0 | 6 | SPT-5 | 9 | 13 | 20 | 33 | | | | | |
| 6.5 | | | | | | | | | | | |
| 7.0 7.5 | 7.5 | SPT-6 | 8 | 10 | 18 | 28 | Brown. Very stiff Silty clay of low | | | | |
| 8.0 | 8 25 | UDS-3 | | | | | plasticity | CL | | | |
| 8.5 | | | | | | | | | | | |
| 9.0 9.5 | 9 | SPT-7 | 7 | 12 | 15 | 27 | | | | | |
| 10.0 | 10 | _SPT-8_ | 8 | 13 | 22 | 35 | | | | | |

| C | DANI DE CARACTER | | | | FIE | CLD | BOREHOLE L | ,OG | | |
|--------------|-------------------------------|----------------|------------------|----------------------|------------|-------------------|--|-------------------|----------------|--------------------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDC | L |
| BH Loc | ation/Ch | ainage :1 | 5+416 | | | | Northing :3121764.321 m | East | ing :70586 | 1.877 m |
| Reduced | d Level (r | n):(+)194 | .416 | | | | BH. No. :BH-CL | BHT | Terminatio | n Depth (m):10 |
| Propose | ed / Exist | ing Struct | <i>ture</i> :Min | or Bridge | | | Water Table (m):3.20 | Incli | nation : Ve | ertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casin | g (m) :Not Used |
| Date of | Start :31 | -10-2021 | | | | | Date of Completion :31-10-2021 | | | |
| | Ê | | В | low cour per 15cm | its າ | | | ion | | 2 |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth (Depth V/s SPT N Value) |
| | | DS | | | | | | | | |
| 0.5 | 0.5 | SPT-1 | 2 | 2 | 4 | 6 | | | | • |
| 1.0 | 1.5 | SPT-2 | 3 | 3 | 4 | 7 | | | | |
| 2.0 | | _ | - | | | | | | | |
| 2.5 | 2.25 | UDS-1 | | | | | | | | |
| 3.0 | . 3 | SPT-3 | 2 | 3 | 3 | 6 | | - | 3.20m | |
| 3.5 | | | | | | | | | | |
| 4.5 | 4.5 | SPT-4 | 2 | 4 | 5 | 9 | | | | |
| 5.0 | 5.25 | UDS-2 | | | | | Brown, Loose to dense, Sandy silt of low plasticity | ML-CL | | |
| 5.5 | | | | | | | | | | |
| 6.0 | 6 | SPT-5 | 9 | 15 | 18 | 33 | | | | |
| 7.0 | | | | | | | | | | |
| 7.5 | 7.5 | SPT-6 | 10 | 14 | 18 | 32 | | | | |
| 8.0 | 8.25 | UDS-3 | | | | | | | | |
| 9.0 | 9 | SPT-7 | 7 | 10 | 17 | 27 | | | | |
| 9.5 | | | | | | | | | | |
| 10.0 | 10 | _SPT-8_ | 8 | 12 | | | | | | |

| Ca | ANI I CARANA | | | | FIE | ELD | BOREHOLE L | ,OG | | | | | | | |
|--------------|-------------------------------|----------------|----------|----------------------|-------------|-------------------|--|-------------------|----------------|-----------|---------------|----------------------|------|------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal te | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDO | CL | | | | | |
| BH Loca | ation/Cha | ainage :1 | 5+441 | | | | Northing :3121753.862 m | East | ing :7058 | 51.853 m | ı | | | | |
| Reduced | l Level (n | n):(+)194 | .160 | | | | BH. No. :BH-A1 | BH | Terminatio | on Depth | <i>(m)</i> :3 | 0 | | | |
| Propose | d / Existi | ing Struct | ure :Maj | or Bridge | | | Water Table (m):3.00 | Incli | ination : V | vertical | . , | | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | ng (m) :N | lot Us | ed | | | |
| Date of | Start :10 | -11-2021 | | | | | Date of Completion :11-11-2021 | | | | | | | | |
| | 6 | | В | low coun per 15cm | its 1 | | | ion | | | | | | | suo |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | 0 10 20 | (I SPT | Depth v/s N Va | lue) | 90 00 1/ | Special Observatic |
| 0.0 | | DS-1 | | | | | | | | 0 10 20 | 30 40 | 30 0 | | 00 30 10 | |
| 0.5 | 1 | UDS-1 | | | | | | | | | | | | | _ |
| 1.5 | | | | | | | | | | | | | | | _ |
| 2.0 | | | | | | | Brown, Loose, Silty sand with clay | SM-SC | | | | | | + | - |
| 2.5 | 2.5 | SPT-1 | 2 | 2 | 3 | 5 | | | | • | | | | | _ |
| 3.0 | | | | | | | | | ¥ 3.00m | | | | | | _ |
| 3.5 | | | | | | | | | | | | | | | _ |
| 4.0 | 4 | UDS-2 | | | | | | | | | | | | | - |
| 4.5 | | | | | | | | | | | | | | | _ |
| 5.0 | | | | | | | | | | | | | | | _ |
| 5.5 | 5.5 | SPT-2 | 11 | 15 | 21 | 36 | | | | | | | | | _ |
| 6.0 | | | | | | | | | | | | | | | _ |
| 6.5 | | | | | | | | | | | | | | | - |
| 7.0 | 7 | UDS-3 | | | | | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | | | | | |
| 7.5 | | | | | | | | | | | | | | | - |
| 8.0 | | | | | | | | | | | | | | $\left \right $ | $\left \right $ |
| 8.5 | 8.5 | SPT-3 | 12 | 17 | 22 | 39 | | | | | | | | | |
| 9.0 | | | | | | | | | | | | | | | |
| 9.5 | | | | | | | | | | | | | | | |
| _10.0_ | 10 | UDS-4 | | | | | | | | | | | | | |

| Project Name : GTI for (HORC) project from Palval to Harsana Kalan in the state of Haryana. Client : HRIDCL BH Location/Chanage : 15441 Northing :3121753.862 m Raxing :705851.853 m Reduced Level (m/:(-1) 94.160 BH No. 7814.A1 BH Termination Depth (m/: 30 Propased / Existing Structure : Major Bridge Water Table (m/: 3.00 Inclination : Vertical Bridge : Strata Date of Completion : 11-11-2021 Date of Completion : 11-11-2021 Depth | CL | IT COMPANY | | | | FIE | ELD | BOREHOLE L | OG | | | |
|---|--|--|---|-------------------|----------------------|------------|-------------------|--|-------------------|----------------|-------------------------------|-----------------------|
| HI I acation/Chainage:15+441 Northing:3121753.862 m Easting:705851.853 m Reduced Level (m):(+)194.160 BH. No.:BH:A1 BH Termination Depth (m):30 Proposed / Existing Structure: Major Bridge Water Table (m):300 Inclination : Vertical Baring type: Rotary Date of Start: 10011-2021 Date of Start: 10011-2021 Depth Sample Northing: 3121753.862 m Easting: 705851.853 m 10.0 Date of Start: 10011-2021 Date of Start: 10011-2021 Termination Depth of Casing (m): Not Used 10.0 Internation Particle Spring type Spring type Spring type -10.5 Into: No No Spring type Spring type -11.0 Into: Into: No Spring type Spring type -11.0 Into: Into: Spring type Spring type Spring type -12.0 Into: Into: Spring type Spring type Spring type -14.0 Into: Into: Into: Spring type Into: Into: -14.0 Into: Into: Into: Into: Into: Into: -15.0 | Project | Name :C | TI for (H | ORC) pr | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L | |
| Berlined Level (m) (+) 194.160 BH: NoBH: A1 BH Termination Depth (m): 30 Proposed / Existing Structure :Major Bridge Water Table (m): 300 Inclination : Vertical Drate of Starr : 10-11-2021 Date of Completion :11-11-2021 Date of Completion :11-12-021 Doght of Casing (m) :No Used Start : 10-11-2021 Date of Completion :11-12-021 Use of Completion :11-12-021 Doght of Casing (m) :No Used Start : 10-12-021 N1 N2 N3 SPT N Value 10.0 Image: Set in the set i | BH Loc | ation/Ch | ainage :1 | 5+441 | | | | Northing :3121753.862 m | East | ing :70585 | 51.853 m | |
| Proposed / Existing Structure :Major Bridge Water Table (m): 3.00 Inclination : Vertical Boring type :Roary Dia of Boring :150 mm Depth of Casing (m) :Not Used Date of Start :10-11-2021 Date of Completion :11-11-2021 Depth of get | Reduce | d Level (i | n):(+)194 | .160 | | | | BH. No. :BH-A1 | BH | Terminatio | n Depth (m):30 | |
| Boring type :Rotary Dite of Baring :150 man Depth of Casing (m) :Not Used Depth <u>gr g g g g g g g g g g g g </u> | Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | 1 | | Water Table (m):3.00 | Incli | nation : V | ertical | |
| Date of Start : 10-11-2021 Date of Completion : 11-11-2021 Depth Bow counts por 18cm SPT 10.0 10.0 -10.0 -10.1 -10.5 -11.0 -11.0 -11.1 -11.5 11.5 SPT-4 8 12 21 -12.0 -12.5 -13.5 -14.5 14.5 14.5 14.5 14.5 14.5 15.0 -15.0 -15.0 -15.5 -16.0 16 UDS-6 -16.5 | Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used | |
| Depth m Biow counts por 15cm SPT Strata Description 2 g g g g g g g g g g g g g g g g g g g | Date of | Start :10 | -11-2021 | | | | | Date of Completion :11-11-2021 | I | | | |
| Depth (m) 2 Sample (5) Sample (1) N1 N2 N3 SPT Nalue Strata Description 2 3 10.5. -10.5. -11.5 SPT.4 8 12 21 33 -11.5. 11.5 SPT.4 8 12 21 33 -12.0. -11.5 SPT.4 8 12 21 33 -13.0. 13 UDS-5 -13.5. -14.5. 14.5 SPT.5 7 12 16 28 -16.0. 16 UDS-6 -11.5. -11.5. -11.5. -11.5. -11.5. -15.5. -15.5. -15.5. -15.5. -15.5. -15.5. -15.5. -16.0. 16 UDS-6 -15.5. -15.5. -15.5. -15.5. | | Ê | | В | low cour per 15cn | nts 1 | | | ion | | | suc |
| _10.5_ _11.0_ _11.5_ 11.5 SPT-4 8 12 21 33 _12.0_ _12.5_ _13.0_ 13 UDS-5 _13.5_ _14.0_ _14.5_ 14.5 SPT-5 7 12 16 28 _15.5_ _15.5_ _15.5_ _16.0_ 16 UDS-6 | Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| 17.0_ 17.5_17.5 SPT-6 9 15 27 42 18.0_ 18.5_ 19.0_19 UDS-7 19.5_10 UDS-7 | 10.0_ 10.5_ 11.0_ 11.5_ 12.0_ 12.5_ 12.5_ 13.0_ 13.5_ 14.0_ 13.5_ 14.0_ 14.5_ 14.0_ 14.5_ 15.0_ 15.5_ 16.0_ 15.5_ 16.0_ 17.0_ 17.5_ 18.0_ 18.5_ 19.0_ 19.5_ | . 11.5 . 13 . 14.5 . 16 . 17.5 . 19 | SPT-4 UDS-5 UDS-6 SPT-6 UDS-7 | 8 | 12 | 21 | 33 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | | |
| Ca | JANI I | | | | FIE | CLD | BOREHOLE L | ,OG | | |
|--|--|--|---------------|----------------------|----------------------------|-------------------|--|-------------------|----------------|--|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal to | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loce | ation/Ch | ainage :1: | 5+441 | | | | Northing :3121753.862 m | East | ing :70585 | 1.853 m |
| Reduced | l Level (r | n):(+)194 | .160 | | | | BH. No. :BH-A1 | BH | Termination | n Depth (m):30 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | : | | Water Table (m):3.00 | Incli | nation : Ve | ertical |
| Boring i | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casin | g (m) :Not Used |
| Date of | Start :10 | -11-2021 | | | | | Date of Completion :11-11-2021 | I | | |
| | . 6 | | В | low cour per 15cn | nts 1 | | | ion | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90100 |
| _20.0_ _20.5_ _21.0_ _21.5_ _21.5_ _22.0_ _22.5_ _23.0_ _23.0_ _23.5_ _24.0_ _24.5_ _25.0_ _24.5_ _25.0_ _25.5_ _26.0_ _26.5_ _26.0_ _26.5_ _27.0_ _27.5_ _28.0_ _28.5_ _29.0_ | 20.5 22 23.5 25 26.5 28 | SPT-7 UDS-8 UDS-8 UDS-9 SPT-9 SPT-9 | N1 9 10 17 18 | N2 14 17 29 30 | N3 27 28 43 43 | Value 41 45 72 77 | Brown, Hard, Silty clay of low plasticity with gravel | CL | | SPT N Value) 30 40 50 60 70 60 90 100 100 I< |
| 29.5 | 29.5 29.95 | SPT-11 DS-2 | 28 | 42 | 58 (12cm) | >100 | | | | |

| Ch | LANT CONTRACTOR | | | | FIE | ELD | BOREHOLE L | OG | | | | | |
|--------------|-------------------------------|----------------|------------------|----------------------|------------|-------------------|--|------------------|----------------|---|--|--|--|
| Project . | Name :G | TI for (H | ORC) pr | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDO | Ľ | | | |
| BH Loca | ation/Ch | ainage :1: | 5+441 | | | | Northing :3121739.334 m | East | ing :7058. | 38.108 m | | | |
| Reduced | l Level (n | n):(+)193 | .216 | | | | BH. No. :BH-A2 | BH | Terminatio | on Depth (m):30 | | | |
| Propose | d / Exist | ing Struct | <i>ture</i> :Maj | or Bridge | : | | Water Table (m):3.10 | Incli | ination : V | ertical | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring : 150 mm Depth of Casing (m) : Not Used | | | | | | |
| Date of | Start :10 | -11-2021 | | | | | Date of Completion :11-11-2021 | L. | | | | | |
| | _ @ Ê | | В | low coun per 15cm | its า | | | tion | | _ us | | | |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classifica | Graphic Log | Depth (Depth v/s V/s SPT N Value) Ops c V T N Value | | | |
| 0.0 | | DS | | | | | | • | | | | | |
| 0.5 | 1 | SPT-1 | 3 | 4 | 6 | 10 | | | | | | | |
| 1.5 2.0 | | | | | | | | | | | | | |
| 2.5 3.0 | 2.5 | UDS-1 | | | | | Brown, Stiff, Silty clay of low plasticity | CL | 2 10m | | | | |
| 3.5 | 4 | SPT-2 | 4 | 5 | 7 | 12 | | | | | | | |
| 4.5 | | | | | | | | | | | | | |
| 5.0 | 5.5 | UDS-2 | | | | | | | | | | | |
| 6.0 6.5 | | | | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 6 | 10 | 15 | 25 | | | | | | | |
| 7.5 8.0 | | | | | | | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | CL | | | | | |
| 8.5 | 8.5 | UDS-3 | | | | | | | | | | | |
| ə.u 9.5 | | | | | | | | | | | | | |
| _10.0_ | 10 | _SPT-4_ | 7 | | 20 | | | | | | | | |

| Project Name :GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana. Client :HRIDCL BH Location/Chainage :15+441 Northing :3121739.334 m Easting :705838.108 m Reduced Level (m):(+)193.216 BH. No. :BH-A2 BH Termination Depth (m):30 Proposed / Existing Structure :Major Bridge Water Table (m):3.10 Inclination : Vertical Revine time :Poterty Dig. of Revine :150 mm Dig. of Revine :150 mm | | | | | | | |
|---|------------------------|--|--|--|--|--|--|
| BH Location/Chainage : 15+441 Northing : 3121739.334 m Easting : 705838.108 m Reduced Level (m): (+) 193.216 BH. No. : BH-A2 BH Termination Depth (m): 30 Proposed / Existing Structure : Major Bridge Water Table (m): 3.10 Inclination : Vertical Revine time : Potery Dig. of Revine : 150 mm Dig. of Revine : 150 mm | | | | | | | |
| Reduced Level (m):(+)193.216 BH. No. :BH-A2 BH Termination Depth (m):30 Proposed / Existing Structure :Major Bridge Water Table (m):3.10 Inclination : Vertical Regime time :Return Dig. of Regime :150 mm Dig. of Regime :150 mm | | | | | | | |
| Proposed / Existing Structure : Major Bridge Water Table (m):3.10 Inclination : Vertical Proving two : Poters Dia of Poving : 150 mm Dia of Poving : 150 mm | | | | | | | |
| Paring two Determ | Inclination : Vertical | | | | | | |
| Doring type . Rotary Dia. 0 Doring . 150 min Depth of Casing (m) : Not Used | | | | | | | |
| Date of Start :10-11-2021 Date of Completion :11-11-2021 | | | | | | | |
| Blow counts | | | | | | | |
| Depth (m) Depth | Special 001 06 08 | | | | | | |
| 100 | | | | | | | |

| Ca | CARLES IN CONTRACTOR | | | | FIE | ELD | BOREHOLE L | OG | | | | | | |
|--------------|-------------------------------|----------------|-------------------|------------|------------|-------------------|--|-------------------------------|------------------|-------------------------------|-----------------------|--|--|--|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | ent :HRIDCL | | | | | |
| BH Loc | ation/Ch | ainage :1 | 5+441 | | | | Northing :3121739.334 m | Eas | ting :705838.1 | 108 m | | | | |
| Reduced | d Level (i | n):(+)193 | .216 | | | | BH. No. :BH-A2 | BH | Termination L | Depth (m):30 | | | | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | ; | | Water Table (m):3.10 | Inc | lination : Verti | cal | | | | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Depth of Casing (m) :Not Used | | | | | | |
| Date of | Start :10 | -11-2021 | | | | | Date of Completion :11-11-2021 | - | | | | | | |
| | _ | | В | low cour | nts | | | uo | | | su | | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificati | Graphic Log | (Depth v/s SPT N Value) | Special Observatio | | | |
| | | | | | | | | | | | | | | |
| _20.5_ | 20.5 | UDS-7 | | | | | | | | | | | | |
| 21.5 | | | | | | | | | | | _ | | | |
| _22.0_ | . 22 | SPT-8 | 12 | 24 | 28 | 52 | | | | | _ | | | |
| _22.5_ | | | | | | | | | | | | | | |
| 23.0 | 23.5 | UDS-8 | | | | | | | | | | | | |
| 24.0 | | | | | | | | | | | | | | |
| 24.5 | | | | | | | | | | | _ | | | |
| _25.0_ | 25 | SPT-9 | 13 | 27 | 29 | 56 | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | CL | | | | | | |
| 25.5 | | | | | | | | | | | | | | |
| _26.5_ | 26.5 | UDS-9 | | | | | | | | | _ | | | |
| _27.0_ | | | | | | | | | | | | | | |
| _27.5_ | 28 | SPT 10 | 15 | 25 | 30 | 55 | | | | | | | | |
| 28.5 | 20 | 571-10 | 10 | 20 | 30 | | | | | | | | | |
| 29.0 | | | | | | | | | | | | | | |
| _29.5_ | 29.5 | UDS-10 | | | | | | | | | _ | | | |
| 30.0 | 30 | | | | | | | | | | | | | |

| Ca | JANI I TELEVISION | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--------------|-------------------------------|----------------|----------|----------------------|-----------|-------------------|---|-------------------|----------------|---------------------------------|-----------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDC | L | |
| BH Loc | ation/Ch | ainage :10 | 5+042 | | | | Northing :3121279.064 m | East | ing :70548 | 2.626 m | |
| Reduced | d Level (r | n):(+)194 | .075 | | | | BH. No. :BH-A1 | BHT | Ferminatio | n Depth (m):30 | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):3.65 | Incli | nation : V | ertical | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casin | g (m) :Not Used | |
| Date of | Start :08 | -10-2021 | | | | | Date of Completion :09-10-2021 | I | | | |
| | Ê | | В | low coun per 15cm | its 1 | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth V/s SPT N Value) | bservatio |
| 0.0 | | DS-1 | | | | | | 0 | | 0 10 20 30 40 50 60 70 80 90100 | |
| 0.51.01.5 | . 1 | SPT-1 | 3 | 4 | 4 | 8 | | | | | |
| 2.0 | | | | | | | | | | | |
| 2.5 | 2.25 | UDS-1 | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 3.5 | | | | | | | | | ¥3.65m | | |
| 4.0 | . 4 | SPT-2 | 3 | 4 | 7 | 11 | | | | | |
| 4.5 | | | | | | | | | | | |
| 5.0 | | | | | | | Brown, Loose to medium dense, Silty sand with clay | SM-SC | | | |
| 5.5 | 5.5 | UDS* | | | | | | | | | |
| 6.0 | 6 | SPT-3 | 5 | 7 | 9 | 16 | | | | | |
| 7.0 | 7 | SPT-4 | 7 | 10 | 12 | 22 | | | | | |
| 7.5 | | | | | | | | | | | |
| 8.0 | | | | | | | | | | | |
| 8.5 | 8.5 | UDS* | | | | | | | | | |
| 9.0 | 9 | SPT-5 | 5 | 8 | 10 | 18 | | | | | |
| 9.5 | | | | | | | | | | | |
| _10.0_ | 10 | SPT-6 | 7 | 10 | 12 | 22 | | | | | |

| CL | CAN IN CASE OF | | | | FIE | ELD | BOREHOLE L | OG | | | |
|--------------|--|----------------|-----------------|------------|------------|-------------------|--|-------------------|------------------|-------------------------------|-----------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loc | ation/Ch | ainage :1 | 6+042 | | | | Northing :3121279.064 m | East | ing :705482.6 | 26 m | |
| Reduced | d Level (i | n):(+)194 | .075 | | | | BH. No. :BH-A1 | BH | Termination D | epth (m):30 | |
| Propose | ed / Exist | ing Struct | <i>ure</i> :Maj | or Bridge | : | | Water Table (m):3.65 | Incli | ination : Vertic | cal | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing (n | n) :Not Used | |
| Date of | Start :08 | -10-2021 | | | | | Date of Completion :09-10-2021 | | | | |
| | _ | | В | low cour | nts 1 | | | ion | | | ns |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatic |
| 10.0 | | | | | | | | 0 | 0 10 | 20 30 40 50 60 70 80 90 100 | 0 |
| 10.5_ | | | | | | | | | | | |
| 11.0 | . 11.5 | UDS-2 | | | | | | | | | |
| _12.0_ | | | | | | | Brown Medium dense. Sandy silt of | | | | |
| _12.5_ | | | | | | | low plasticity | ML-CL | | | |
| _13.0_ | . 13 | SPT-7 | 8 | 9 | 12 | 21 | | | | - | |
| _13.5_ | | | | | | | | | | | |
| 14.0 | | | | | | | | | | | |
| 14.5 | 14.5 | UDS-3 | | | | | | | | | |
| 15.0 | | | | | | | | | | | |
| _15.5_ | | | | | | | | | | | |
| 16.0 | . 16 | SPT-8 | 9 | 14 | 17 | 31 | | | | | |
| 16.5 | | | | | | | | | | | |
| 17.5 | 17.5 | UDS-4 | | | | | Brown yellowish, Hard, Silty clay of low plasticity with gravel | CL | | | |
| | | | | | | | | | | | |
| 18.5_ | | | | | | | | | | | |
| 19.0_ | . 19 | SPT-9 | 10 | 15 | 21 | 36 | | | | | |
| 19.5_ | | | | | | | | | | | |
| 20.0 | | | | | | | | | | | |

| CHIT | And reached | | | | FIE | | BOREHULE L | UG | | |
|--------------|-------------------------------|----------------|----------|------------|------------|-------------------|--------------------------------------|-------------------|------------------|-----------------------------------|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | a Kalan in the state of Haryana. | Clie | ent :HRIDCL | |
| BH Loc | ation/Ch | ainage :1 | 6+042 | | | | Northing :3121279.064 m | Eas | ting :705482.62 | 26 m |
| Reduce | d Level (i | m):(+)194 | .075 | | | | BH. No. :BH-A1 | BH | Termination De | epth (m):30 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):3.65 | Incl | ination : Vertic | al |
| Boring | <i>type</i> :Rot | tary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing (m | n) :Not Used |
| Date of | Start :08 | 3-10-2021 | | | | | Date of Completion :09-10-2021 | | | |
| | _ a Ê | | В | per 15cn | nts 1 | | | tion | | _ |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s V/s SPT N Value) |
| | | | | | | | | | | |
| _20.5_ | 20.5 | UDS-5 | | | | | | | | |
| 21.5 | - | | | | | | | | | |
| _22.0_ | 22 | SPT-10 | 12 | 17 | 25 | 42 | | | | + + + |
| _22.5_ | - | | | | | | | | | |
| _23.0_ | _ | | | | | | | | | |
| _23.5_ | 23.5 | UDS-6 | | | | | | | | |
| _24.0_ | _ | | | | | | | | | |
| _24.5_ | 25 | SPT-11 | 20 | 25 | 32 | 57 | Brown vellowish. Hard. Silty clay of | 0 | | |
| 25.5_ | 20 | | 20 | 20 | 52 | 51 | low plasticity with gravel | CL | | |
| _26.0_ | - | | | | | | | | | |
| _26.5_ | 26.5 | SPT-12 | 25 | 39 | 47 | 86 | | | | |
| _27.0_ | - | | | | | | | | | |
| _27.5_ | - | | | | | | | | | |
| _28.0_ | 28 | SPT-13 | 32 | 39 | 49 | 88 | | | | |
| 29.0_ | | | | | | | | | | |
| 29.5_ | 29.5 | SPT-14 | 25 | 34 | 55 | 89 | | | | |
| 20.0 | 29.95 | DS-2 | | | | | | | | |

| Ca | JAHI ITT CARA M | | | | FIE | ELD | BOREHOLE L | OG | | |
|---|-------------------------------|-------------------------|----------|----------------------|------------|-------------------|--|-------------------|-------------------|--|
| Project | <i>Name</i> :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | <i>ıt :</i> HRIDC | Ľ |
| BH Loce | ation/Ch | ainage :1 | 6+042 | | | | Northing :3121262.045 m | East | ing :70547 | 72.02 m |
| Reduced | d Level (r | n):(+)194 | .105 | | | | BH. No. :BH-A2 | BH | Ferminatio | on Depth (m):30 |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):3.68 | Incli | nation : V | fertical |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | h of Casin | ng (m) :Not Used |
| Date of | Start :08 | -10-2021 | | | | | Date of Completion :09-10-2021 | | | |
| | . (| | В | low cour per 15cm | its າ | | | ion | | suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | Depth (Depth v/s v/s SPT N Value) SPT N Value |
| 0.0 | | DS-1 | | | | | | <u> </u> | | |
| 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 | 2.5 | UDS-1 SPT-1 UDS-2 | 3 | 4 | 5 | 9 | Brown, Loose to medium dense, Silty sand with clay | SM-SC | ¥3.68m | |
| 5.0 5.5 6.0 6.5 7.0 | 5.5 | SPT-2 UDS-3 | 5 | 7 | 9 | 16 | | | | |
| 7.5 | 7.5 | SPT-3 | 6 | 9 | 10 | 19 | | | | |
| 8.0 | 8.5 | SPT-4 | 11 | 15 | 18 | 33 | | | | |
| 9.09.5 | | | | | | | Brown yellowish, Very stiff to hard, Silty clay of low plasticity | CL | | |
| _10.0_ | 10 | UDS-4 | | | | | | | | |

| C | ESAMI THE CARDON | | | | FIE | ELD | BOREHOLE L | OG | | |
|---|-------------------------------|-------------------------|-------------------|------------|------------|-------------------|--|--------------------|----------------|--|
| Project | Name :C | TI for (H | ORC) pro | oject fron | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDC | L |
| BH Loc | ation/Ch | ainage :1 | 6+042 | | | | Northing :3121262.045 m | Eas | ting :70547 | 2.02 m |
| Reduce | d Level (i | n):(+)194 | .105 | | | | BH. No. :BH-A2 | BH | Termination | n Depth (m):30 |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | ; | | Water Table (m):3.68 | Incl | ination : Ve | ertical |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used |
| Date of | Start :08 | 3-10-2021 | | | | | Date of Completion :09-10-2021 | | | |
| | | | В | low cour | nts | | | u | | S |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificati | Graphic Log | (Depth Use of the constraint o |
| 10.5_ 11.5_ 11.5_ 12.0_ 12.5_ 13.0_ 13.5_ 14.0_ 14.5_ 15.0_ 15.5_ | 11.5 | SPT-5 UDS-5 SPT-6 | 8 | 9 | 11 | 20 | Brown yellowish, Very stiff to hard, Silty clay of low plasticity | CL | | |
| 16.0_ 16.5_ 17.0_ 17.5_ 18.0_ 18.5_ 19.0_ 19.5_ | . 16 | UDS-6 SPT-7 UDS-7 | 15 | 18 | 24 | 42 | Brown yellowish, Hard, Silty clay of low plasticity with gravel | CL | | |

| Cas | JANI I | | | | FIE | ELD | BOREHOLE L | OG | | | | | | |
|--|-------------------------------|----------------------------------|------------------|----------------------|------------|-------------------|--|-------------------|------------------------|--|-----------------------|--|--|--|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCI | _ | | | | |
| BH Loc | ation/Ch | ainage :1 | 6+042 | | | | Northing :3121262.045 m | East | ing :705472 | 2.02 m | | | | |
| Reduced | l Level (i | n):(+)194 | .105 | | | | BH. No. :BH-A2 | BH | Termination | Depth (m):30 | | | | |
| Propose | ed / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | : | | Water Table (m):3.68 | Incli | Inclination : Vertical | | | | | |
| Boring | ype :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | (m) :Not Used | | | | |
| Date of | Start :08 | -10-2021 | | | | | Date of Completion :09-10-2021 | | | | | | | |
| | Ê | | В | low cour per 15cm | nts 1 | | | ion | | | ons | | | |
| Depth (m) | In-Situ Sample Depth (m | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth V/s SPT N Value) 10 20 30 40 50 60 70 60 90100 | Special Observatio | | | |
| _20.5 _21.0 _21.5 _22.0 _22.5 _23.0 _23.5 _23.5 _24.0 _24.5 _25.0 _25.5 | 20.5 22 23.5 25 | SPT-8 UDS-8 SPT-9 UDS-9 | 20 | 25 | 31 | 56 | Brown yellowish, Hard, Silty clay of low plasticity with gravel | CL | | | | | | |
| 26.0 26.5 27.0 | 26.5 | SPT-10 | 25 | 30 | 47 | 77 | | | | | | | | |
| 27.5_ 28.0_ 28.5_ | 28 | SPT-11 | 21 | 29 | 49 | 78 | | | | | | | | |
| 29.0 29.5 30.0 | 29.5 29.95 | SPT-12 DS-2 | 27 | 40 | 50 | 90 | | | | | | | | |

| CE | CAPITY CARDANE | | | | FIE | | BOREHOLE L | OG | | | | | | | |
|--------------------------|--------------------------------|-----------------|------------------|----------------|------------|-------------------|--|-------------------|--------------------------------|--------------------------------|-----------------------|--|--|--|--|
| Project | Name :G | fII for (H | ORC) pr | oject fron | n Palwal t | to Harsana | a Kalan in the state of Haryana. | Clie | ent :HRIDCI | | | | | | |
| BHLoc | ation/Ch | ainage :1 | 6+231 | | | | Northing :3121114.308 m | Eas | ting :70583 | 6.344 m | | | | | |
| Reduced | $\frac{1}{1}$ Level (i | $\frac{n}{(+)}$ | | D 1 | | | BH. No. :BH-A1 | BH | Termination | n Depth (m):30 | | | | | |
| Propose | ed / Exist | ing Struci | <i>ture</i> :Maj | or Bridge | • | | Water Table (m): 3.13 | | ination : ve | | | | | | |
| Data of | Start 11 | ary | | | | | Date of Completion :12 11 2021 | Dep | Depin of Casing (m) . Not Osca | | | | | | |
| Dule 0j | Siari . 11 | -11-2021 | В | low cour | nts | | Dute of Completion .12-11-2021 | ç | | | s | | | | |
| Depth (m) | In-Situ Sample Depth (m) | Sample Type | N1 | per 15cn N2 | n N3 | SPT N Value | Strata Description | IS assificatio | Graphic Log | (Depth v/s SPT N Value) | Special bservation | | | | |
| 0.0 | | DS-1 | | | | | | Ū | 0 | 10 20 30 40 50 60 70 80 90 100 | 0 | | | | |
| 0.5 1.0 1.5 2.0 | . 1 | UDS-1 | | | | | | | | | - | | | | |
| 2.5 3.0 3.5 | 2.5 | SPT-1 | 2 | 4 | 7 | 11 | Greyish brown, Medium dense, Silty sand with clay | SM-SC | ¥ 3.13m [−] | | - | | | | |
| 4.0 4.5 5.0 | 4 | UDS-2 | | | | | | | | | - | | | | |
| 5.5 6.0 | 5.5 | SPT-2 | 5 | 11 | 16 | 27 | | | | | - | | | | |
| 6.5 | . 7 | UDS-3 | | | | | | | | | - | | | | |
| 7.5 | | | | | | | | | | | - | | | | |
| 9.0 | . 8.5 | SPT-3 | 12 | 22 | 26 | 48 | Greyisn brown, Dense, Sandy silt of low plasticity with gravel | ML-CL | | | - | | | | |
| 9.5 | 10 | | | | | | | | | | - | | | | |

| Cas | INTE EXAMINE | | | | FIE | ELD | BOREHOLE L | OG | | | | | |
|--|--|---|-------------------|----------------------|------------|-------------------|--|-------------------|------------------------|-------------------------------|-------------|--|--|
| Project N | Vame :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clier | nt :HRIDCL | | | | |
| BH Loca | tion/Ch | ainage :1 | 6+231 | | | | Northing :3121114.308 m | East | ing :705836 | .344 m | | | |
| Reduced | Level (n | n):(+)192 | .968 | | | | BH. No. :BH-A1 | BH | Termination | Depth (m):30 | | | |
| Proposed | d / Existi | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):3.13 | Incli | Inclination : Vertical | | | | |
| Boring ty | vpe :Rot | ary | | | | | Dia. of Boring :150 mm | Dept | th of Casing | (m) :Not Used | | | |
| Date of S | Start :11 | -11-2021 | | | | | Date of Completion :12-11-2021 | | | | | | |
| | _ ج | | В | low coun per 15cm | its า | | | ion | | | ons | | |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Observation | | |
| 10.0 10.5 11.5 11.5 12.0 12.5 13.0 13.5 13.5 13.5 13.5 13.5 14.0 14.5 14.0 14.5 15.5 15.5 16.0 15.5 16.0 17.0 17.5 17.0 17.5 18.0 18.5 19.0 19.5 | 11.5 13 14.5 16 17.5 19 | SPT-4 UDS-5 UDS-6 SPT-6 UDS-7 | 10 | 17 | 22 | 39 | Greyish brown, Hard, Silty clay of low plasticity with gravel | CL | | | | | |

| Der 1 | Marrie | TIE O | | aia - 4 C | <u>I'IC</u> | | | | | | |
|------------------|-------------------------------|----------------|-----------------|----------------|--------------|-------------------|---|-------------------|----------------|--------------------------------|------------|
| Project | Name :C | 11 for (H | ORC) pro | oject fron | n Palwal to | o Harsana | a Kalan in the state of Haryana. | Clie | ent :HRIDCL | | |
| BH Loc | ation/Ch | ainage :1 | 6+231 | | | | Northing :3121114.308 m | Eas | ting :705836. | 344 m | - |
| Reduced | l Level (1 | n):(+)192 | .968 | | | | BH. No. :BH-A1 | BH | Termination I | Depth (m):30 | |
| Propose | ed / Exist | ing Struct | <i>ure</i> :Maj | or Bridge | e | | Water Table (m):3.13 | Incl | ination : Vert | | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | oth of Casing | (m) :Not Used | |
| Date of | Start :11 | -11-2021 | В | low cour | nts | | Date of Completion :12-11-2021 | - | | | |
| Depth (m) | In-Situ Sample epth (m) | Sample Type | - N1 | per 15cr N2 | N3 | SPT N Value | Strata Description | IS Issificatio | Graphic Log | (Depth v/s SPT N Value) | servations |
| _20.0_ | | | | | | | | CI® | 0 - | 10 20 30 40 50 60 70 80 90 100 | q |
| _20.5_ _21.0_ | 20.5 | SPT-7 | 11 | 18 | 29 | 47 | Greyish brown, Hard, Silty clay of | CL | | | |
| _21.5_ _22.0_ | 22 | UDS* | | | | | low plasticity with gravel | | | | |
| _22.5_ | 22.5 | SPT-8 | 30 | 64 | 36 (10cm) | >100 | | | | | |
| _23.0_ | | | | | | | | | | | |
| _23.5_ _24.0_ | 23.5 | SPT-9 | 32 | 67 | 33 (9cm) | >100 | | | | | |
| 24.5 25.0 | 25 | SPT-10 | 35 | 73 | 27 (7cm) | >100 | | | | | |
| 25.5 26.0 | | | | | | | Greyish brown, Very dense, Sandy silt of low plasticity with gravel | ML-CL | | | |
| 26.5 27.0 | 26.5 | SPT-11 | 17 | 34 | 55 | 89 | | | | | |
| _27.5_ _28.0_ | 28 | SPT-12 | 16 | 31 | 49 | 80 | | | | | |
| _28.5_ | | | | | | | | | | | |
| 29.0 | 29.5 | SPT-13 | 14 | 35 | 52 | 87 | | | | | |
| 30.0 | 30 | 2 20 | | | | | | | | | |

| Charles | (LANI) IN CARACINE | | | | FIE | ELD | BOREHOLE L | OG | | | |
|-------------------|-------------------------------|----------------|-------------------|----------------------|------------|-------------------|---|-------------------|--------------------|-------------------------------|-----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | Clie | nt :HRIDCL | | |
| BH Loc | ation/Ch | ainage :1 | 6+231 | | | | Northing :3121096.697 m | East | ing :705376.865 | m | |
| Reduced | d Level (r | n):(+)193 | .065 | | | | BH. No. :BH-A2 | BH | Termination Dep | oth (m):30 | |
| Propose | ed / Exist | ing Struct | <i>ture :</i> Maj | or Bridge | | | Water Table (m):3.10 | Incli | ination : Vertical | l | |
| Boring | type :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing (m) | :Not Used | - |
| Date of | Start :11 | -11-2021 | | | | | Date of Completion :12-11-2021 | I | | | |
| | Ê | | В | low cour per 15cm | its າ | | | ion | | | suc |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS Classificat | Graphic Log | (Depth v/s SPT N Value) | Special Observatio |
| 0.0 | | DS-1 | | | | | | 0 | | 0 30 40 50 60 70 80 90100 | |
| 0.5 1.0 1.5 | . 1 | SPT-1 | 3 | 4 | 4 | 8 | | | | | - |
| 2.0 2.5 | 2.5 | UDS-1 | | | | | | | | | - |
| 3.0 3.5 | | | | | | | | | 3.10m | | - |
| 4.0 4.5 | 4 | SPT-2 | 4 | 5 | 7 | 12 | | | | | - |
| 5.0 5.5 | 5.5 | UDS-2 | | | | | Greyish brown, Loose to medium dense, Sandy silt of low plasticity | ML-CL | | | - |
| 6.0 6.5 | | | | | | | | | | | - |
| 7.0 7.5 | 7 | SPT-3 | 7 | 10 | 13 | 23 | | | | | - |
| 8.0 | 85 | UDS-3 | | | | | | | | | - |
| 9.0 | | | | | | | | | | | - |
| 9.5 | 10 | _SPT-4 | 9 | 13 | 20 | 33 | | | | | |

| Ca | JANI UTE LANA MI | | | | FIE | CLD | BOREHOLE L | O | G | | | | | |
|--------------|-------------------------------|----------------|----------|----------------------|-----------|-------------------|---|----|-------------|----------------|-------------|------------------------|-------|---------|
| Project | Name :G | TI for (H | ORC) pro | oject from | Palwal to | o Harsana | Kalan in the state of Haryana. | | Clien | t :HRIDCL | | | | |
| BH Loca | ation/Ch | ainage :1 | 6+231 | | | | Northing :3121096.697 m | | Easti | ing :705376. | .865 m | | | |
| Reduced | l Level (r | n):(+)193 | .065 | | | | BH. No. :BH-A2 | | BH T | ermination . | Depth (m):3 | 0 | | |
| Propose | ed / Exist | ing Struct | ure :Maj | or Bridge | | | Water Table (m):3.10 | | Inclin | nation : Ver | tical | | | |
| Boring t | ype :Rot | ary | | | | | Dia. of Boring :150 mm | | Dept | h of Casing | (m) :Not Us | ed | | |
| Date of | Start :11 | -11-2021 | | | | | Date of Completion :12-11-2021 | | | | | | | |
| | . 6 | | В | low coun per 15cm | its 1 | | | | ion | | | | | |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | S | classificat | Graphic Log | (E SPT | Depth v/s N Valu | e) | Special |
| 10.0 | | | | | | | | | 0 | | | 50 60 | 70 80 | 90 100 |
| _10.5_ | | | | | | | Greyish brown, Loose to medium dense, Sandy silt of low plasticity | ML | -CL | | | | | |
| 11.0 11.5 | 11.5 | UDS-4 | | | | | | | | | | | | |
| _12.0_ | | | | | | | | | | | | | | |
| _12.5_ | | | | | | | | | | | | | | |
| 13.0 13.5 | 13 | SPT-5 | 10 | 12 | 16 | 28 | | | | | | | | |
| 14.0 | | | | | | | | | | | | | | |
| _14.5_ | 14.5 | UDS-5 | | | | | | | | | | | | |
| 15.0 | | | | | | | | | | | | | | |
| 16.0 | 16 | SPT-6 | 12 | 15 | 25 | 40 | Greyish brown, Very stif to Hard, Silty clay of low plasticity with gravel | C | CL | | | | | |
| _16.5_ | | | | | | | | | | | | | | |
| 17.0 | 17.5 | 201 | | | | | | | | | | | | |
| | 17.5 | 003-0 | | | | | | | | | | | | |
| _18.5_ | | | | | | | | | | | | | | |
| _19.0_ | 19 | SPT-7 | 13 | 17 | 22 | 39 | | | | | | | | + |
| 19.5 | | | | | | | | | | | | | | |

| Ca | ALANII TUTT LANA MA | | | | FIE | ELD | BOREHOLE L | OG | | |
|------------------|-------------------------------|----------------|------------------|----------------------|------------|-------------------|---|------------------|----------------|---|
| Project | Name :C | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | a Kalan in the state of Haryana. | Clie | nt :HRIDCI | _ |
| BH Loce | ation/Ch | ainage :1 | 6+231 | | | | Northing :3121096.697 m | East | ing :705376 | 5.865 m |
| Reduced | d Level (i | n):(+)193 | .065 | | | | BH. No. :BH-A2 | BH | Termination | <i>Depth (m)</i> :30 |
| Propose | ed / Exist | ing Struct | <i>ure :</i> Maj | or Bridge | : | | Water Table (m):3.10 | Incli | ination : Ve | rtical |
| Boring i | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | Dep | th of Casing | g (m) :Not Used |
| Date of | Start :11 | -11-2021 | | | | | Date of Completion :12-11-2021 | | | |
| | | | В | low cour per 15cn | nts n | | | tion | | _ us |
| Depth (m) | In-Situ Sample Depth (r | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | IS :lassifica | Graphic Log | titiciai (Depth) se کم در از کم کم در از کم |
| _20.0_ | | | | | | | | 0 | 0 | 10 20 30 40 50 60 70 80 90100 U |
| _20.5_ _21.0_ | 20.5 | UDS-7 | | | | | | | | |
| _21.5_ | 22 | SPT-8 | 14 | 21 | 25 | 46 | | | | |
| _22.5_ | | | | | | | | | | |
| _23.0_ | | | | | | | Greyish brown, Very stif to Hard, Silty clay of low plasticity with gravel | CL | | |
| 23.5 | 23.5 | 003-6 | | | | | | | | |
| _24.5_ | | | | | | | | | | |
| 25.0 25.5 | 25 | SPT-9 | 15 | 25 | 28 | 53 | | | | |
| 26.0 | | | | | | | | | | |
| _26.5_ | 26.5 | UDS-9 | | | | | | | | |
| 27.0 | | | | | | | | | | |
| 28.0 | 28 | SPT-10 | 16 | 20 | 27 | 47 | Couriele la surre Donne de surre | | | |
| _28.5_ | | | | | | | dense, Sandy silt of low plasticity with gravel | ML-CL | | |
| _29.0_ | | | | | | | | | | |
| _29.5_ | 29.5 | SPT-11 | 17 | 24 | 29 | 53 | | | | |

| Ca | ILINI TET COMPANY | | | | FIE | ELD | BOREHOLE L | 0 | G | | | | |
|--------------|-------------------------------|----------------|------------------|----------------------|------------|-------------------|--------------------------------|-----|------------------|--------------|----------------------|--------------------|----------------------|
| Project | Name :G | TI for (H | ORC) pro | oject from | n Palwal t | o Harsana | Kalan in the state of Haryana. | | Client :I | IRIDC | Ĺ | | |
| BH Loc | ation/Ch | ainage :1 | 6+815 | | | | Northing :3120569.349 m | | Easting | :70515 | 3.768 m | | |
| Reduced | d Level (r | n):(+)194 | .981 | | | | BH. No. :BH-CL | | BH Tern | nination | Depth (m):10 | | |
| Propose | ed / Exist | ing Struct | <i>ture</i> :Min | or Bridge | : | | Water Table (m):4.10 | | Inclinati | on : Ve | rtical | | |
| Boring | <i>type</i> :Rot | ary | | | | | Dia. of Boring :150 mm | | Depth o | Casing | g (m) :Not Used | | |
| Date of | Start :04 | -10-2021 | | | | | Date of Completion :20-10-2021 | I | | | | | |
| | (u | | В | low cour per 15cm | າts າ | | | | tion | | | | l ons |
| Depth (m) | In-Situ Sample Depth (n | Sample Type | N1 | N2 | N3 | SPT N Value | Strata Description | SI | Classificat D | aphic Log | (Dej v/: SPT N | oth s Value) | Special Dbservati |
| 0.0 | | DS | | | | | | | | | 10 20 30 40 50 | 60 70 80 90 10 | |
| 0.5 | . 1 | SPT-1 | 2 | 5 | 8 | 13 | | | | | • | | _ |
| 1.5 | - | | | | | | | | | | | | |
| 2.0 | | | | | | | | | | | | | |
| 2.5 | 2.5 | UDS-1 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | | | |
| 3.5 | | | | | | | | | | | | | |
| 4.0 | 4 | SPT-2 | 7 | 10 | 19 | 29 | | | 4 | 10m | | | |
| 4.5 | | | | | | | Duran Madium danaa ta danaa | | | | | | |
| 5.0 | | | | | | | Sandy silt of low plasticity | ML· | -CL | | | | |
| <u></u> 5.5 | 5.5 | 003-2 | | | | | | | | | | | |
| 6.5 | | | | | | | | | | | | | |
| 7.0 | 7 | SPT-3 | 5 | 7 | 12 | 19 | | | | | | | |
| 7.5 | | | | | | | | | | | | | |
| 8.0 | | | | | | | | | | | | | |
| 8.5 | 8.5 | UDS-3 | | | | | | | | | | | _ |
| 9.0 | | | | | | | | | | | | | |
| 9.5 | | | | | | | | | | | | | |
| _10.0_ | 10 | _SPT-4_ | 14 | | 24 | 43 | | | | | | | |





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) WATER TABLE SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line) CI- Clay of medium plasticity (Above A-line, 35≤LL<50) CL-Silty Clay of low plasticity (Above A-line, LL<35) BOREHOLE REQUIRED SCALE:- VER:- 1:285

SCALE:- HOR:- 1:2850

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

| <u>R.L. (m)</u> | 211.00 | 209.00 | 208.00 | 207.00 | 205.00 | 204.00 | 203.00 | 202.00 | 201.00_ | 200.00 | 199.00_ | 198.00_ | 197.00_ | 196.00_ | 195.00_ | 194.00 | 193.00_ | 192.00_ | 191.00_ | 190.00 | 189.00_ | 188.00_ | 187.00_ | 186.00_ | 185.00_ | 184.00_ | 183.00_ | 182.00 | 181.00_ | 178.00 | 177.00 | 176.00 | 175.00 | 174.00_ | 173.00_ | 172.00_ | 171.00_ | 170.00 |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|--------|---------|---------|---------|---------|---------|--------|---------|---------|---------|--------|---------|---------|---------|---------|---------|---------|---------|--------|---------|--------|--------|--------|--------|---------|---------|---------|---------|--------|

Note:-

- provided in the table 4.3 & table 4.4. Ι. с.
- Bore holes which are liquefied greater than 4m depth, Some other suitable ground improvement methods may be adopted.



SCALE:- VER:- 1:285

SCALE:- HOR:- 1:2850

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) BOREHOLE REQUIRED

WATER TABLE

CI- Clay of medium plasticity (Above A-line, 35≤LL<50)

CL-Silty Clay of low plasticity (Above A-line, LL<35)

ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)

Geotechnical Investigation Repor

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.



8

2.1 K 2.4

EH-A2

3CH 394 287 NC 1-34472

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| | | | | Chainaga BH | | tum in some of the bore holes is f been re-evaluated considering the the table 4.3 & table 4.4. | DESCRIPTION | fines Less Than 50% and no plasticity or l | aving fines Less Than 50% and in the ha clay (Having fines greater than 50% and // I < 35,8, 4 <di<7)< th=""><th>city (Above A-line, LL<35)</th><th>icity (Above A-line, 355LL<5U)</th><th>:=.73(wl-20) SCALE:- HOR:- 1:2850</th></di<7)<> | city (Above A-line, LL<35) | icity (Above A-line, 355LL<5U) | :=.73(wl-20) SCALE:- HOR:- 1:2850 |
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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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Note:-

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provided in the table 4.3 & table 4.4.

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SCALE:- VER:- 1:285

SCALE:- HOR:- 1:2850

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

BOREHOLE REQUIRED

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WATER TABLE

CI- Clay of medium plasticity (Above A-line, 35≤LL<50)



Geotechnical Investigation Repor

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SCALE:- VER:-

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) SCALE:- HOR:- 1:2850

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APPENDIX – B (LAB TEST RESULTS)

| Appendix No. | ITEMS |
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| B-1 | SOIL CHARACTERISTICS SHEETS |
| B-2 | RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES |
| B-3 | GSD CURVES |



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| Conducting { of bridges an | Corridor (H existing IR | (ɯ) " | L.Ə morî diqeQ | 00.00 | 0.50 | 1.50 | 2.25 | 3.00 | 4.50 | 5.25 | 6.00 | 7.50 | 8.25 | 9.00 | 10.00 |



| d) | -22 | | noression lex (C,) | no) Dnl | | ı | | | | ı | | | | | | |
|--|---|--------------------|--|----------------------|------|--|-------|--------|-------|--------|--------|--|-------|--------|-------|-------|
| kef. Cod | -544_21 | ameters. | (37/2m 2-01 x | iə) W | | 1 | ı | ı | ı | 1 | ı | ı | | | ı | , |
| R | SR | tion Par | (395/ ₂ u +-01 x ^ | (6) C | | ı | 1 | 1 | | ı | 1 | ı | | | 1 | |
| L. | 5.557 m | Consolida | sinssə. | १) 'त | - | | | | | | | | - | - | | , |
| H | (+)19. | | (₀ 9) oit&A | bioV | - | - | - | - | - | - | - | - | - | - | - | |
| | 3 m | Â | ermeabilit (cm/sec) | d | - | ı | ı | ı | - | ı | ı | ı | - | - | ı | |
| | 3947.90 | əans | (kg/cm ²) | эмs | ' | ı | ı | I | , | ı | ı | ı | ' | ' | ı | ı |
| s (E,N) | 312 | хәр | ont lləw2 ə: (%) | Fre | | | | r | · | | | ı | | | | |
| ordinate | n | th | to slgn tion (φ°) | A Fric | - | ı | ı | 24 | | ı | ı | | - | - | ı | |
| C | 954.798 I | r Streng | D noisər (² mə ²) | (k Col | | | ı | 0.21 | | | ı | ı | | | ı | |
| | 2089 | Shea | te of Test | dxT | | | | DST | | | | | | | | , |
| nation pth | 00 m | ,ity | vrrð offios | odS | - | - | - | 2.66 | - | - | 2.66 | - | - | 2.66 | - | , |
| Termi De _l | 10.0 | (_e wə, | (g) (Jisn9Q | Dry | | ı | ı | 1.55 | | ı | 1.54 | | | 1.53 | ı | , |
| Table | |) ture | tsioM Isru %) tnotno? | te ^N D | | | | 15.10 | | | 19.12 | | | 20.30 | | , |
| of Water | 4.60 m | (_e wə/ | g) yiiensd | Aluf | - | - | | 1.78 | - | - | 1.83 | | - | 1.84 | | ı |
| Depth | | 6 | rinkage Limit | (I YS | - | 1 | | | | 1 | | | - | - | | ı |
| . No. | -CL | ; Limits 9 | asticity Asticity | l Id | | L | ı | L | | 1 | L | ı | | 9 | ı | I |
| B.H | BH | Atterberg | timi.I sit | erl4 | | 20 | ' | 21 | ' | ' | 20 | ' | | 21 | ' | ' |
| e tion | lge | 7 | timi.I bit | ıpiJ | ' | 27 | ' | 28 | ' | ' | 27 | ' | ' | 27 | ' | |
| Chainag m.)/Loca | 11+614 finor Bri | | Coarse Fine Garse | | , | 0 | ı | 0 | | 1 | 0 | ı | , | 0 | ı | , |
| (k | V | etained | Q sui | ł | ' | 0 | ı | 1 | ' | ı | 2 | ı | ' | 2 | ı | , |
| | 0-2021 | n % wt 1 | oarse | ວ | ' | 0 | ' | 1 | ' | ' | 2 | ' | ' | 3 | ' | , |
| oring | 30-1 | stributio | Sand muib | эМ | ' | 7 | ı | 7 | ı | ı | 9 | ı | ' | 9 | ı | ' |
| ate of Bc | to | Size Di | əni | ł | ' | 40 | ı | 31 | ' | 1 | 28 | ' | ' | 30 | ı | ' |
| D | 0-2021 | Grair | HiS | | ' | 47 | ' | 52 | ' | ' | 55 | ' | ' | 52 | ' | ' |
| | 30-1 | | VrID | | ' | 9 | ı | 8 | ' | ' | 7 | ı | ' | 7 | ı | ' |
| ssigning ital Rail | to | | lodmy2 21 | | | | | | | | | | | | | |
| ıl report for de î Haryana Orb | connectivity | uoi | trsifieerl | SI | I | ML-CL | I | ML-CL | I | I | ML-CL | I | I | ML-CL | I | I |
| investigation, preparation of geotechnic ment in connection with construction o | from Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | Brown, Loose, Sandy silt of low plasticity | | | | | | Brown, Medium dense, Sandy silt of low plasticity | | | | |
| technical or embank | C) project /ork in the | Tq | Value (N _e) | o | ' | 14 | 10 | ' | 18 | 20 | , | 18 | 15 | ' | 13 | 15 |
| cting geot ges and fc | or (HOR(g IR netw | ənløV | V TAS bəvi (V) | əsqO | ' | 8 | 7 | ı | 15 | 19 | ı | 21 | 16 | ' | 14 | 16 |
| Condu. of bridg | corrid existing | (ໝ) " | I.Ə mort d | Depti | 0.00 | 0.50 | 1.50 | 1 2.25 | 3.00 | 1 4.50 | 2 5.25 | 6.00 | 7.50 | 3 8.25 | 9.00 | 10.00 |
| iou | nglor | ə | qvT slqms | S | DS | SPT-1 | SPT-2 | UDS-1 | SPT-3 | SPT-4 | UDS-2 | SPT-5 | SPT-6 | UDS-3 | SPT-7 | SPT-8 |



| | 12 | | Compression (.C) xəbnl | | | | ı | | | I | ı | | | | |
|---|---|--------------------|--|------|-------|------|--------|---|--------|--------|------|------|--------|---|-------|
| f. Code | 544_21-2 | meters | (SM ² /Kg) | , | 1 | 1 | , | , | 1 | ı | ı | ı | 1 | ı | , |
| Re | SR-5 | on Para | (5) (5) (5) (5) (5) (5) (5) (5) (5) (5) | , | , | , | , | , | 1 | ı | ı | | | I | , |
| Ŀ | 027 m | onsolidati | (kg/cm ²⁾ | | | | | | | | | | | ı | , |
| R.] | (+)195. | 0 | Void Ratio (e_) | | | | , | | ı | ı | | | | ı | |
| | ш | Â | Permeabilit (cm/sec) | | | | , | | 1 | , | | , | | ı | 1 |
| | 935.677 | ente | Swelling Press (kg/cm ²) | | , | | | | 1 | ı | ı | | | I | , |
| ; (E,N) | 3123 | хәр | Free Swell Inc (%) | | , | | | ' | 1 | ı | ı | | | I | 1 |
| rdinates | | th | fo ofgnA Friction (φ°) | | | , | 24 | | - | 25 | | - | 5 | ı | , |
| Co | 10.733 n | Strengt | Cohesion C (kg/cm ²) | , | , | | 0.18 | , | | 0.20 | - | | 0.56 | I | ı |
| | 7089 | Shear | ts9T fo 9qyT | | | | DST | | | DST | | | UUT | | , |
| nation oth | 0 m | ity | vrad sifisəq8 | | | | 2.66 | | | 2.66 | | | 2.68 | | 1 |
| Termir Dep | 10.00 | (_e wə) | Dry Density (g/ | | | | 1.50 | | - | 1.54 | | - | 1.52 | ı | ı |
| Table | |) Inte | tsioM lkrutk ^N %) tnotnoD | | | | 15.25 | | ' | 18.89 | , | | 26.81 | ' | , |
| f Water | 4.70 m | (_e wə/ | Bulk Density (g | | , | , | 1.73 | , | | 1.83 | | | 1.93 | ı | |
| Depth o | | | Shrinkage Limit | | | | | | | | | | | , | , |
| No. | CL | Limits % | Plasticity Index | | 7 | , | 9 | , | - | L | - | - | 11 | ı | ı |
| B.H. | BH- | tterberg | Plastic Limit | | 20 | | 20 | | | 21 | , | | 21 | ı | I |
| e ion | ge | V | timiJ biupiJ | | 27 | | 26 | | - | 28 | - | - | 32 | 1 | I |
| Chainag n.)/Locat | 11+657 inor Brid | | Coarse | , | 0 | , | 0 | , | 1 | 0 | | | 0 | I | ı |
| (kr | W | Fine Gravel | | , | 0 | | 2 | | ' | 2 | ' | | 2 | ' | ' |
| | 0-2021 | n % wt r | Coarse | | 2 | ' | 3 | | ' | 1 | | ' | 3 | ' | , |
| oring | 30-1 | stributio | Sand Muib9M | ' | 4 | ' | 9 | ' | ' | 3 | ' | ' | 9 | ı | , |
| te of Bo | to | Size Dis | eniA | ' | 40 | ' | 38 | ' | ' | 41 | ' | ' | 28 | ı | 1 |
| Dî | 0-2021 | Grain | માંડ | ' | 47 | ' | 45 | ' | 1 | 45 | ı | ' | 50 | ı | , |
| | 30-1 | | Clay | | 7 | | 9 | | - | 8 | • | • | 11 | I | |
| ssigning ital Rail | to | | lodmy2 21 | | | | | | | | | | | | |
| l report for d Haryana Ort | connectivity | uoj | IS Classificati | | ML-CL | ' | ML-CL | | | ML-CL | ı | | CL | 1 | ı |
| investigation, preparation of geotechnics cment in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | | | Brown, Loose to medium dense, Sandy silt of low plasticity | | | | | | Brown, Medium stiff to stiff, Silty clay of low plasticity | |
| technical or embank | C) project ork in the | Te | IS bətəərvə Value (N.) | ' | 13 | 12 | ' | 17 | 22 | ı | 18 | 19 | | 16 | 16 |
| cting geot ges and fo | or (HORC g IR netw | ənleV | (N) VDServed SPT V | , | Δ | ~ | , | 14 | 20 | ı | 20 | 24 | , | 16 | 16 |
| Conduc of bridg | cu Corride existing | (ɯ) " | I.Ə morî diqəU | 0.00 | 0.50 | 1.50 | 1 2.25 | 3.00 | 1 4.50 | 2 5.25 | 6.00 | 7.50 | 3 8.25 | 9.00 | 10.00 |
| | 5 | ə | qvT əlqms2 | DS | PT-1 | PT-2 | DS-1 | PT-3 | PT-4 | DS-2 | PT-5 | PT-6 | DS-SO | PT-7 | 9-T |



| e | -22 | | Compression Index (C,) | I | | , | , | | | | ı |
|--|---|--------------------|---|---------------------------------|-------|--------------------------------|-------|-------|-------------------------------|------------------------------|-------|
| lef. Cod | -544_21 | ameters. | (cm ² /Kg) M ^{x x} 10 ⁻² | | | | , | | , | | , |
| Я | SR | tion Par | (cm ² /Sec) C ^x x 10 ⁻⁴ | | | | | | | | 1 |
| T. | .849 m | Consolida | (kg/cm ²⁾ Pressure | | | | , | - | | | , |
| Я | (+)194 | | (09) oitrA bioV | | | | , | | | | ı |
| | m (| Á | Permeabilit (cm/sec) | | | | | | | | ' |
| | 3758.29(| nre | Swelling Press (kg/cm ²) | ı | | | | - | | | ' |
| s (E,N) | 312 | xəp | Free Swell Inc (%) | | | | | | | | |
| rdinate | | th | fo slgnA (°φ) nottori Τ | ı | | 29 | | 25 | | 24 | |
| Co | 479.897 n | ır Strengt | O noisəhoD (kg/cm²) | | | 0.00 | | 0.20 | | 0.21 | , |
| | 708 | Shea | test to sqyT | | | DST | | DST | | DST | |
| ation th | u C | ity | Specific Grav | | | 2.62 | | 2.66 | | 2.66 | , |
| Termir Dep | 10.0(| (₂ mə | Dry Density (g/ | | | 1.54 | | 1.58 | | 1.55 | , |
| r Table | |) n.e | tsioM Istural Moist %) tnotnoD | | | 14.33 | , | 19.60 | | 20.30 | 1 |
| of Wateı | 1.56 m | (_e wə/ | Bulk Density (g/ | ı | | 1.76 | | 1.89 | | 1.86 | 1 |
| Depth | | % | Shrinkage Limit | , | , | , | , | - | , | , | ' |
| . No. | -cL | Limits 9 | Plasticity Index | | NP | NP | ' | L | ' | 7 | ' |
| B.H | BH | Atterberg | timi.J siterla | , | lin | Nil | , | 20 | , | 21 | , |
| e tion | lge | V | timi.J biupi.J | 1 | , | | | 27 | | 28 | |
| Chainag n.)/Loca | 12+125 linor Bric | | Coarse | , | 0 | 0 | , | 0 | | 0 | ' |
| (kı | × | etained | ۹ni ^T | | 1 | 2 | , | 4 | | 3 | 1 |
| | 0-2021 | n % wt r | Coarse | | ŝ | 2 | , | 3 | , | ŝ | ' |
| ring | 06-1(| tribution | Sand Medium M | , | s | 3 | , | L | | 5 | ı |
| ate of Bo | to | Size Dis | əniA | | 67 | 73 | , | 31 | , | 33 | ' |
| Dî | 0-2021 | Grain | માંડ | | 24 | 20 | , | 48 | ' | 48 | ' |
| | 06-11 | | Clay | I | 0 | 0 | , | 7 | , | 8 | |
| signing tal Rail | to | | lodmy2 21 | i adadi Sanakana Sanakana | | | | | | | |
| report for de Haryana Orbi | connectivity | uoj | IS Classificati | | SM | SM | ı | ML-CL | ı | ML-CL | , |
| ivestigation, preparation of geotechnical nent in connection with construction of | rom Palwal to Harsana Kalan including tate of Haryana. | | Soil Description | | | Drown, Medium dense, July sand | | | Brown, Medium dense to dense, | Sandy silt of low plasticity | |
| chnical in embankn | project fi k in the s | Т | AS bətəərvə Value (N,) | | 17 | | 21 | , | 27 | | 18 |
| ng geotec s and for e | (HORC) R networ | ənır | (N) (N) | | 11 | | 20 | , | 34 | | 20 |
| Conducti of bridge: | Corridor existing I | (w) " | J.Ə morî diqəD | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 |
| 10100 | roject | ə | qvT əlqms2 | DS | SPT-1 | UDS-1 | SPT-2 | UDS-2 | SPT-3 | UDS-3 | SPT-4 |





| e | -22 | | Compression (,C) x9bn1 | ı | | | | | | | I |
|--|---|--------------------|---|------|---------------------------------|-------|--------------|-------|---|-------|---------------|
| tef. Cod | -544_21 | ameters | (53/ ₇ wo) 7-01 ^{x ^} W | | | | | , | ı | | |
| Я | SR | tion Par | (cm ² /Sec) C ^x x 10 ⁻⁴ | | | | 1 | , | ı | | |
| Ŀ | .631 m | Consolida | (kg/cm ²⁾ Pressure | | | | | | | | |
| R. | (+)195 | Ŭ | Void Ratio (e_) | ı | | , | - | ' | - | , | |
| | в | Â | Permeabilit (cm/sec) | | | , | , | , | 1 | , | |
| | \$592.675 | nre | Swelling Press (kg/cm ²) | | | | | | 1 | | |
| s (E,N) | 3123 | xəp | Free Swell Inc (%) | ı | | , | , | , | 1 | , | I |
| rdinate | U | ų. | Angle of Friction (\$) | ı | 28 | | 31 | | 30 | | |
| C | 224.151 n | ır Streng | Cohesion C (kg/cm²) | | 0.00 | | 0.00 | | 0.00 | | ı |
| | 708 | Shea | ts9T fo 9qYT | | DST | | DST | | DST | | ı |
| nation pth | 10 m | ity | Vrav Specific Grav | , | 2.62 | | 2.62 | ' | 2.63 | | ı |
| Termi De _l | 10.0 | (_e wə | Dry Density (g/ | | 1.54 | | 1.63 | | 1.58 | | |
| Table | |) nı.e | tsioM læutæV %) tnotnoD | | 13.22 | | 15.60 | | 16.54 | | , |
| of Water | 1.50 m | (_e wə/ | Bulk Density (g | | 1.74 | , | 1.88 | | 1.84 | , | 1 |
| Depth (| | • | Shrinkage Limit | | | | - | | - | | ı |
| No. | CL | Limits % | Plasticity Index | , | NP | | NP | | NP | | ı |
| B.H. | BH | tterberg | Plastic Limit | | Nil | | Nil | | Nil | | ı |
| e ion | ge | V | timiJ biupiJ | ı | | | - | | - | | I |
| Chainag n.)/Locat | 12+431 inor Brid | | Coarse | ı | 0 | , | 0 | , | 0 | , | I |
| (kr | M | etained | e Pani ^T | | - | ' | 5 | ' | 4 | ' | ı |
| | 0-2021 | n % wt r | Coarse | , | 3 | ' | 2 | | 1 | ' | ı |
| ring | 06-10 | stributio | Sand Medium | ı | 4 | , | 3 | ' | 2 | , | I |
| ate of Bo | to | Size Dis | əniA | | 72 | ' | 61 | ' | 64 | ' | 1 |
| Di | 0-2021 | Grain | માંડ | | 20 | , | 29 | ' | 29 | , | ı |
| | 06-1(| | Clay | ' | 0 | ' | 0 | ' | 0 | ' | , |
| signing ital Rail | to | | lodmy2 21 | | | | 4183311 1 | | 51,1825-111 Arita (1992) Marita (1992) | | 4.185311 1 |
| report for de Haryana Orbi | connectivity | uoj | IS Classificati | 1 | SM | ı | SM | ı | SM | ı | ı |
| nvestigation, preparation of geotechnical ment in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | Brown, Medium dense, Silty sand | | | | Brown, Dense to very dense, Silty sand with gravel | | |
| echnical i r embank |) project ork in the | T | Corrected SI Value (N.) | ı | ' | 19 | ' | 46 | ' | 26 | ı |
| ting geote es and for | r (HORC) IR netwo | ənlaV | (N) (V) | | | 16 | ' | 64 | 1 | 34 | ı |
| Conduct of bridge | Lorrido existing | (ɯ) " | I.Ə morî diqaQ | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 |
| | rrojec | ə | qvT əlqms2 | DS | UDS-1 | SPT-1 | UDS-2 | SPT-2 | UDS-3 | SPT-3 | UDS-4 |



| | 2 | | Compression Index (C,) | | | | | | | | | | | | T |
|---|---|---------------------------|--|------|---|--------|--------|----------|--------------------------------------|------------|--------|--------|--------|--|---------|
| f. Code | 44_21-2 | neters | | | | , | , | | | , | 1 | | 1 | , | , |
| Re | SR-5 | n Paraı | (cm ² /2ec) | | - | - | | - | | - | | | - | - | 1 |
| | 27 m | onsolidatio | ر ۲۵۰٬۳ (لاو/cm ²⁾ ۲۳۰۶ | | | | | | | | | | | | , |
| R.L | (+)195.0 | CC | (₀ 9) oitaR bioV | | | , | | , | | , | 1 | | | , | |
| | ш | Â | Permeabilit (cm/sec) | , | , | , | , | , | | , | , | , | | , | , |
| | 118.176 | enre | Swelling Press (kg/cm ²) | , | - | - | | - | | - | | , | | - | ı |
| (E,N) | 3123 | хәр | Free Swell Ind (%) | | | , | , | | | , | , | | ı | , | , |
| dinates | | _ | Angle of Friction (\$°) | , | 27 | , | 5 | , | , | 9 | ı | , | 24 | , | , |
| Cor | 94.763 m | Strengtl | Соћезоп С (^s mɔ\gx) | - | 0.00 | - | 0.53 | - | | 0.75 | - | - | 0.21 | - | I |
| | 70759 | Shear | Type of Test | | DST | | UUT | | | UUT | | | DST | | ı |
| ation h | m | ity | vrað sífissq2 | | 2.62 | | 2.67 | | | 2.68 | | | 2.66 | | , |
| Termin: Dept | 10.00 | (_e wə | Dry Density (g/ | | 1.46 | | 1.52 | | | 1.56 | | | 1.53 | | ı |
| Table | |) Inte | tsioM lsrutsN %) tnstnoD | | 14.16 | | 20.30 | | | 25.60 | | | 20.10 | | 1 |
| of Water | 3.10 m | (_e wə/ | Bulk Density (g | | 1.67 | | 1.83 | | | 1.96 | | | 1.84 | | ı |
| Depth o | | , o | Shrinkage Limit | | | - | , | - | | - | | | | - | ı |
| No. | CL | Limits % | Plasticity Index | | ΝΡ | | 10 | | | 11 | | | 7 | | 7 |
| B.H. | BH | tterberg | timid sitself | - | liN | - | 21 | - | - | 21 | - | - | 20 | - | 21 |
| e tion | lge | V | timiJ biupiJ | ' | - | - | 31 | - | ' | 32 | 1 | ' | 27 | - | 28 |
| Chainag m.)/Loca | 13+218 finor Bric | | a Coarse | ' | 0 | ' | 0 | ' | ' | 0 | ' | ' | 0 | ' | 0 |
| (k | N | rt retained Fine Grave | | ' | 0 | ' | 1 | ' | ' | 2 | ' | ' | 2 | ' | 3 |
| | 0-2021 | n % wt i | Coarse | ' | 1 | ' | 1 | ' | ' | 1 | ' | ' | 4 | ' | 2 |
| oring | 31-1 | istributio | Sand muibəM | ' | 9 | ' | 5 | ' | ' | 9 | ' | ' | 7 | ' | 6 |
| ate of B | to | n Size D | əniA | ' | 62 | ' | 29 | ' | ' | 30 | ' | ' | 30 | ' | 33 |
| D | 0-2021 | Grai | માંડ | ' | 14 | ' | 54 | ' | ' | 49 | ' | ' | 50 | ' | 48 |
| | 31-1 | | Сіау | - | 0 | - | 10 | - | • | 12 | - | - | 7 | - | 8 |
| esigning ottal Rail | to | | lodmy2 21 | | 51,1525-111 10,146-025 22,141-025 12,141-025 12,141-025 12,141-025 12,141-025 12,141-025 12,141-025 12,141-025 12,141-025 14,141-020 | | | | | | | | | | |
| report for d Haryana Orb | connectivity | uoj | IS Classificati | ı | SM | I | CL | ı | ı | CL | I | ı | ML-CL | I | ML-CL |
| investigation, preparation of geotechnica kment in connection with construction of | from Palwal to Harsana Kalan including e state of Haryana. | | Soil Description | | Brown, Loose, Silty sand | | | | Brown, Very stiff, Silty clay of low | plasticity | | | | Brown, Medium dense, Sandy silt of low plasticity | |
| stechnical or emban | C) projec vork in th | Te | Corrected SI Value (N.) | ' | 7 | 6 | ' | 12 | 18 | ' | 21 | 24 | , | 16 | 17 |
| toting gec ges and f | lor (HOR ig IR netv | ənleV | (N) VD\$\$\$\$7.00 VD\$\$ | I | 4 | 9 | , | 12 | 18 | , | 21 | 24 | I | 17 |) 20 |
| Condu of brid | corrid existin | (ɯ) " | I.Ə morî diqe | 0.00 | 0.50 | 2 1.50 | 1 2.25 | 3.00 | 1 4.50 | 2 5.25 | 5 6.00 | 5 7.50 | 3 8.25 | 00.6 | 3 10.00 |
| | | | | - | | 2 | 2 | <u>.</u> | 4 | S-2 | T-5 | T-6 | S-S | Γ-7 | T-8 |



| 6 | 22 | | Compression (,C) x9bn | - | | | - | | | | - | | - | - | - | | - | | - | - | | |
|---------------------------------|--------------------------|--------------------|--|-------------|-----------|-------|-------|------|-------|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------------|------------|-------|--------|-------|
| ef. Code | -544_21- | ameters | (54/ ₇ wo) ₇₋ 01 x [^] W | | | | | | | | , | | , | , | , | | 1 | , | , | | | |
| R | SR- | tion Par: | (cm ² /Sec) C ^x x 10-4 | ı | 1 | , | | | | , | ı | | ı | ı | ı | | I | ı | ı | | 1 | |
| L. | .731 m | Consolida | (kg/cm ²⁾ | - | | | | | | | | | | 1 | | | 1 | | | | | , |
| R. | (+)194 | • | Void Ratio (e_) | | | | - | - | | | - | - | - | , | - | - | T | - | - | - | | |
| | Ш | Â | Permeabilit; (cm/sec) | | | | | | | | | | | , | | | ı | ı | | | | |
| | 2785.015 | n.e | Swelling Press (kg/cm ²) | | | | - | - | | | | - | | ' | | - | ī | | | - | | |
| es (E,N) | 312 | xəp | Free Swell Inc (%) | I | ı | | - | - | ı | , | - | - | - | T | - | - | T | - | - | - | ı | |
| ordinate | ш | gth | Angle of Friction (\$°) | | 4 | 4 | | | ' | ' | 5 | | 5 | 1 | 9 | | ı | | 1 | - | ' | |
| Č | 7152.851 | ar Streng | O noisədoD (kg/cm²) | ' | 0.23 | 0.49 | ' | | | | 0.70 | ' | 0.88 | ' | 1.02 | ' | ' | ' | ' | | | , |
| | 702 | She | Type of Test | | UUT+ | UUT | | | | | UUT | | UUT | | UUT | | ı. | | | | | |
| nation oth | 0 m | ţţ | vrad offic Grav | | 2.70 | 2.68 | | | | | 2.67 | | 2.68 | | 2.67 | | | | - | | | ı |
| Termi Dej | 40.0 | (_e wə | Dry Density (g/ | | 1.45 | 1.52 | | | | | 1.55 | | 1.58 | ı | 1.60 | | T | ı | | 1.60 | | |
| Table | |) n.c | tsioM IsrutsN (%) tnэtnoD | I | 14.00 | 27.11 | | | 1 | | 26.06 | | 24.80 | I | 23.84 | | I | ı | ı | 23.90 | 1 | ı |
| of Water | 2.53 m | (_e wə, | Bulk Density (g/ | ı | 1.65 | 1.93 | - | - | | , | 1.95 | - | 1.97 | ı | 1.98 | - | I | - | - | 1.98 | | |
| Depth (| | • | Shrinkage Limit | | | | - | - | | | | - | | ' | | - | ı. | | | - | | |
| . No. | -A1 | Limits % | Plasticity Index | | 15 | 11 | - | - | 11 | | 11 | - | 11 | ı. | 11 | - | T | 11 | - | 11 | | |
| B.H. | BH | Atterberg | Plastic Limit | | 24 | 22 | - | - | 21 | | 20 | - | 21 | 1 | 22 | - | ı | 23 | | 23 | | ı |
| e tion | lge | 7 | timiJ biupiJ | | 39 | 33 | - | | 32 | ' | 31 | ' | 32 | ' | 33 | ' | ' | 34 | ' | 34 | | |
| Chainag m.)/Loca | 13+787 Aajor Brio | Coarse Coarse | ı | 0 | 0 | ' | , | 0 | , | 0 | , | 0 | ı | 0 | , | I | 2 | ı | 0 | ' | | |
| (k | 2 | Fine Coarse | | ' | 0 | 2 | ' | ' | 2 | ' | 3 | ' | 4 | ' | 4 | ' | 1 | 3 | ' | 5 | ' | |
| | 1-2021 | n % wt i | Coarse | ' | 1 | 3 | ' | ' | 3 | ' | 1 | ' | 1 | ' | 3 | ' | 1 | 5 | ' | 1 | ' | ı |
| oring | 10-1 | stributio | Man MuiboM | ı | 5 | 4 | ' | · | 9 | 1 | 9 | ı | 7 | ı | 4 | ı | ı | 2 | ı | 9 | ' | |
| ate of Bc | to | ı Size Di | Fine | ı | 13 | 23 | 1 | 1 | 24 | , | 26 | 1 | 24 | I | 23 | 1 | I | 26 | 1 | 20 | ' | |
| D | 1-2021 | Graiı | HIS | ı | 65 | 55 | ' | ' | 53 | ' | 53 | ' | 52 | ı | 54 | ' | ı | 49 | ' | 55 | ' | |
| | 60-1 | | Clay | - | 16 | 13 | - | - | 12 | ' | 11 | - | 12 | • | 12 | - | - | 13 | - | 13 | ' | • |
| esigning of I Rail | to existing | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| eport for de ana Orbita | onnectivity | uo | IS Classificati | ľ | CI | CL | | | CL | | CL | · | CL | 1 | CL | · | ı | CL | T | CL | | |
| technical r | icluding cc | | | ff, Silty | ity | | | | 1 | y stiff, city | | | | | | | | clay of | vel | | | |
| n of geot onstructi | Kalan in | | ription | dium sti | n plastic | | | | | iff to ver w plastic | | | | | | | | rd, Silty | with gra | | | |
| eparatio n with co | Harsana | | ll Desci | wn, Me | mediun | | | | | own, Sti ay of lov | | | | | | | | own, Hai | asticity v | | | |
| estigation, pr in connection | n Palwal to I yana. | | Soi | Greyish bro | clay of | | | | | Greyish bro Silty cla | | | | | | | | Greyish bro | low pla | | | |
| nical inve ankment | oject froi ate of Hai | T | Sorrected SP Value (N,) | - | 6 | , | 14 | ı | 16 | 14 | ı | 20 | ı | 26 | ı | 31 | ı | 36 | 31 | , | 32 | |
| ; geotech for emb | IORC) pi in the st | ən[v] | (N) (V) | I | 9 | | 14 | 1 | 16 | 14 | ı | 20 | ı | 26 | ı | 31 | I | 36 | 31 | , | 32 | |
| anducting idges and | orridor (F : network | (w) | Depth from G.L | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 6.00 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 18.00 | 19.00 | 20.50 | 22.00 | 23.50 |
| During br | | ə | qyT slqms2 | DS | SPT-1 | UDS-1 | SPT-2 | *SQU | SPT-3 | SPT-4 | UDS-2 | SPT-5 | UDS-3 | SPT-6 | UDS-4 | SPT-7 | UDS* | SPT-8 | 6-TqS | UDS-5 | SPT-10 | UDS* |



| | Conductir bridges an | ng geotec nd for em | echnical in mbankmen | vestigation, preparation of geotechnical rep tt in connection with construction of Haryar | ort for design aa Orbital Rai | ing of l | | Date of F | 3 oring | | (kn | Chainage 1.)/Locati | ion | B.H. N | Vo. | Depth of | Water T | able | Terminati Depth | uo | | Cordi | nates (E, | 2 | | R. | L. | В | ef. Code | |
|------------|-------------------------|-------------------------|---|--|----------------------------------|-------------|-----------|-------------|----------------|----------|----------|------------------------|----------------|---------------|---------------------|--------------------|--------------------|-----------------------------|--------------------|-------------|---------------------------|-----------------------------------|---------------------------------|-----------------------|-------------|----------------------|--|---|---|--------------------------|
| rroject | Corridor (IR networ | (HORC) rk in the | () project fr e state of H | rom Palwal to Harsana Kalan including con laryana. | mectivity to ex | visting | 09-11-202 | il to | 10-] | 1-2021 | M | 13+787 ajor Bridg | ge | BH-A | 11 | 2 | .53 m | | 40.00 m | | 707152 | .851 m | | 122785.0 | 15 m | (+)194. | .731 m | SR. | -544_21- | 22 |
| ə | (w) " | 9ulsV | Te | | uoj | | Gr | rain Size D | listributic | m % wt 1 | etained. | | Ą | tterberg L | imits % | | (_e wo) | () | (_e wə | , Ity | Shear S | trength | xəp | nre | Á | | Consolida | tion Par | ameters | |
| qvT slqms2 | Depth from G.L | (N) VD\$\$\$\$\$\$\$ | (v1) Forrected SI (v,) sulas (V,) | Soil Description | IS Classificati | lodmy2 21 | Clay | me | an muib9M | Coarse | Pine Q | Coarse | timi.I biupi.I | Plastic Limit | Plasticity Index | Shrinkage Limit | Bulk Density (g | %) tnstno 2007 is insert | Dry Density (g/ | vry officed | tsof to oqyf O noisonO | Jo əlgnA (² mə/gA) | Friction (9°) Free Swell Inc | (%) seera gnillow2 | Permeabilit | (09) oita Ratio (00) | (kg/cm ²⁾ | (cm ² /Sec) C ^{x x} 10-4 | (Tay/ ² mo) ²⁻ 01 x ₂ M | Compression (C.) x9bn |
| SPT-11 | 24.00 | 34 | 34 | | CL | | 11 5 | 1 21 | 6 | 2 | 9 | 0 | 31 | 21 | 10 | | , | , | | | | | ' | ' | , | | | 1 | | |
| SPT-12 | 25.50 | 37 | 37 | - - - - - - - - - - - - - - - - - - - | | | | | ' | ' | ' | ' | | | | | | , | | | | | ' | ' | , | | | 1 | | |
| 0DS-6 | 26.50 | , | 1 | ureyish brown, Hatu, Shiy clay or low plasticity with gravel | CL | | 12 4 | l8 23 | 7 | 4 | 5 | 1 | 31 | 20 | 11 | 1 | 2.01 2 | 3.07 | 1.63 2 | 0 89. | UT 1 | 42 | | ı | ı | 0.645 | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | 7.10 4.97 3.89 3.08 | 1.84 1.24 0.78 0.53 | 0.1100 |
| SPT-13 | 28.00 | 48 | 48 | | , | | | | ' | ' | ' | ' | | , | | | , | , | | - | - | - | | ' | ' | | | | | |
| UDS-7 | 29.50 | ı | ' | | CI | | 15 5 | 0 18 | 7 | 2 | 7 | 1 | 37 | 24 | 13 | 1 | 2.04 2 | 0.79 | | .67 U | UT 2 | 56 5 | ' | ' | ı | ' | | I | ı | · |
| SPT-14 | 31.00 | 71 | 71 | | - | | | 1 | ı | ' | ' | 1 | | , | | | , | | | - | - | - | | 1 | ı | , | | T | ı | ı |
| SPT-15 | 32.50 | 85 | 85 | | CI | | 16 5 | 11 16 | 4 | 3 | 10 | 0 | 38 | 24 | 14 | , | , | 1 | | | | | | 1 | ı | ı | | I | ı | T |
| SPT-16 | 34.00 | 93 | 93 | Greyish brown, Hard, Silty clay of | | | | 1 | , | ' | ' | 1 | , | , | | | , | , | | | - | | | ' | ı | ' | | ı | ı | ı |
| UDS-8 | 35.50 | I | | medium plasticity with gravel | CI | | 17 5 | 11 13 | 9 | 2 | 8 | 3 | 40 | 25 | 15 | | 2.04 2 | 0.67 | 69.1 | | | | • | ' | ı | ľ | | I | ı | ı |
| SPT-17 | 37.00 | 73 | 73 | | 1999 | | | , | 1 | ' | ' | ı | ' | , | ı | | , | 1 | , | | | | 1 | ' | I | 1 | | T | ı | T |
| 6-SQU | 38.50 | ı | ' | | CI | | 16 5 | 3 15 | 5 | 2 | 6 | 0 | 39 | 24 | 15 | 1 | 2.05 2 | 0.45 | 70 | | | | 1 | ' | ı | ı | | I | ı | - |
| SPT-18 | 40.00 | 83 | 83 | | | | | | | ' | ' | ' | | | | | | , | | | | | ' | ' | , | | | ı | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



| | | | | | r | | | | r | | | r | r | | r | | | | | | | |
|--|---|-------------------|---|---------------|-------|-------|-----------------------------------|-------|-------|-------|-------|---------------------------------------|-------------------|-------|-------|-------|-------|------------------------------------|----------------------------|-------|-------|-------|
| <u>ى</u> | -22 | | Compression Index (C _c) | | , | | , | | , | , | | | , | , | | , | | | ı | | T | |
| kef. Cod | -544_21 | ameters. | (бу/ ₇ шэ) ₇₋ 01 ^{х ^} М | | | | | | | | | | | | | | | | | | ı | |
| Ι | SR | ation Par | (cm ² /Sec) C ^x x 10-4 | ı | | | - | | | | | | | | | | - | | - | - | T | |
| Ţ. | .755 m | Consolida | (kg/cm ²⁾ | | | | | | | | | | | | | | | | | | | |
| Я | (+)194 | | (09) oitsA bioV | | | | | , | | | , | , | | | , | , | 1 | | | | I | |
| | 4 m | Á | Permeability (cm/sec) | ı | | | - | | | | | | | | | | - | | - | - | T | |
| | 22775.68 | nre | Swelling Press (kg/cm ²) | | ' | ' | ' | ' | | | | ' | | | | | ' | | ' | | ı | ' |
| es (E,N) | 312 | xəj | Free Swell Inc (%) | , | , | ' | - | ' | , | , | ' | , | , | , | ' | ' | | , | - | ' | I | |
| ordinat | в | gth | fo slgnA Friction (φ°) | | , | | 25 | ' | , | , | 5 | , | 9 | , | s | ' | 9 | , | 5 | ' | 5 | |
| U | 7140.474 | ear Stren |) noisənd Соһезіоп С | , | ' | ' | 0.09 | ' | ' | ' | 0.82 | ' | 0.95 | ' | 1.85 | ' | 2.03 | ' | 1.42 | ' | 2.08 | ' |
| | 70 | She | tesT to sqyT | · | | | DST | | ' | | TUU | | UUT | | UUT | | LUU | | TUU | - | UUT | ' |
| nation pth | 0 m | ity | Specific Grav | | | | 2.65 | | | | 2.67 | | 2.68 | | 2.68 | | 2.67 | | 2.68 | - | 2.68 | - |
| Termi Dej | 40.0 | (_e wə | Dry Density (g/0 | | | - | 1.47 | | 1.48 | | 1.58 | | 1.60 | | 1.65 | | 1.67 | | 1.62 | - | 1.67 | - |
| Table | |) nre | tsioM IstursI (%) tnotnoD | | | | 15.10 | | 15.60 | | 24.74 | | 23.88 | | 22.08 | | 21.10 | | 23.36 | - | 21.78 | |
| of Water | 2.55 m | (_e wə | Bulk Density (g/ | , | , | | 1.69 | , | 1.71 | , | 1.97 | , | 1.98 | , | 2.01 | , | 2.02 | , | 2.00 | - | 2.03 | 1 |
| Depth o | | • | Shrinkage Limit | | | | - | ' | | | | | | | | | - | | - | - | 1 | |
| . No. | -P1 | Limits % | Plasticity Index | | 9 | | 5 | | 5 | | 10 | | 11 | | 10 | | 11 | | 10 | - | 11 | |
| B.H | BH | Atterberg | Plastic Limit | | 20 | ' | 20 | ' | 20 | | 21 | ' | 23 | | 21 | | 21 | ' | 21 | ' | 23 | ' |
| e tion | lge | 7 | timi.I biupi.I | , | 26 | ' | 25 | ' | 25 | ' | 31 | , | 34 | ' | 31 | | 32 | ' | 31 | - | 34 | ' |
| Chainag m.)/Loca | 13+787 1ajor Brio | | a Coarse | , | 0 | , | 0 | , | 0 | , | 0 | , | 0 | , | 0 | , | 1 | , | 0 | ' | 0 | ı |
| (k | 2 | Coarse wt | | , | - | ' | 2 | ' | - | ' | 1 | ' | 3 | ' | 5 | ' | 9 | ' | 7 | ' | 8 | ' |
| | 1-2021 | n % wt | Coarse | , | 2 | , | 1 | ' | 2 | ' | 1 | ' | 2 | ' | 1 | ' | 3 | ' | 1 | ' | 3 | ' |
| oring | 09-1 | istributio | Sand Maine M | , | 5 | ' | 9 | ' | 7 | ' | 5 | ' | ŝ | ' | 9 | ' | 4 | ' | 5 | ' | 9 | ' |
| ate of Bo | to | n Size Di | əniA | ' | 48 | ' | 51 | ' | 45 | ' | 29 | ' | 24 | ' | 20 | ' | 23 | ' | 21 | ' | 19 | ' |
| Ω | 11-2021 | Graii | માંડ | ' | 38 | ' | 35 | ' | 40 | ' | 53 | ' | 55 | ' | 57 | ' | 51 | ' | 56 | ' | 51 | ' |
| IJ | 608- | | Val D | ्रक्षे सुर्वह | 9 | - | 5 | - | 5 | - | 11 | • | 13 | • | 11 | • | 12 | • | 10 | - | 13 | ' |
| esigning o I Rail | to existing | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| report for d ryana Orbita | connectivity | uo | IS Classificati | ' | SM-SC | ı | SM-SC | ' | SM-SC | | CL | ' | CL | | CL | ' | CL | ı | CL | | CL | ' |
| estigation, preparation of geotechnical in connection with construction of Ha | m Palwal to Harsana Kalan including ryana. | | Soil Description | | | | Grey, Loose, Silty sand with clay | | | | | Greyish brown, Very stiff, Silty clay | of low plasticity | | | | | Greyish brown, Hard, Silty clay of | low plasticity with gravel | | | |
| hnical inv bankment | project frc state of Ha | T | Corrected SP Value (N,) | | | 5 | ' | 8 | | 10 | ' | 24 | | 29 | | 56 | ' | 65 | ' | 43 | ı | 64 |
| ng geotec nd for eml | (HORC) _l rk in the s | ənle/ | Opserved SPT V (V) | | | 4 | | 7 | | 6 | ' | 24 | | 29 | | 56 | ' | 65 | ' | 43 | ' | 64 |
| Conducti. bridges at | Corridor IR netwo | (w) · | J.Ə morî diqəD | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 |
| | Loject | ə | qvT slqms2 | DS | 1-SQ(| SPT-1 | JDS-2 | SPT-2 | JDS-3 | SPT-3 | JDS-4 | PT-4 | JDS-5 | SPT-5 | JDS-6 | SPT-6 | 7-SQ(| SPT-7 | JDS-8 | SPT-8 | JDS-9 | 6-T48 |



| a | -22 | | U | Compression (,C) xəbnl | , | 1 | , | , | , | , | , | ı | ı |
|--|------------------------------------|--------------------|-----------------------|---|--------|--------|-------|--------|--|--------|--------|--------|--------|
| tef. Code | -544_21 | ameters | | (87/2mo) 2-01 x M | | 1 | | 1 | | 1 | 1 | 1 | ı |
| В | SR | tion Par | | (cm ² /Sec) C ^x x 10 ⁻⁴ | , | ı | | 1 | , | 1 | 1 | 1 | ı |
| i | .755 m | Consolidat | | Lressure | | | | | | | | | |
| R. | (+)194 | | (⁰ | 9) oita Ratio (e | , | I | | , | , | , | | - | - |
| | m t | Â |) (; | dramıaP Davlaev | | | | | | | | | |
| | 2775.684 | nre | (₇ ssə | ng gnillow2 mo/ga) | , | ı | | , | , | , | , | | |
| s (E,N) | 3122 | xəp | ouj | Free Swell (%) | | | | | | | | | |
| rdinate | | h | (| fo slgnA φ) noitsirA | 9 | | | | 9 | | | | |
| Co | 140.474 n | ar Strengt | | O noisədoD (kg/cm²) | 2.50 | | | | 2.37 | | | | |
| | 707 | Shea | 1 | rs9T fo 9qYT | UUT | | | | UUT | , | | | |
| nation oth | 0 m | ţţ | ЛВ. | nD office Gr | 2.67 | 1 | | ' | 2.67 | , | , | 1 | 1 |
| Termi Del | 40.0 | (_e wə | /වි) | Dry Density | 1.69 | 1 | | | 1.68 | | 1.68 | | |
| r Table | |) nı.e | tsi | oM latural Mo) tnotnoD | 20.70 | ' | | ' | 21.06 | ' | 21.10 | - | - |
| of Wate | 2.55 m | (_e wə/ | (B) | Bulk Density | 2.04 | ı | ı | , | 2.03 | , | 2.03 | - | - |
| Depth | | % | | Shrinkage Jimit | | ' | | ' | | ' | | - | - |
| I. No. | I-P1 | g Limits ' | | Plasticity Vioitex | 11 | , | , | , | 11 | , | 11 | , | ' |
| B.H | BI | Atterber | 1 | imiJ siterla | 21 | ' | | ' | 22 | ' | 23 | ' | ' |
| ge ation | 7 idge | | J | imiJ biupiJ | 32 | ' | | ' | 33 | ' | 34 | ' | ' |
| Chaina (m.)/Loc | 13+78 Major Bri | | ravel | ostsoD | 2 | ' | ' | ' | 0 | ' | 0 | ' | ' |
| Ð | | retained | retained Grave | | 9 | ' | ' | ' | 6 | ' | 11 | ' | ' |
| | 1-2021 | on % wt | | 92780D | 1 | ' | ' | ' | 2 | ' | 2 | ' | ' |
| oring | 09-1 | istributio | Sand | muibəM | 9 | ' | ' | ' | 5 | ' | 9 | ' | ' |
| ate of B | to | n Size D | | əniA | 22 | , | ' | , | 20 | , | 13 | , | ' |
| Π | 11-2021 | Grai | | H IS | 51 | ' | ' | , | 51 | , | 53 | ' | ' |
| | 08-1 | | | VRD | 12 | | | | 13 | | 15 | - | - |
| esigning of I Rail | to existing | | 100 | dmy8 SI | | | | | | | | | |
| report for de yana Orbita | connectivity | uoj | ite | IS Classific | CL | ı | ı | ı | CL | ı | CL | ı | ı |
| 'estigation, preparation of geotechnical in connection with construction of Har | ıryana. ıryana. | | _ | Soil Description | | | | | Greyish brown, Hard, Silty clay of low plasticity with gravel | | | | |
| hnical inv bankment | project fr tate of Ha | T | (°N AS | Corrected Value (1 | | 86 | | 47 | | 75 | ' | 81 | 72 |
| ng geotech 1d for emt | (HORC) _I tk in the s | ənleV | ۲ ۱ | (N) Observed SP | ' | 86 | | 47 | ' | 75 | ' | 81 | 72 |
| Conductii bridges an | Corridor (IR networ | (ɯ) " | 1.4 | Depth from C | 28.00 | 29.50 | 31.00 | 32.50 | 34.00 | 35.50 | 37.00 | 38.50 | 40.00 |
| 1 | Froject | ə | đ٨ | T əlqms2 | UDS-10 | SPT-10 | *SQU | SPT-11 | UDS-11 | SPT-12 | UDS-12 | SPT-13 | SPT-14 |





| | 2 | | Compression Compression | | ı. | ı | | | I | | | | | | | | | | | ı | ı. | ı |
|--|--|-------------------|---|------|-------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|------------------------------------|------------------------------|-------|-------|-------|-------|-------|--------|
| f. Code | 44_21-2 | neters | (SM/ ² mo) | - | | | | | | | - | | - | | | - | | | | - | | |
| Re | SR-5 | on Parai | (0) X M (0) X (0) | , | | | | | | , | , | | , | | , | ' | | | , | | | |
| | 84 m | nsolidatio | (kg/cm ²⁾ | | | | | 1 | | | | | | | | | | | | | | |
| R.L | (+)194.7 | Ŭ | (09) oitsA bioV | | | | | | | | | | | , | , | | , | | , | | | |
| | u | | rermeanum (298/m2) | | | | , | | | | , | | | | , | | | | , | | | ı |
| | 66.353 1 | nre | איני וויאס איניאלע אינ איניאלע איניאלע | | | | | | | | , | | | | , | | , | | , | | | , |
| (E,N) | 31227 | xə | Free Swell Ind (%) | , | | | | | | | , | | | | | , | | | | | | , |
| rdinates | | ч | fo slgnA Friction (φ°) | 1 | | 26 | | 1 | | 5 | , | 9 | | | , | , | | , | 9 | , | | |
| Col | l28.097 m | r Strengt | O noisəhoD (kg/cm ²) | | | 0.11 | | | | 0.75 | | 1.02 | | | | | | | 1.40 | | | |
| | 707 | Shea | tsoT to ofT | | | DST | | | | UUT | | UUT | | | | | | | UUT | | | |
| ation th | m (| ity | Specific Gravi | | | 2.65 | | | | 2.67 | | 2.68 | | | | | | | 2.68 | | | , |
| Termin Dep | 40.00 | (_e wa | Dry Density (g/0 | | | 1.50 | | 1.50 | | 1.56 | | 1.60 | | 1.60 | | | | | 1.62 | | 1.63 | |
| Table | |) nre | ttsioM lkrutkV (%) tnotnoD | | | 15.42 | | 16.62 | | 25.16 | | 23.80 | | 23.89 | | | | | 23.24 | ' | 23.30 | , |
| f Water | 2.50 m | (_e wə | Bulk Density (g/ | | | 1.73 | , | 1.75 | | 1.95 | | 1.98 | | 1.98 | | | | | 2.00 | | 2.01 | , |
| Depth o | | | Shrinkage Limit | | | | | | | | | | | | | | | | | | | |
| No. | A2 | Limits % | Plasticity Index | - | | 5 | | 6 | | 11 | - | 11 | - | 10 | | - | 11 | | 11 | - | 10 | |
| B.H. | BH- | tterberg | Plastic Limit | - | | 20 | | 20 | | 20 | - | 21 | - | 21 | | - | 23 | | 21 | - | 20 | , |
| ion | ge | V | timiJ biupiJ | - | , | 25 | | 26 | , | 31 | - | 32 | - | 31 | , | - | 34 | , | 32 | - | 30 | , |
| Chainage 1.)/Locat | 13+787 ajor Bridş | Fine Coarse | Coarse | | ı | 0 | ı | 0 | 1 | 0 | | 1 | | 0 | | | 0 | | 1 | | 0 | ı |
| (kn | Μ | Fine Coarse | - | ı | 0 | , | 0 | 1 | 2 | - | 3 | - | 4 | | - | 5 | | 9 | - | 7 | , | |
| | -2021 | 1 % wt r | Coarse | | 1 | 0 | ı | 2 | , | - | | 1 | | 1 | , | | 2 | ' | 1 | ' | 2 | , |
| ring | 09-11 | tributior | Man ManuibaM | - | , | 9 | , | 5 | ' | 5 | - | ٢ | - | 9 | ' | - | 5 | | 7 | • | 9 | , |
| te of Bo | to | Size Dis | əniA | | , | 53 | , | 48 | ' | 23 | - | 21 | - | 25 | ' | ' | 20 | ' | 22 | - | 24 | , |
| Da | 1-2021 | Grain | માંડ | ' | , | 36 | , | 39 | ' | 58 | | 55 | | 53 | ' | | 55 | ' | 51 | - | 51 | , |
| | 08-1 | | Val | 1 | | Ś | | 9 | | 11 | | 12 | - | 11 | , | 1 | 13 | | 12 | 1 | 10 | |
| igning of Rail | o existing | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| eport for des ana Orbital | unectivity to | uo | IS Classificati | | | SM-SC | | SM-SC | | CL | | CL | | CL | | | CL | | CL | | CL | , |
| vestigation, preparation of geotechnical r t in connection with construction of Har | om Palwal to Harsana Kalan including co aryana. | | Soil Description | | | Grey, Loose, Silty sand with clay | | | | | | | | | Greyish brown, Very stiff to hard, | Silty clay of low plasticity | | | | | | |
| chnical in thankmen | project fi state of H | T | Corrected SP Value (N.) | ı | 16 | | 6 | | 19 | | 24 | , | 30 | | 29 | , | 34 | 39 | , | 43 | , | 44 |
| ing geoted and for end | r (HORC) ork in the | ən[v/ | (N) (V) | ' | 10 | | 7 | | 19 | | 24 | | 30 | ' | 29 | ' | 34 | 39 | ' | 43 | | 44 |
| Conducti bridges a | Corridor IR netwo | (w) · | J.Ə morî diqəU | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 18.00 | 19.50 | 20.50 | 22.00 | 23.50 | 25.00 |
| | | ə | oqyT slqms2 | SQ | SPT-1 | UDS-1 | SPT-2 | UDS-2 | SPT-3 | UDS-3 | SPT-4 | UDS-4 | SPT-5 | UDS-5 | SPT-6 | uDS* | SPT-7 | SPT-8 | 9-SQU | 6-TqS | UDS-7 | SPT-10 |



| 6 | 22 | | U | Compression (.C) x9bnI | ı | ī | | | ı | ı | ı | | ı | |
|--|--|--------------------|------------------------|---|-------|--------|-------|--------|------------------------------------|----------------------------|--------|--------|--------|-----------|
| ef. Code | 544_21- | ameters | | (Tay/2mo) 2-01 x M | | | | | | | | | | |
| Я | SR | ion Par: | | (cm ² /Sec) C ^x x 10 ⁻⁴ | | | | | | | | | | , |
| Ŀ | 784 m | Consolidat | | ر لاق/saure Pressure | | | | | | | | | | |
| R.] | (+)194. | Ŭ | (⁰ |) oita Ratio (e | | | | | | | | , | | |
| | в | Á | i) (i | Permeabi 998/m9) | | | , | | | , | | , | | |
| | 766.353 | nıç | (₇ Issə | ord gnillow2 ² mo/gA) | | 1 | | | | 1 | 1 | , | 1 | |
| (E,N) | 3122 | xəj | puj | Free Swell] (%) | | | | | | 1 | | , | | , |
| rdinates | | h | (| fo slgnA (°φ) noitsirT | 5 | | | | 5 | | | , | | |
| Co | 128.097 п | ır Strengt | | О noisədo (^s mэ\g¥) | 2.18 | | | | 2.56 | - | | | , | |
| | 707 | Shea | 1 | tesT to sqvT | UUT | | | | UUT | - | | | | |
| nation oth | 0 m | ity | įAB. | aD office Gr | 2.67 | ' | ' | ' | 2.68 | 1 | ' | ' | 1 | |
| Termi Dej | 40.0 | (_e wo | o/a) | Dry Density (| 1.67 | | 1.67 | | 1.69 | | 1.69 | | | , |
| Table | |) nre | (%) (%) | oM lstursl) tnotnoD | 21.69 | | 21.30 | | 21.08 | , | 20.89 | | | · |
| f Water | 2.50 m | (_e wə) | /ฮิ) | Bulk Density | 2.03 | | 2.03 | | 2.05 | | 2.04 | | | |
| Depth o | | | | Shrinkage Limit | | | | | | - | | | | |
| . No. | -A2 | Limits 9 | | Plasticity Index | 11 | | 11 | | 11 | | 11 | , | 10 | |
| B.H | BH | Atterberg | 1 | nimiJ ətterl¶ | 20 | ' | 22 | | 23 | ' | 22 | | 21 | , |
| e tion | lge | | Ĵ | himiJ biupiJ | 31 | ' | 33 | ' | 34 | ' | 33 | ' | 31 | |
| Chainag n.)/Loca | 13+787 Iajor Brio | | avel | Coarse | 0 | ' | 0 | , | 0 | | 1 | ' | 0 | , |
| (kı | 2 | etained | Gr | əniA | 6 | ' | 11 | ' | 10 | | 8 | ' | 10 | , |
| | 1-2021 | n % wt r | | Coarse | 3 | , | - | ' | 2 | 1 | 2 | , | -1 | , |
| ring | 09-1 | tributio | Sand | muibəM | L | , | 9 | ' | ŝ | 1 | L | , | 9 | , |
| te of Bo | to | Size Dis | | Aine | 20 | ' | 19 | , | 21 | | 22 | ' | 21 | , |
| Da | -2021 | Grain | | HIS | 50 | ' | 51 | , | 51 | | 48 | , | 52 | |
| | 08-1] | | | VBID | 11 | ' | 12 | • | 13 | - | 12 | ' | 10 | |
| igning of Rail | o existing | | ю | dmy2 21 | | | | | | | | | | |
| eport for des ana Orbital | nnectivity to | uo | ite | officer[] SI | CL | | CL | | CL | | CL | | CL | |
| estigation, preparation of geotechnical r in connection with construction of Hary | m Palwal to Harsana Kalan including co ryana. | | | Soil Description | | | | | Greyish brown, Hard, Silty clay of | low plasticity with gravel | | | | · |
| hnical inv ankment | roject fro tate of Ha | T | (°) dS | Corrected Value (V | I | 63 | I | 72 | I | 62 | 1 | 81 | 82 | <i>LL</i> |
| ng geotecl 1d for emt | (HORC) _I tk in the s | ənle/ | ۲ ۷ | (N) Opserved SP1 | 1 | 63 | | 72 | ı | 62 | | 81 | 82 | <i>LL</i> |
| Conductii bridges an | Corridor (IR networ | (w) • | Т. { | Depth from C | 26.50 | 28.00 | 29.50 | 31.00 | 32.50 | 34.00 | 35.50 | 37.00 | 38.50 | 40.00 |
| | roject | ə | dA | T əlqms2 | UDS-8 | SPT-11 | 6-SQU | SPT-12 | UDS-10 | SPT-13 | UDS-11 | SPT-14 | SPT-15 | SPT-16 |


| ć, ž | echnical or embank | investigation, preparation of geotechnical cment in connection with construction of l | report for des Haryana Orbit | tigning al Rail | | Date of | Boring | | (k | Chainag m.)/Locat | e ion | B.H. N | Vo. 1 | Depth of | Water Ta | | l'erminatio Depth | u | | Cordin | ates (E,N | (1 | | R.J | L. | R | ef. Code | |
|---|------------------------|--|---------------------------------|--------------------|----------|-----------|---------------|----------|----------|----------------------|-------------|--------------|---------------------|--------------------|--------------|-----------|----------------------|-----------|--|---|--|-----------------------|---------------------|---------------|--|---|------------------------------|---------------------------|
| C) project from Pal vork in the state of | from Pal s state of | wal to Harsana Kalan including (Haryana. | connectivity to | 0 | 31-10-20 |)21 tu | 0 31 | -10-2021 | V | 13+917 1inor Brid | ge | BH-C | T | 2. | 90 m | | 10.00 m | | 707035.8 | 322 m | 3 | 122696.7 | 87 m | (+)194. | .850 m | SR- | 544_21-2 | 22 |
| La | | | uoi | | 9 | rain Size | Distribut | ion % wt | retained | | A 1 | tterberg L | imits % | | nre /cm³) | (| (_wə) | ÂU | Shear St | ength | хәр | ente | Â | 0 | Consolida | tion Para | ameters | |
| (°N AS | | | ite: | Ιος | | | San | q | G | avel | ļ | Ţ | | | (g) teid | %) | /ð) | ABJ | ; | | ouI | (₇ 559 | ilit) () | (0; | | | | u |
| (1) Corrected 1) sulaV | | Soil Description | offieerID 81 | dmy2 21 | VRID | ગાંસ | ama muibaM | Serse | əniA | 98780D | imiJ biupiJ | imiJ siterla | Plasticity x9bn1 | Shrinkage JimiJ | Bulk Density |) tnotnoD | Dry Density | no omooqe | e noisende de la conserve | Jo ə[Bu¥ (,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | ^γ φ) notion (φ) Free Swell | Tagnillaw2 | Permeab) (cm/sec | 9) oitsЯ bioV | Lressure | (cm ² /Sec) C ^A X 10-4 | (8y/zwo) z-01 x M | Compression (.C) xəbnl |
| 1 | | | ı | | , | | | , | , | - | - | | | | | - | | | | ' | ' | ı | | | | 1 | , | |
| 6 | <u> </u> | Grey, Loose, Sandy silt of low plasticity | ML-CL | | 7 | 46 4 | 9 0 | 1 | 0 | 0 | 26 | 20 | 9 | | 1 69 1 | 3.50 1 | .49 2. | 66 DS | T+ 0.2 | 23 | 1 | ı | - | | | 1 | | |
| 13 | - | I | 1 | | | | | ' | , | | , | | | | , | | | | | ' | ' | ' | | | | | | |
| , | | | G | | 19 | 71 5 | 5 4 | - | 0 | 0 | 44 | 24 | 20 | 1 | 1.91 2' | 7.10 1 | .50 2. | 70 MI | JT 0.4 | 4 | 1 | 1 | I | 0.800 | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | 7.73 5.29 3.77 3.12 | 2.14 1.88 1.24 0.74 | 0.1660 |
| 16 | | orey, very suri, sury clay or medium plasticity | | | 1 | , | | ' | 1 | ' | ı | 1 | ı | ı | ı | ı | | | | ' | I | I | 1 | ı | | ı | | |
| 12 | | <u> </u> | 1 | | | | | ' | , | | , | | , | | , | | | | | ' | ' | ' | | | | , | | |
| | | | ML-CL | | 7 | 47 3 | 6 5 | 1 | 4 | 0 | 26 | 20 | 9 | | 1.89 | 9.67 | .58 2. | 66 Dt | ST 0.2 | 1 25 | ' | ' | | | | , | , | |
| 24 | | Grey, Dense, Sandy silt of low plasticity | ı | | | | | ' | , | - | | | , | | | | | | | ' | ' | ' | | , | | , | | |
| 25 | | | ı | | ı | | | ı | 1 | 1 | 1 | 1 | ı | ı | 1 | 1 | | | | 1 | ı | ı | ı | ı | | ı | | - |
| I | | | CL | | 11 | 50 2 | 8 6 | 2 | 3 | 0 | 32 | 21 | 11 | | 1.99 24 | 4.16 1 | .60 2. | 68 UT | JT 1.0 | 3 5 | ı | ı | | , | | 1 | | |
| 32 G | G | rey, Very stiff to hard, Silty clay of low plasticity | ····· | | , | | | ' | ' | ' | ı | | , | 1 | 1 | 1 | | | | ' | 1 | ı | 1 | ı | | ı | | |
| 29 | | | CL | | 12 | 54 2. | 5 3 | 2 | 4 | 0 | 33 | 22 | 11 | 1 | 1 | 1 | | | | ' | 1 | 1 | ' | ı | , | ı | , | I. |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



| ode | 21-22 | ters | ı | (cm ^{-/Kg}) Compression (C,) | ı | ı | ' | 0.156 | ı | ı | 1 | ı | ı | ı | 1 | ı |
|---|--|--------------------|------------------|---|---|-------|-------|--|-------|-------|-------|------------------------------------|----------------|-------|-------|-------|
| Ref. (| SR-544 | Paramet | | _{z-} 01 x [^] W (395/ _z w3) | ' | ' | , | 9 2.37 89 2.37 88 1.72 0 1.16 3 0.70 | 1 | ' | ' | ' | ' | 1 | ' | ' |
| | в | olidation | - | C [^] x 10 ⁻⁴ | ' | ' | ' | 1.0 5.8 2.0 4.8 2.0 4.8 4.0 3.9 3.0 3.1 | ' | ' | ' | ' | ' | ' | ' | ' |
| R.L. | 194.471 | Conse | | Pressure | ' | ' | ' | 5 1.0-2 2.0-2 4.0-8 | ' | ' | ' | ' | ' | ' | ' | 1 |
| | (+) | | (0 | osecmo) ooid Ratio (e. | ' | ' | ' | 0.79 | ' | ' | ' | ' | ' | ' | ' | 1 |
| | 267 m | Â |) 114 | ⁻ mɔ/gʎ) idsəmnə¶ | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | 1 |
| 2 | 122602. | nre | ISS | (%) Preguing Pre | ' | ' | 1 | ' | ' | ' | ' | ' | ' | ' | ' | ' |
| ates (E, | | xəp | pu] | ('q) notional Free Swell I | ' | 1 | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' |
| Cordin | 19 m | ngth | | fo algaA | ' | 26 | ' | 4 | ' | ' | s. | ' | ' | ' | ' | ' |
| | 06910.44 | ear Stre | | O noisəhoO Cohesion C | ' | 0.0 | ' | 0.51 | ' | ' | 1.02 | ' | ' | ' | ' | ı |
| | 20 | Sh | : | ts9T to 9qVT | | DST+ | ' | UUT | - | , | UUT | ' | ' | - | , | ı |
| nation pth | 0 m | ţţ | ivb | Specific Gr | | 2.65 | | 2.71 | | | 2.68 | | | | | |
| Termi Dej | 10.0 | (_e wə | o/8) | Dry Density (| | 1.50 | | 1.51 | | | 1.60 | | | 1.60 | | ı |
| Table | |) nıç | (% | ioM IsrutsN) tnotnoD | | 12.50 | | 25.46 | | | 24.10 | | | 24.19 | | , |
| of Water | 3.10 m | (_e wə/ | /ฮิ) | Bulk Density | - | 1.69 | - | 1.89 | - | , | 1.99 | | , | 1.99 | | ı |
| Depth (| | • | | Shrinkage JimiJ | - | | - | | - | | | | | - | | ' |
| No. | CL | Limits % | | Plasticity x9bn1 | - | 5 | • | 14 | - | | 11 | | | 11 | | 11 |
| B.H. | BH | Atterberg | 1 | timiJ siterla | - | 20 | - | 24 | - | | 21 | | | 22 | | 21 |
| e tion | lge | V | 1 | himiJ biupiJ | - | 25 | - | 38 | - | | 32 | | | 33 | | 32 |
| Chainag m.)/Loca | (km.)/Location 14+072 Minor Bridge | | avel | Coarse | | 0 | • | 0 | - | | 0 | | ' | 0 | | 0 |
| (kı | (km.)/I (km.)/I 144 Minor vt retained | | G | əniA | ' | 0 | , | 0 | , | , | 4 | , | , | 5 | , | 4 |
| | 0-2021 | n % wt i | | Coarse | ' | 0 | ' | 0 | ' | ' | - | ' | ' | 1 | ' | 3 |
| oring | 31-1 | stributio | Sand | muibəM | ' | ٢ | ' | e | ' | ' | ٢ | ' | ' | 9 | ' | 7 |
| ate of Bc | to | ı Size Di | | əniA | ' | 51 | ' | 10 | ' | ' | 25 | ' | ' | 23 | ' | 21 |
| Ũ | 0-2021 | Grair | | માંડ | ' | 37 | ' | 11 | ' | ' | 52 | ' | ' | 53 | ' | 54 |
| | 31-10-2021 | | | VRID | - | 5 | - | 16 | , | , | 11 | • | 1 | 12 | • | 11 |
| esigning oital Rail | designing Drbital Rail ity to | | ю | dmy2 21 | | | | | | | | | | | | |
| ical report for desig 1 of Haryana Orbital ing connectivity to | | uoj | its | IS Classifica | ٦ | SM-SC | | CI | I | I | CL | ı | ı | CL | ı | CL |
| nvestigation, preparation of geotechnic nent in connection with construction o | nvestigation, preparation of geotechnical repo ment in connection with construction of Hary from Palwal to Harsana Kalan including conn state of Haryana. | | Soil Description | | Brownish grey, Loose, Silty sand with clay | | | Brownish grey, Very suff, Suffy clay of medium plasticity | | | | Brownish grey, Hard, Silty clay of | low plasticity | | | |
| schnical i r embank |) project ark in the | Te | (°) dS | Corrected Value (N | 1 | 6 | 15 | ' | 15 | 13 | ' | 32 | 31 | 1 | 30 | 33 |
| ting geote es and for | r (HORC) IR netwo | ənlaV | ۱J | (N) LAS pəajəsqO | ı | 5 | 10 | | 15 | 13 | | 32 | 31 | ı | 30 | 33 |
| Conduct of bridge | Corridor existing | (ɯ) " | т; | Depth from G | 00.00 | 0.50 | 1.50 | 2.25 | 3.00 | 4.50 | 5.25 | 6.00 | 7.50 | 8.25 | 9.00 | 10.00 |
| | roject | ə | d A | T əlqms2 | DS | SPT-1 | SPT-2 | UDS-1 | SPT-3 | SPT-4 | UDS-2 | SPT-5 | SPT-6 | UDS-3 | SPT-7 | SPT-8 |



| e | -22 | | Compression (.C) x9bn1 | | | ı | ı | ı | ı | ı | ı | ı | ı | ı | ı |
|---|--|--------------------|--|--------|---|--------|--------|---|---------|--------|---------|------------------------------------|----------------|---------|----------|
| kef. Cod | -544_21 | ameters | (53/ ₇ wo) 7-01 ^{x ^} W | | | | ı | ı | 1 | ı | ı | 1 | | | |
| ł | SR | tion Par | (cm ₅ /2ec) C ^a x 10-4 | ' | | | I | ı | - | | I | - | | | |
| L. | .541 m | Consolida | (kg/cm ²⁾ Pressure | | | | | | | | | | | | |
| R. | (+)194. |) | Void Ratio (e_) | , | 1 | , | I | ı | 1 | ı | I | | 1 | , | |
| | В | Â | Permeabilit (cm/sec) | , | 1 | , | ı | ı | ı | ı | ı | | 1 | , | |
| | 396.987 | enre | Swelling Press (kg/cm ²) | | | | ı | ı | 1 | 1 | ı | | | | |
| ; (E,N) | 3122 | хәр | Free Swell Inc (%) | ' | , | 1 | T | T | - | - | T | - | - | 1 | |
| rdinates | _ | h | Angle of Friction (\$°) | | 23 | | 4 | | 1 | 24 | 1 | | | | |
| Co | 38.160 n | r Strengt | Cohesion C (kg/cm²) | | 0.19 | | 0.71 | | - | 0.22 | ı | - | - | | |
| | 7066 | Shea | ts9T to 9qYT | | DST+ | , | UUT | , | , | DST | , | , | | , | , |
| nation oth | 0 m | ity | vrad sifis9q8 | | 2.66 | | 2.68 | | | 2.66 | | | | | |
| Termiı Dep | 10.00 | (_e wə) | Dry Density (g/ | | 1.48 | , | 1.55 | | , | 1.55 | | | 1.54 | , | , |
| Table | |) Inte | tsioM IsrutsN %) tnэtnoD | | 12.50 | | 20.30 | | - | 20.24 | ı | - | 20.60 | | , |
| f Water | 3.00 m | (_e wə/ | Bulk Density (g | , | 1.67 | , | 1.86 | , | , | 1.86 | ı | | 1.86 | , | , |
| Depth o | | `0 | Shrinkage Limit | | | , | ı | 1 | 1 | 1 | ı | | | , | , |
| No. | CL | Limits % | Plasticity Index | | 9 | | 11 | | | 7 | | | 7 | | |
| B.H. | BH | Atterberg | Plastic Limit | | 20 | , | 23 | | | 21 | ı | | 20 | , | |
| je tion | dge | ł | timiJ biupiJ | | 26 | ' | 34 | ' | - | 28 | 1 | - | 27 | ' | ' |
| Chainag m.)/Loca | 14+415 linor Brio | | e Coarse | ' | 0 | ' | 0 | ı | ı | 0 | ı | ' | 0 | ' | |
| (kı | 21 Cha (km.)/l 21 Mino wt retained | | ۹. P | , | 0 | , | 4 | 1 | ' | 3 | ı | ' | 2 | , | , |
| | 0-2021 | n % wt 1 | Coarse | ' | - | ' | 2 | ı | ı | 1 | I | ' | 3 | ' | |
| oring | 31-1 | stributio | Sand MuibəM | ' | 7 | ' | 7 | ' | ' | 7 | 1 | ' | 5 | ' | ' |
| ate of Bo | to | Size Di | əniA | ' | 38 | ' | 21 | ' | ' | 28 | ' | ' | 30 | ' | ' |
| D | 0-2021 | Grain | માંડ | ' | 48 | ' | 52 | ' | ' | 53 | ' | ' | 53 | ' | |
| | 31-10-2021 Grai | | Clay | | 9 | - | 14 | • | - | 8 | • | - | 7 | • | |
| esigning ottal Rail | to | | lodmy2 21 | | | | | | | | | | | | |
| l report for d Haryana Or l | connectivity | uoj | IS Classificati | | ML-CL | | CL | ı | | ML-CL | | | ML-CL | | |
| investigation, preparation of geotechnic cment in connection with construction o | îom Palwal to Harsana Kalan includinç state of Haryana. | | Soil Description | | Brown, Loose, Sandy silt of low plasticity | | | Brown, Very stiff, Silty clay of low plasticity | | | | Brown, Medium dense, Sandy silt of | low plasticity | | |
| | - <u>.</u> | | a > | | = | 10 | | 19 | 21 | | 19 | 20 | | 17 | 18 |
| echnical r embank | () project 1 ork in the | Lc | AS bailes (N) (N) aulay | | | | | | | | | | | | |
| sting geotechnical ses and for embank | or (HORC) project 1 3 IR network in the | onlaV Palue | V TAS by TAS Parts (N) Value (V,) | , , | 9 | 7 | ı | 19 | 21 | ' | 20 | 24 | 1 | 18 | 22 |
| Conducting geotechnical of bridges and for embank | Corridor (HORC) project 1 existing IR network in the | Tg Value (m) | L.Ə morî fiyad Observed SPT V (V) Orrected SF Silue (L.) | 00.0 | 0.50 6 | 1.50 7 | - 2.25 | 3.00 19 | 4.50 21 | 5.25 - | 6.00 20 | 7.50 24 | 8.25 - | 9.00 18 | 10.00 22 |



| d) | -22 | | Compression (C) x9bn1 | | | , | | | | | | | | , | |
|---|--|--------------------|---|------|-------|-------------------------------|------------------------------|------|-------|-------|------|--------------------------------------|------------|------|-------|
| tef. Cod | -544_21 | ameters | (57/ ² mo) ²⁻ 01 x ^v M | | 1 | | , | 1 | ı | ı | ı | 1 | | | |
| Я | SR | tion Par | (cm ² /Sec) C ^x x 10 ⁻⁴ | | 1 | ı | , | 1 | ı | ı | ı | ı | 1 | ı | , |
| L. | .786 m | Consolidat | ر لاقرار (لاقرار من المناقر من ال المناقب المناقب | | | - | | | | | | | | - | |
| R. | (+)193 | • | Void Ratio (e_) | | | - | | | - | | - | - | - | - | |
| | m | Â | Permeabilit (cm/sec) | | | | | | | 1 | ı | | | | |
| | 873.019 | nre | sereng Press (kg/cm²) | | , | - | , | , | ı | ı | - | - | - | - | |
| s (E,N) | 3121 | хәр | Free Swell Inc (%) | | | - | | | | | | - | - | - | |
| ordinate | u | th | Angle of Friction (\$°) | , | 1 | | 24 | , | ı | 5 | ı | 1 | 1 | | |
| C | 71.993 r | r Streng | O noisənoO (kg/cm²) | | | - | 0.19 | | - | 1.05 | - | - | - | - | |
| | 2059 | Shea | tesT to sqvT | | | | DST | | | UUT | | | | | |
| nation oth | 0 m | կն | Vrav Specific Grav | | | | 2.66 | | - | 2.67 | | | | | |
| Termii Dep | 10.0 | (_e wə) | Dry Density (g/ | | | | 1.50 | | | 1.60 | | | 1.60 | | ' |
| Table | |) Inte | tsioM IsrutsN %) tnэtnoD | , | , | - | 17.13 | , | | 24.23 | | | 24.80 | - | |
| of Water | 2.90 m | (_e wə/ | Bulk Density (g | | | | 1.76 | | | 1.99 | | | 2.00 | | |
| Depth o | | , | Shrinkage Limit | | , | - | | , | - | - | - | - | - | - | |
| .No. | -CL | Limits % | Plasticity Index | | 7 | - | 9 | | L | 11 | | - | 11 | - | |
| B.H. | BH | tterberg | timi.I siterla | | 20 | - | 20 | | 21 | 21 | | - | 22 | - | - |
| e tion | m.//Location 15+259 Ainor Bridge arse id Limit | | timi.I biupi.I | | 27 | - | 26 | | 28 | 32 | | - | 33 | - | |
| Chainag n.)/Locat | (km.)/Locatio 15+259 Minor Bridge Gravel | | Coarse | , | 0 | | 0 | , | 0 | 0 | | | 2 | | , |
| (kr | М | etained | eni ⁿ | ' | 1 | ' | 0 | ' | 1 | 4 | ' | ' | 3 | ' | |
| | 0-2021 | n % wt r | Coarse | , | 2 | , | 3 | , | 1 | 1 | , | , | 2 | , | |
| oring | 31-1 | stributio | Sand MuibəM | , | 9 | ' | 4 | ' | 5 | 9 | ' | ' | 9 | ' | ' |
| ate of Bo | to | Size Dis | eniA | ' | 32 | ' | 33 | ' | 30 | 22 | ' | ' | 26 | ' | |
| D |)-2021 | Grain | માંડ | ' | 52 | ' | 54 | ' | 55 | 56 | ı | ' | 49 | ' | , |
| | 31-10-2021 Gra | | Clay | ' | 7 | - | 9 | , | 8 | 11 | - | ' | 12 | - | , |
| esigning otal Rail | ot hodmy2 & | | lodmy2 21 | | | | | | | | | | | | |
| l report for de Haryana Orb | al report for design of Haryana Orbital I ug connectivity to | | IS Classificati | , | ML-CL | I | ML-CL | | ML-CL | CL | I | ı | CL | I | 1 |
| nvestigation, preparation of geotechnics ment in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | Brown, Loose to medium dense, | Sandy silt of low plasticity | | | | | Brown, Very stiff, Silty clay of low | plasticity | | |
| echnical i r embank | () project ork in the | Te | AS betrected SI Value (N.) | , | 16 | 17 | , | 6 | 10 | I | 33 | 28 | 1 | 27 | 35 |
| ting geoto es and for | or (HORC ; IR netwo | ənleV | V TAS bəvrəsdO (V) | ' | 6 | 12 | ' | 7 | 8 | ı | 33 | 28 | , | 27 | 35 |
| Conduc. of bridg. | L Corrido existing | (ɯ) " | I.Ə morî diqaD | 0.00 | 0.50 | 1.50 | 2.25 | 3.00 | 4.50 | 5.25 | 6.00 | 7.50 | 8.25 | 9.00 | 10.00 |
| | 2 | | dy l' siqmes | SC | T-1 | PT-2 | DS-1 | PT-3 | PT-4 | DS-2 | PT-5 | PT-6 | DS-3 | PT-7 | 9-T-8 |



| A | 22 | | Compression (,C) X9bn | | | ı | ı | ı | | ı | ı | ı | I | I | |
|---|---|-----------------------|--|-------|-------|-------|-------|-------|--------------------------------------|----------------|-------|-------|-------|-------|-------|
| tef. Code | -544_21- | ameters | (cm ² /Kg) M ^{a x} 10 ⁻² | | | ı | , | 1 | | ı | ı | ı | I | ı | ı |
| В | SR | tion Par | (cm ² /Sec) C ^x x 10-4 | | | | | | | | | | ' | 1 | |
| R.L. | 94.416 m | Consolida | (kg/cm ²⁾ Pressure | ' | ' | ı | | - | ' | ı | 1 | 1 | 1 | ı | , |
| | (+)1 | | Void Ratio (e ₀) | ' | ' | ı | ' | ' | ' | ı | ı | ı | T | I | ' |
| | 21 m | Â | Permeabilit (cm/sec) | ' | 1 | ı | 1 | 1 | 1 | ı | 1 | ı | 1 | ı | |
| (| 21764.3 | ente | Swelling Press (kg/cm ²) | ' | ' | ı | ' | ' | ' | ı | I | ı | I | I | |
| es (E,N | 31 | хәр | Free Swell Inc (%) | | | ı | ı | ' | | ı | I | ' | ' | ' | |
| ordinat | в | gth | Angle of Friction (\$°) | | ' | | 24 | | 1 | 25 | ' | ' | 26 | ' | 1 |
| С | 861.877 | ar Streng | Соћезио) (^s mɔ\g¥) | | , | | 0.18 | | | 0.20 | r | | 0.19 | ı | |
| | 50L | Shea | ts9T to 9qYT | | | | DST | - | | DST | | | DST | ı | ı |
| nation pth | 0 m | ity | vrad sifisəq8 | | | - | 2.65 | - | - | 2.66 | - | - | 2.66 | | |
| Termi De _l | 10.0 | (_e wə | Dry Density (g/ | | | | 1.50 | | | 1.58 | | | 1.60 | | ' |
| r Table | |) nre | tsioM IrrutrN %) tn9tn0D | | | | 17.54 | - | | 17.51 | | | 17.18 | ı | |
| of Wateı | 3.20 m | (_e wə/ | Bulk Density (g | , | , | | 1.76 | - | | 1.86 | 1 | | 1.87 | ı | |
| Depth | | % | Shrinkage Limit | | ' | | ' | | ' | | | ' | 1 | 1 | |
| . No. | I-CL | g Limits ^o | Plasticity Index | | 7 | , | L | | | 7 | ' | ' | 7 | ' | , |
| B.H | BH | Atterberg | Plastic Limit | | 20 | ' | 22 | | ' | 22 | ' | ' | 22 | ' | |
| je tion | lge | 7 | timiJ biupiJ | ' | 27 | | 29 | ' | ' | 29 | ' | ' | 29 | 1 | |
| Chainag (km.)/Locs 15+41/ Minor Bri | | | e Coarse | , | 0 | ı | 0 | , | ' | 0 | ı | ı | 0 | ı | |
| Chain (km.)/Lo 15+4 Minor F | | retained | S ^{9niA} | ' | - | ' | 0 | ' | ' | 1 | ' | ' | 1 | ' | ı |
| | 0-2021 | n % wt i | Coarse | ' | 2 | ' | 3 | ' | ' | 1 | ' | ' | 1 | ' | |
| oring | 31-1 | stributio | Sand muibəM | ' | 5 | ı | 5 | · | ' | 4 | ı | ı | 6 | ı | |
| ate of Bc | to | ı Size Di | əniA | ' | 32 | ı | 32 | 1 | ' | 31 | I | ı | 32 | I | |
| D |)-2021 | Grair | HIS | | 53 | | 55 | - | | 56 | ' | 1 | 51 | ı | 1 |
| | 31-1 | | Clay | | L | · | 5 | ' | | L | ' | r | 6 | ı | |
| signing tal Rail | 0 | | lodmy2 21 | | | | | | | | | | | | |
| l report for designing Haryana Orbital Rail connectivity to | | uoi | IS Classificati | 1 | ML-CL | I | ML-CL | - | ' | ML-CL | ı | ı | ML-CL | ı | , |
| nvestigation, preparation of geotechnic ment in connection with construction o | from Palwal to Harsana Kalan includin. state of Haryana. | | Soil Description | | | | | | Brown, Loose to dense, Sandy silt of | low plasticity | | | | | |
| schnical i r embankı |) project ark in the | Te | As barbeeted SI Value (N.) | 1 | 11 | 10 | I | 7 | 10 | I | 25 | 24 | I | 21 | 23 |
| ting geote ss and for | r (HORC) IR netwc | ənleV | (N) VD56FV6d SPT V | ' | 9 | 7 | ' | 9 | 6 | 1 | 33 | 32 | ' | 27 | 32 |
| Conduct of bridge | Corridor existing | (w) " | J.Ə morî diqe | 00.00 | 0.50 | 1.50 | 2.25 | 3.00 | 4.50 | 5.25 | 6.00 | 7.50 | 8.25 | 9.00 | 10.00 |
| Ductoot | | ə | qyT slqms2 | DS | SPT-1 | SPT-2 | UDS-1 | SPT-3 | SPT-4 | UDS-2 | SPT-5 | SPT-6 | UDS-3 | SPT-7 | SPT-8 |



| | 22 | | Compression Index (C _c) | ı | I | ı | ı | ı | ı | ı | 1 | ı | ī | ı | ī | ı | ı | ı | ı | ı | 1 | ı |
|--|---|-----------------------|---|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------------------------------|------------------------|-------|-------|-------|-------|-------|-------|-------|
| ef. Code | 544_21- | imeters | (Sy/zmo) 2-01 x ^W | ı | I | | | | | 1 | 1 | , | 1 | 1 | 1 | 1 | 1 | 1 | , | 1 | , | |
| К | SR- | tion Para | י (כא _ג אני) (^א ג 10-4 | ' | , | | | | | | | | , | , | ' | ' | | | | | | , |
| Ŀ | 160 m | onsolidat | (kg/cm ²⁾ | , | ı | | | | | | | | , | , | , | | | , | | | | 1 |
| R.J | (+)194. | U | (₀ 9) oitrA bioV | | ı | | | | | | | | 1 | - | - | | - | | - | - | | |
| | m | Â | Permeability (cm/sec) | 1 | ı | | | | | | | | 1 | , | | | | | | | | |
| | 1753.862 | nıç | Swelling Press (kg/cm ²) | ı | I | | | | ı | | | | | | | | | | - | | | I |
| s (E,N) | 312 | xəl | Free Swell Inc (%) | | | | | | | | | | | | | | | | | | | |
| ordinate | n | th | Angle of Friction (\$\$) | 1 | 25 | - | 6 | | | | ' | ' | ı | - | 9 | | - | | - | - | 6 | ' |
| Ŭ | 5851.853 1 | ar Streng | Cohesion C (kg/cm²) | ' | 0.10 | | 1.13 | | | | | | ' | ' | 1.38 | ' | ' | | | ' | 2.35 | ı |
| | 70: | əys | tseT to eqT | | DST | - | UUT | | | , | | | - | - | TUU | - | - | | - | - | UUT | |
| nation oth | 0 m | ţţ | Specific Grav | | 2.65 | | 2.67 | | 1 | ' | | ' | | , | 2.68 | | | | | | 2.68 | , |
| Termi De _l | 30.0 | (_e wə | Dry Density (g/o | 1 | 1.45 | | 1.61 | | 1.62 | | 1.61 | | 1.60 | · | 1.62 | | 1.62 | | 1.63 | ı | 1.68 | ' |
| . Table | |) n.c | ttsioM IsturaN (%) tnotnoO | | 13.10 | - | 23.68 | | 23.60 | , | 23.62 | | 23.70 | - | 23.16 | - | 22.90 | , | 22.41 | - | 21.10 | |
| of Water | 3.00 m | (_e wə, | Bulk Density (g/ | ' | 1.64 | - | 1.99 | | 2.00 | | 1.99 | | 1.98 | - | 2.00 | - | 1.99 | | 2.00 | - | 2.03 | , |
| Depth | | % | Shrinkage Limit | 1 | ı | - | | | | | | | - | - | - | - | - | , | - | - | | |
| l. No. | I-A1 | g Limits ⁹ | Plasticity Index | ' | 5 | | 10 | | Π | , | 11 | | 11 | | 11 | | 11 | | 11 | | 11 | |
| B.H | BF | Atterberg | Plastic Limit | ' | 20 | | 20 | , | 22 | , | 21 | , | 22 | , | 23 | , | 20 | , | 20 | , | 22 | |
| ge ation | 1 idge | | timiJ biupiJ | ' | 25 | | 30 | ' | 33 | ' | 32 | ' | 33 | ' | 34 | ' | 31 | ' | 31 | ' | 33 | |
| Chaina; cm.)/Loc: | 15+44 Major Bri | | Coarse Coarse | ' | 0 | | - | ' | 0 | ' | 2 | | 0 | ' | 0 | | 0 | , | 0 | ' | 0 | |
| Ð | | retained | Fine O | ' | 0 | ' | 5 | ' | 5 | ' | 4 | ' | 5 | ' | L | ' | 9 | ' | 9 | ' | 6 | |
| | 11-2021 | on % wt | Coarse | 1 | 1 | | ŝ | ' | - | ' | 1 | ' | 3 | ' | 2 | | 3 | ' | 1 | ' | 1 | |
| 3 oring | 11- | Distributi | ∑ muib9M | ' | 6 | ' | 7 | ' | 5 | ' | 9 | ' | 8 | ' | 9 | ' | L | ' | L | ' | 9 | |
| Date of F | to | in Size I | eniA | ' | 51 | ' | 28 | ' | 26 | ' | 30 | ' | 28 | ' | 24 | ' | 30 | ' | 28 | ' | 26 | • |
| | -11-2021 | Gra | HIS | ' | 37 | ' | 46 | ' | 51 | ' | 46 | ' | 44 | ' | 48 | ' | 43 | ' | 47 | ' | 46 | • |
| of | ng 10 | | Clay | - 10 | 5 | - 17 | 10 | | 12 | 1 | 11 | | 12 | , | 13 | | 11 | 1 | 11 | | 12 | |
| designing ital Rail | ty to existi | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| l report for aryana Orb | connectivi | uo | IS Classificati | I | SM-S0 | ı | C | ı | C | ı | CL | ı | CL | I | CL | I | CL | I | CL | ı | CL | 1 |
| tigation, preparation of geotechnics to connection with construction of H | Palwal to Harsana Kalan including ana. | | Soil Description | | rown, Loose, Silty sand with clay | | | | | | | | | Brown, Hard, Silty clay of low | plasticity with gravel | | | | | | | |
| nical inves unkment ir | oject fron te of Hary | J | Corrected SP (₅ N) sulue (_N ,) | , | н - | 9 | | 36 | | 39 | | 33 | ı | 28 | , | 42 | | 41 | | 45 | | 72 |
| g geotechr. I for emba | HORC) pr | anis. | (N) (V) | ' | ' | 5 | | 36 | | 39 | | 33 | , | 28 | , | 42 | | 41 | | 45 | | 72 |
| Conducting ridges and | Corridor (F R network | (m) . | Depth from G.L | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 |
| | | ə | qvT əlqms2 | DS-1 | 1-SQU | SPT-1 | UDS-2 | SPT-2 | UDS-3 | SPT-3 | UDS-4 | SPT-4 | 0DS-5 | SPT-5 | 9-SQU | SPT-6 | 1-SQU | SPT-7 | NDS-8 | SPT-8 | 6-SQU | SPT-9 |



| | 6 | | | (°C) xəpul | | | ı |
|---|-----------------------------------|--------------------|----------------|---|---------|---|------|
| Code | 4_21-2 | eters | | (3X/ ² mo) | | | |
| Ref. | SR-54 | Param | | _{z-} 01 x [^] W (ɔəS/,_wɔ) | | | |
| | | dation | | C^ x 10-4 | ' | ' | ' |
| R.L. | 94.160 m | Consoli | | (kg/em ^{z)} | ' | 1 | ı |
| | (+)1 | | (⁰ | 9) oita Ratio (e | ' | | · |
| | Ш | Â | ;) Iit | Permeabi 998/m9) | | | |
| | 753.862 | əans | ;) ssa | ⁵ mə\gay) ² mə\gay | | | I |
| E,N) | 31217 | van | | (%) (%) | | | ı |
| inates (| | Tob | (| Friction (9°) | | | |
| Cord | 53 m | ength | | 10 əlznA) | | | |
| | 15851.8 | ear Str | | O noisentoD | ' | ' | ' |
| | 70 | She | 1 | isəT to əqvT | | ' | ı |
| ation th | Ш | ŢţŢ | лв | Specific Gr | | | |
| Termin Dept | 30.00 | (_e wə | / d) | Dry Density (| | - | , |
| Fable | |) nre | tsi % | oM lærutæN) tnэtnoD | | | |
| Water 7 | .00 m | (_e wə/ | B) | Bulk Density | | - | |
| Depth of | 3 | | | Shrinkage timiJ | | | ı |
| lo. | Γ | imits % | | Plasticity Tabul | 10 | | ı |
| B.H. N | BH-A | tterberg L | 1 | imiJ siterIA | 20 | - | |
| u | 0 | At | J | imiJ biupiJ | 30 | 1 | ı |
| lainage /Locatio | 5+441 or Bridge | | el | Coarse | 0 | | ı |
| Ch (km.) | 1 Maj | tained | Grav | eniA | 10 | | |
| | 2021 | % wt re | | Coarse | 5 | ı | I |
| ng | 11-11- | ibution ' | Sand | muibəM | 4 | | , |
| of Bori | to | ize Distr | | eniA | 30 | 1 | ı |
| Date | 021 | Grain Si | | માંડ | 41 | , | , |
| | 10-11-2 | | | Clay | 10 | 1 | ı |
| ning of ail | sxisting | | 10 | dmy2 21 | | | |
| ort for desig a Orbital R | ectivity to e | uoj | ite | officersID ZI | CL | | |
| otechnical repc tion of Haryan | including conn | | | | | of low el | |
| tigation, preparation of ge connection with construc | l Palwal to Harsana Kalan ana. | | | Soil Descriptio | | Brown, Hard, Silty clay plasticity with grav | |
| ical inves ıkment ir | ject fron e of Hary | - | (°) | V) sulsV | 77 | 100 7cm) | , |
| geotechni îor embar | ORC) pro n the stat | Lc əniv A | 15 | (N) | 77 | 100 (7cm) (2 | , |
| nducting { lges and f | rridor (H(network ii | (m) | 1.3 | O mort dtgga 79 hours of Con | 8.00 | 9.50 (2 | 9.95 |
| Co brid | | ə | đ٨ | T əlqms2 | YT-10 2 | 7-11 2 |)S-2 |
| | - | 1 | | | SP | зP | Ц |



| е | -22 | | Compression (.C) x9bnl | | | 0.166 | T | ı | ı | ı | ı | ı | ı | ı | T | ı | ı | ı. | ī | ı | ı | |
|---|--|--------------------|--|------|-------|---|-------|-------|-------|-------|-------|-------|-------|-------|--|-------|-------|-------|-------|-------|-------|-------|
| Ref. Cod | R-544_21 | rameters | (cm ² /Kg) M _{v x} 10 ⁻² | ı | 1 | 2.03 1.82 1.16 0.74 | I | I | I | - | - | - | - | - | I | I | ı | I | I | - | - | , |
| [| SF | tion Pa | (cw ₅ /Zec) C ^{^ x} 10-4 | | | 8.54 6.28 4.71 4.14 | - | ı | T | - | - | - | - | - | T | | · | - | ī | - | - | |
| .L. | 3.216 m | Consolida | (kg/cm ²⁾ | | | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | 1 | | ı | - | - | - | - | | ' | ı | | | ī | - | - | |
| Я | (+)19; | | Void Ratio (e ₀) | | | 0.795 | 1 | , | | | | | | | | ' | | | ı. | | | |
| | 4 m | Â | Permeabilit (cm/sec) | ' | | 1 | I | I | ı | - | - | - | - | - | T | I | | ı | I | - | - | |
| | 1739.33 | nıç | Swelling Press (kg/cm ²) | | , | | I | T | ı | - | - | - | - | - | T | ı | r | ı. | ī | - | - | |
| s (E,N) | 312 | xəp | Free Swell Inc (%) | | | | | | | | | | | | , | ' | | | , | | | |
| ordinate | m | ţth | Angle of Friction (\$) | , | | 4 | I | 5 | I | 4 | - | 5 | | ı | ı | I | ı | 5 | ī | | ı | |
| Č | 838.108 | ar Streng | Соћезио) Сијезио) | | | 0.39 | T | 0.85 | ı | 1.19 | - | 1.36 | - | - | T | ı | - | 1.79 | I | - | - | |
| | 705 | She | tsoT to oqYT | | | UUT | | UUT | | UUT | | UUT | | | | ' | | UUT | | | | |
| nation oth | 0 m | ţţ | лвад Specific Grav | | | 2.68 | - | 2.68 | - | 2.67 | - | 2.68 | | - | - | - | - | 2.68 | | - | | |
| Termi Dej | 30.0 | (_e wə | Dry Density (g/ | | | 1.49 | | 1.58 | | 1.61 | - | 1.62 | - | 1.62 | | 1.62 | | 1.64 | | 1.65 | | 1.65 |
| Table | |) nı.c | tsioM IsrutsN %) tnotnoD | | | 15.43 | I | 24.81 | ı | 23.60 | | 23.16 | | 23.19 | I | 22.96 | | 22.40 | ı | 22.73 | | 21.97 |
| f Water | 3.10 m | (_e wə/ | Bulk Density (g/ | | | 1.72 | | 1.97 | | 1.99 | | 2.00 | | 2.00 | 1 | 1.99 | | 2.01 | ī | 2.03 | | 2.01 |
| Depth o | | | Shrinkage Limit | , | | 1 | ı | ı | ı | | | | | | ı | ı | 1 | 1 | ı | | | , |
| No. | A2 | Limits % | Plasticity Index | | | 11 | ı | 11 | ı | 11 | | 11 | | 11 | ı | 11 | ı | 11 | ı | 11 | | 11 |
| B.H. | BH- | Atterberg | Plastic Limit | | | 22 | ı | 23 | | 22 | - | 21 | - | 22 | 1 | 23 | | 20 | ı | 21 | - | 22 |
| ion | ge | V | timiJ biupiJ | | ' | 33 | - | 34 | - | 33 | | 32 | | 33 | - | 34 | - | 31 | ī | 32 | | 33 |
| Chainage 1.)/Locat | 15+441 ajor Brid | | Coarse | | | 0 | - | 1 | - | 0 | - | 0 | | 0 | - | 1 | - | 0 | ī | 0 | | 0 |
| ия)) | W | etained | Rine B | | | 1 | 1 | 3 | ı | 4 | - | 5 | - | L | 1 | 5 | | 6 | ı | 9 | - | 7 |
| | -2021 | 1 % wt r | Coarse | | | 1 | I | 1 | ı | 2 | - | 1 | - | 5 | I | 1 | ı | 4 | ı | 1 | - | 1 |
| ing | 11-11 | tribution | Sand Medium | ' | ' | 5 | T | 5 | ı | 9 | | 9 | ' | 3 | I | 5 | ı | 3 | I | 9 | | 7 |
| te of Bor | to | Size Dist | əniA | , | | 13 | I | 15 | ı | 18 | | 20 | | 17 | I | 14 | ı | 16 | ı | 15 | | 20 |
| Da | -2021 | Grain | માંડ | ' | ' | 68 | I | 61 | ı | 57 | ' | 57 | ' | 56 | ı | 61 | ' | 60 | ı | 09 | ' | 53 |
| | 10-1] | | Clay | ' | | 12 | ' | 14 | ' | 13 | | 11 | ' | 12 | ' | 13 | 1 | 11 | 1 | 12 | | 12 |
| signing of Rail | o existing | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| eport for des ana Orbital | nnectivity to | uoj | IS Classificati | | , | CL | ı | CL | ı | CL | · | CL | , | CL | ı | CL | ı | CL | ı | CL | ı | CL |
| vestigation, preparation of geotechnical I the in connection with construction of Harr | om Palwal to Harsana Kalan including co aryana. | | Soil Description | | | Brown, Stiff, Sulty clay of low plasticity | | | | | | | | | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | | | | | | | |
| chnical ir nbankmer |) project fi state of F. | Te | Corrected SP Value (N.) | , | 10 | , | 12 | ı | 25 | , | 35 | , | 39 | ı | 43 | ı | 42 | ' | 52 | , | 56 | |
| ting geoter and for en | r (HORC) ork in the | ənleV | V TAS bəvrəsdO (N) | ' | 10 | ı | 12 | ı | 25 | ' | 35 | ' | 39 | ' | 43 | ı | 42 | ı | 52 | ' | 56 | , |
| Conduct bridges a | Corridoi IR netwo | (w) " | J.Ə morî diqe | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 |
| Duction | rrojec | ə | qvT slqms2 | DS | SPT-1 | I-SQU | SPT-2 | UDS-2 | SPT-3 | UDS-3 | SPT-4 | UDS-4 | SPT-5 | S-SQU | SPT-6 | 9-SCI | SPT-7 | 1-SQU | SPT-8 | 8-SQU | 6-TqS | 6-SQU |



| | 2 | | I | Compression (,C) xəbnl | | | ı |
|---|--|--------------------|----------------|---|--------|--|-------|
| . Code | 14_21-2 | neters | | (gX/ ² mo) | | | |
| Ref | SR-54 | ı Paran | | (0) x M (0) x M (0) x M | | | |
| | с. | lidatior | | С ^л х 10- ₄ | | | |
| 8.L. | 3.216 n | Conso | | Pressure | ' | ' | I |
| Ι | (+)19 | | (⁰ | 9) oita Ratio V | | | ı |
| | h m | Â | ;) Iit | Permeabi 998/m9) | - | - | · |
| | 739.334 | enre | (ssa | ora gnillow2 ^r mo\gx) | | | |
| (E,N) | 3121 | хәр | u | [[]%8 []%) [] [] [] [] [] [] [] [] [] [] [] [] [] [| - | - | ı |
| dinates | | _ | (| Angle of (°q) (q°) | | | |
| Cor | 3.108 m | Strengtl | | (_z wɔ/ธิงุ) | | | |
| | 705838 | Shear S | | | | | |
| | | | 1 | is9T to 9avT | | ' | ' |
| nation pth | 0 m | ŢţŢ | лв | Specific Gr | • | - | |
| Termi De _l | 30.0 | (_e wə) | / d) | Dry Density (| | 1.66 | I |
| r Table | |) m.e | dzi | oM latural Mo) tnotno) | - | 22.03 | I |
| of Water | 3.10 m | (_e wə/ | 5) | Bulk Density | - | 2.03 | · |
| Depth o | | | | Shrinkage Jimit | | ı | , |
| No. | A2 | Limits % | | Plasticity Vabal | | 11 | , |
| В.Н. | BH- | tterberg | 1 | imiJ otterlA | - | 23 | ' |
| ion | ge | Α | ļ | imiJ biupiJ | | 34 | I |
| hainage .)/Locati | 15+441 jor Bridį | | vel | Coarse | - | 0 | |
| C (km | Ma | etained | Gra | aniA | - | 8 | I |
| | -2021 | % wt r | | Coarse | | 3 | |
| ing | 11-11 | ribution | Sand | muibəM | | 4 | ı |
| te of Bor | to | Size Dist | | əniA | - | 17 | ı |
| Dat | -2021 | Grain | | માંડ | | 55 | , |
| | 10-11 | | | Val D | | 13 | |
| igning of Rail |) existing | | 10 | dmy2 SI | | | |
| eport for des ana Orbital | onnectivity t | uoj | jr | officeral SI | ı | CL | ı |
| nvestigation, preparation of geotechnical and in connection with construction of Har. | from Palwal to Harsana Kalan including c Haryana. | | | Soil Description | | Brown, Very stiff to hard, Silty clay of low plasticity with gravel | |
| chnical ir ıbankmeı | project f state of F | Le | (°N IS | Corrected Value (P | 55 | 1 | ' |
| ing geoter nd for en | (HORC) rrk in the | ənlaV | J | (N) (V) | 55 | ı | |
| Conducti bridges a | Corridor IR netwo | (ɯ) " | Ľ | D mort dtgaD | 28.00 | 29.50 | 30.00 |
| Ducion | mafarr | ə | đ٨ | T slqms2 | SPT-10 | UDS-10 | ı |



| | 22 | | Compression (.C) x9bnl | | | | | ı | | | 1 | | ı | | | ı | ī | | | | | |
|---|---|--------------------|--|------|------|-------|--------|---|-------|---------------|------|-------|-------|--|-------|-------|--------|---------|--|-------|---------|----------|
| tef. Code | -544_21- | ameters | (The second seco | | | | | | | | | | 1 | | | | ı | | | | | |
| R | SR | ttion Par | (cm ² /Sec) C ^A x 10-4 | , | 1 | | | | , | , | ı | | ı | , | 1 | | ı | 1 | , | 1 | , | , |
| .L. | 1.075 m | Consolida | (kg/cm ²⁾ | - | | | | | | | - | | - | | - | - | T | | | - | | |
| R | (+)194 | | Void Ratio (e_) | - | | | | ı | | - | - | - | - | - | - | - | - | | | - | | |
| | 4 m | Â | Permeabilit; (cm/sec) | | 1 | , | | , | , | - | - | | 1 | - | - | - | - | - | , | - | , | , |
| | 21279.06 | ane | Swelling Press Swelling Press | ı | , | , | , | ı | , | , | ı | , | ı | , | ı | 1 | I | , | , | ı | , | |
| es (E,N) | 312 | xəp | Free Swell Inc (%) | ' | ' | ' | ' | ı | ' | ' | ı | ' | 1 | ' | ' | ' | I | ' | ' | ' | ' | , |
| Cordinat | ш | gth | Angle of (°°) | ' | ' | 26 | ' | ' | 27 | ' | ' | ' | ' | 24 | ' | 5 | 1 | 4 | ' | 4 | ' | 4 |
| 0 |)5482.626 | ear Stren | O noisənoO (^s mə/gy) | ' | ' | 0.10 | , | ' | 0.11 | ' | ' | ' | ' | 0.20 | ' | 1.06 | ' | 1.23 | , | 1.40 | ' | 2.74 |
| | 70 | Sho | Type of Test | , | , | DST | , | , | DST+ | , | ' | | ' | DST | , | UUT | ı | UUT | , | UUT | , | UUT |
| ination pth | 00 m | ity | vraD offiogR | | | 2.65 | | ' | 2.65 | ' | ' | ' | ' | 2.66 | ' | 2.68 | | 2.67 | | 2.68 | ' | 2.68 |
| Termi De | 30.(| (_e wə | Dry Density (g/d | | | 1.50 | | , | 1.53 | , | , | | 1 | 1.54 | , | 1.60 | ı | 1.61 | | 1.62 | | 1.69 |
| r Table | |) nıç | tsioM IstutsN (%) tn9tn0D | - | | 14.16 | | ı | 16.00 | | - | | - | 20.86 | - | 23.84 | T | 23.54 | | 23.41 | | 20.86 |
| of Wateı | 3.65 m | (_e wə/ | Bulk Density (g/ | - | | 1.71 | | | 1.77 | - | - | - | - | 1.86 | - | 1.98 | - | 1.99 | | 2.00 | | 2.04 |
| Depth | | % | Shrinkage Limit | - | | | | 1 | | ' | 1 | | 1 | ' | - | | ı | | | - | | |
| . No. | -A1 | Limits 9 | Plasticity Index | | ' | 5 | ' | ı | 5 | ' | 1 | 5 | 9 | 9 | | 10 | I | 11 | | 11 | ' | 11 |
| B.H | BH | Atterberg | Plastic Limit | ' | ' | 20 | ' | ı | 21 | ' | ' | 20 | 20 | 21 | ' | 20 | ı | 22 | ' | 21 | ' | 23 |
| je tion | lge | ł | timiJ biupiJ | - | ' | 25 | | | 26 | ' | ' | 25 | 26 | 27 | - | 30 | 1 | 33 | | 32 | ' | 34 |
| Chainag m.)/Loca | 16+042 Aajor Brio | | a Coarse | , | , | 0 | , | ı | 0 | , | ' | 0 | 1 | 0 | , | 0 | I | 0 | , | 1 | , | 0 |
| (k | Ν | retained | Q 9niT | ' | ' | - | ' | ' | 2 | ' | ' | 2 | 2 | 3 | ' | 4 | ' | 5 | ' | 5 | ' | 7 |
| | 0-2021 | n % wt | Coarse | ' | ' | ŝ | , | ı | 2 | ' | ı | 2 | 1 | 3 | ' | 1 | I | 1 | ' | 1 | ' | 3 |
| oring | 09-1 | stributio | S muibəM | ' | ' | 2 | ' | ' | 3 | ' | ' | 5 | 5 | 4 | ' | 2 | ı | 3 | ' | 4 | ' | 5 |
| ate of B | to | n Size Di | Fine | ' | ' | 54 | ' | ' | 50 | ' | ' | 64 | 31 | 25 | ' | 24 | 1 | 21 | ' | 23 | ' | 24 |
| D | 0-2021 | Grai | માંડ | ' | ' | 35 | ' | ' | 37 | ' | ' | 23 | 54 | 58 | ' | 59 | ' | 58 | ' | 55 | ' | 49 |
| | -80 | | Clay | - | 1 | 5 | | | 9 | - | - | 4 | 9 | 7 | - | 10 | - | 12 | • | 11 | , | 12 |
| designing tbital Rail | y to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| l report for Haryana Oi | connectivit | uo | IS Classificati | , | | SM-SC | | | SM-SC | I | T | SM-SC | ML-CL | ML-CL | ı | CL | ı | CL | | CL | , | CL |
| investigation, preparation of geotechnic cment in connection with construction o | from Palwal to Harsana Kalan including s state of Haryana. | | Soil Description | | | | | Brown, Loose to medium dense, Silty sand with clay | | | | | | Brown, Medium dense, Sandy silt of low plasticity | | | | | Brown yellowish, Hard, Silty clay of low plasticity with gravel | | | |
| technical br embanl | C) project vork in the | Te | Corrected SP Value (N.) | ı | 13 | | 13 | | 17 | 20 | ı | 17 | 19 | ı | 17 | ı | 31 | ı | 36 | , | 42 | |
| cting geo ges and fi | lor (HOR(g IR netw | ənlæ | (N) V TAS bəvrəsdO | ' | 8 | | 11 | | 16 | 22 | ' | 18 |) 22 | - |) 21 | - | 31 | - | 1 36 | - | 1 42 | ' |
| Condu of brid | orrid xistin | (ໝ) " | L.Ə morî diqaD | 0.00 | 1.00 | 2.25 | 4.00 | 5.50 | 6.00 | 7.00 | 8.50 | 9.00 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | . 17.50 | 19.00 | 20.50 | 0 22.00 | 5 23.50 |
| , | 5 8 | | | | - | - | \sim | м. | ~ | ~+ | * | 10 | · C | 5 | ~ | ŝ | \sim | 4 | <u> </u> | ŝ | - | . |



| | - | | | | | | | | |
|--|---|--------------------|------------------------|--|----------|----------|--|----------|---------|
| a | -22 | | u | oissərqmoD (,D) xəbnl | | T | ı | r | I |
| tef. Cod | -544_21 | ameters | | (cm ² /Kg) M ^{x x} 10 ⁻² | ı | ı | I | ı | |
| F | SR | tion Par | | (cm ^{2/S} ec) C ^{^ x} 10-4 | ı. | ı | T | 1 | ı |
| .Т. | .075 m | Consolida | | (kg/cm ^{z)} | | - | ı | | ı |
| R | (+)194 | | (⁰ ĉ |) oitsA bioV | - | - | - | - | I |
| | 4 m | Â | ilit () | Permeab Permeab | T | - | I | T | I |
| | 1279.06 | nre | (₇ 559. | r¶ gnilləw2 mə\g¥) | ı | 1 | ı | ı | ı |
| es (E,N) | 312 | xəp | oul | lləw2 sər7 (%) | T | - | T | - | |
| ordinate | m | gth | (, | fo slgnA Pφ) noitsirA | 1 | 1 | ı | 1 | ı |
| С | 5482.626 | ar Streng | ĥ | Cohesion C (² mɔ/gx) | | ' | | | |
| | 70. | She | 1 | es to sqyT | | 1 | ı | | I |
| ination pth | 00 m | ţţ | VB'I | aD officode | , | ' | , | ' | |
| Termi De _l | 30.(| (_e wə | /ð) | Dry Density | ' | ' | ' | ' | ' |
| . Table | |) n.c | tsia %) | Matural MC Content | - | - | - | - | ı |
| of Water | 3.65 m | (_ք աշ/ | ති) | Bulk Density | | - | ı | | ı |
| Depth | | % | | Shrinkage Jimit | | | ı | | ı |
| . No. | [-A1 | Limits | | Plasticity Index | ' | 11 | ' | 11 | ' |
| B.H | BH | Atterberg | j | imiJ siterIf | ' | 22 | ' | 20 | , |
| ge ition | dge | 7 | ti | тіл binpiЛ | 1 | 33 | ı | 31 | I |
| Chainag m.)/Loca | 16+042 Aajor Bri | | ravel | Soarse | ' | 1 | ' | 0 | ' |
| (k | V | retained | 5 | əniA | ' | 8 | ' | 11 | ' |
| | 0-2021 | n % wt | | Soarse | ' | 4 | ' | 2 | ' |
| ring | 09-1 | stributio | Sand | muibəM | ' | 7 | ' | 4 | ' |
| ate of Bo | to | ı Size Di | | əniA | ' | 21 | ' | 20 | , |
| D | 0-2021 | Grain | | માંડ | ' | 48 | ' | 53 | ı |
| | 08-1 | | | VrIJ) | • | 11 | • | 10 | • |
| designing bital Rail | ly to | | lod | Imy2 21 | | | | | |
| ll report for f Haryana O | connectivit | uoj | ite: | offieerID 21 | ı | CL | | CL | • |
| investigation, preparation of geotechnic kment in connection with construction o | t from Palwal to Harsana Kalan includin. e state of Haryana. | | | Soil Description | | | Brown yellowish, Hard, Silty clay of low plasticity with gravel | | |
| stechnical or emban | C) project vork in th | Te | (°N IS | Corrected Value (1 | 57 | 86 | 88 | 89 | |
| ucting geo lges and fi | dor (HOR) 1g IR netv | ənla\ | T | (N) Opserved SP | 0 57 | 0 86 | 0 88 | 0 89 | - 2 |
| Condt of brid | existir | (ɯ) " | 1.5 | Depth from (| 11 25.00 | 12 26.50 | 13 28.00 | 14 29.50 | 2 29.9: |
| Ducio | I I O I | ə | đ٨ | l əlqms2 | SPT-1 | SPT-1 | SPT-J | SPT-1 | DS-2 |



| ode | 21-22 | srs | Compression Compression (C) x9bnl | 1 | , | ı | 1 | , | ı | I | I | I | ı | ı | 1 | 0.1030 | 1 | , | 1 | ı | I | |
|---|---|-----------------------|---|------|--------|-------|---|-------|--------|-------|-------|---------|--|---------|-------|---|---------|---------|--|---------|-------|---------|
| Ref. Co | R-544_2 | aramete | (cm ² /Kg) | ' | | ' | ' | ' | ' | ' | ' | 1 | ' | ' | ' | $ \begin{array}{c} 1.84 \\ 1.18 \\ 0.88 \\ 0.49 \end{array} $ | ' | ' | ' | ' | ı | ' |
| | S | ation P | (cm ² /Sec) C ^{x x} 10-4 | ' | | ' | ' | ' | ' | ' | ' | ı | ' | ' | | 9.46 6.91 6.14 5.01 | ' | | ' | ' | ı | ' |
| R.L. | 04.105 m | Consolid | (kg/cm ²⁾ Pressure | ' | | , | ' | | , | , | 1 | ı | , | , | | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | ' | | , | , | I | ' |
| | (+)19 | | (₀ 9) oitsA bioV | ' | ı | , | ' | , | | , | , | , | | ' | , | 0.650 | ' | | , | , | I | , |
| | ł5 m | Â | Permeabilit; (cm/sec) | ' | | ' | ' | ' | ' | ' | ' | 1 | ' | ' | ' | 1 | | ' | ' | ' | , | |
| | 21262.04 | nıç | sera guillaw <i>2</i> Swelling Press | ' | , | ' | ' | ' | ' | ı | ı | ı | ' | ' | ' | , | ' | ' | ' | ' | I | , |
| es (E,N) | 312 | xəp | Free Swell Inc (%) | ' | ' | ' | ' | ' | ' | ' | 1 | 1 | ' | ' | , | , | ' | , | ' | ' | T | , |
| ordinat | ш | gth | Angle of Friction (\$°) | ' | 25 | ' | 26 | ' | ' | ' | 1 | 4 | ' | ' | , | 4 | ' | 5 | ' | 4 | I | 4 |
| С | 5472.020 | ear Stren |) noisəh0) (kg/cm²) | | 0.11 | | 0.12 | ' | | ' | 1 | 0.85 | | | , | 1.40 | ' | 1.83 | , | 1.98 | I | 2.50 |
| | 70 | She | tsoT to of Test | ' | DST | | DST | | ' | ' | ' | UUT | ' | | , | UUT | ' | UUT | | UUT | ' | UUT |
| nation pth | 00 m | ţţ | Specific Grav | | 2.65 | | 2.65 | | | | ' | 2.68 | | | | 2.67 | | 2.68 | | 2.68 | I | 2.67 |
| Term | 30.(| (_e wə | Dry Density (g/ | | 1.50 | | 1.53 | | 1.53 | | | 1.58 | | 1.58 | | 1.62 | | 1.65 | | 1.66 | | 1.69 |
| · Table | |) n.c | tsioM IrrutrN %) tnotnoO | - | 12.76 | | 14.26 | | 14.80 | - | - | 24.30 | - | 23.88 | | 22.70 | - | 22.40 | , | 21.89 | I | 20.79 |
| of Wateı | 3.68 m | (_e wə/ | Bulk Density (g/ | - | 1.69 | | 1.75 | | 1.76 | - | - | 1.96 | - | 1.96 | | 1.99 | - | 2.02 | | 2.02 | - | 2.04 |
| Depth | | % | Shrinkage Limit | - | | , | - | , | - | - | ' | | - | - | , | 1 | - | , | , | - | I | 1 |
| . No. | I-A2 | g Limits ⁹ | Plasticity Index | | 5 | | 5 | | 5 | 9 | ' | 11 | | 11 | , | 11 | | 11 | | 11 | | 11 |
| B.H | BH | Atterberg | Plastic Limit | | 20 | | 20 | | 21 | 19 | ' | 22 | | 21 | , | 23 | | 22 | | 21 | | 23 |
| ge ition | dge | - | timiJ biupiJ | ' | 25 | , | 25 | ' | 26 | 25 | ' | 33 | , | 32 | , | 34 | , | 33 | , | 32 | ı | 34 |
| Chainag m.)/Loca | 16+042 Major Bri | | ra Coarse Coarse | ' | 0 | ' | 0 | ' | 0 | 0 | ' | 0 | ' | 0 | ' | 0 | ' | 0 | ' | 2 | 1 | 0 |
| (k | 4 | retained | G | ' | 0 | ' | 0 | ' | 1 | 0 | ı | 1 | ' | 2 | ' | 5 | ' | 7 | ' | 9 | I | 6 |
| | 10-2021 | 0n % wt | Соягsе | ' | - | , | 3 | ' | 2 | 1 | ' | 4 | , | 5 | ' | 1 | , | 2 | , | 3 | 1 | 2 |
| oring | -60 | istributi | an MaripaM | ' | 5 | ' | L | ' | 8 | 5 | ' | 3 | ' | 3 | ' | 4 | ' | 3 | ' | 5 | ' | 7 |
| Date of F | to | in Size D | Fine | ' | 55 | ' | 44 | ' | 40 | 58 | 1 | 20 | ' | 18 | ' | 18 | ' | 20 | ' | 17 | I | 19 |
| | 10-2021 | Gra | HIS | ' | 34 | ' | 43 | ' | 45 | 32 | ' | 60 | ' | 61 | ' | 59 | ' | 56 | ' | 55 | | 50 |
| | 08 | | Clay | - | 5 | - | 3 | - | 4 | 4 | | 12 | | 11 | , | 13 | | 12 | , | 12 | - | 13 |
| designing rbital Rai | ty to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| ll report for Haryana O | connectivi | uoj | IS Classificati | | SM-SC | ' | SM-SC | | SM-SC | SM-SC | 1 | CL | | CL | | CL | | CL | | CL | | CL |
| investigation, preparation of geotechnic kment in connection with construction o | from Palwal to Harsana Kalan includin; s state of Haryana. | | Soil Description | | | | Brown, Loose to medium dense, Silty sand with clay | | | | | | Brown yellowish, Very stiff to hard, Silty clay of low plasticity | | | | | | Brown yellowish, Hard, Silty clay of low plasticity with gravel | | | |
| technical or embanl | C) project /ork in th | Te | Corrected SP Value (N.) | , | | 12 | , | 17 | , | 18 | 25 | ı | 20 | , | 27 | ı | 42 | , | 56 | , | 62 | , |
| cting geoi ges and fc | or (HOR(g IR netw | ənlaV | V TAS bəvrəsdO (V) | ' | | 6 | ' | 16 | ' | 19 | 33 | 1 | 20 | 1 | 27 | 1 | 42 | 1 | 56 | 1 | 62 | , |
| Condue of bridg | Corride existing | (w) " | J.Ə morî diqəD | 0.00 | 1 1.00 | 2.50 | 2 4.00 | 5.50 | 3 7.00 | 7.50 | 8.50 | 4 10.00 | 11.50 | 5 13.00 | 14.50 | 5 16.00 | , 17.50 | 7 19.00 | 20.50 | 3 22.00 | 23.50 |) 25.00 |
| Draiar | | ə | qvT əlqms2 | DS-1 | UDS-1 | SPT-1 | C-SQU | SPT-2 | UDS-S | SPT-3 | SPT-4 | UDS-∠ | SPT-5 | ;-SQU | SPT-6 |)-SQU | 2-T-7 | C-SQU | SPT-8 | -SQU | SPT-9 | 5-SQU |



| le | -22 | 8 | τ | Compression (C) Xobrion | | - | ı | ı |
|--|---|---------------------------------|-----------|---|--------|--------------------------------------|----------------------------|-------|
| tef. Cod | -544_21 | ameter | | (دس ₂ /یره) M ^{^ x} ا0 ₋₂ | | | | |
| H | SR | tion Par | | (cw ₅ /Zec) C ^{a x} 10-4 | ı | I | I | ı |
| L. | .105 m | Consolida | | (kg/cm ²⁾ | | 1 | ı | |
| R | (+)194 | • | (0 | e) oitsA bioV | | T | ı | , |
| | 5 m | Â | jit (| idsəmrə¶ 998/m9) | 1 | ı | ı | ı |
| | 1262.04 | nı.e | (ssa | Prelling Pre mə\gy) | - | - | T | |
| s (E,N) | 312 | xəp | ouj | Free Swell] Free Swell] | | I | I | ı. |
| rdinate | υ | łł. | (| Angle of Friction (\$ | 1 | I | I | I |
| C | 472.020 n | ar Strengt | | O noisəhoO (kg/cm²) | - | | | ı |
| | 705 | She | 1 | ts9T to 9qvT | | | , | |
| ination pth | 00 m | ţţ | VB | rD offiogR | | | , | ' |
| Term De | المالية | | | Dry Density (| | , | , | , |
| Table | |) nı.ç | tsi % | oM lerursl Mo) tnotnoD | - | | | , |
| of Water | 3.68 m | | | Bulk Density | - | 1 | ' | , |
| Depth | | • | | Shrinkage Limit | - | T | T | I. |
| No. | BH-A2 berg Limits % | | | Plasticity x9bn1 | | 11 | | ı |
| B.H. | B.H. No. BH-A2 Atterberg Limits % | | 1 | himiJ siterIA | - | 22 | | , |
| e tion | lge | Liquid Limit | | | | 33 | ı | ı |
| Chainag n.)/Loca | m.)/Location 16+042 fajor Bridge | | avel | Coarse | ' | 1 | ı | 1 |
| (kı | N | etained | G | əniA | , | 7 | ı | ı |
| | 0-2021 | istribution % wt retain Sand | | Coarse | · | 3 | ı | ı |
| ring | 09-1 | | | muibəM | ' | 9 | I | ı |
| ate of Bo | to | ı Size Dis | əniA | | ' | 16 | ' | , |
| â | 0-2021 | Grair | | માંડ | ' | 55 | ' | ' |
| | 08-1 | | | VRID | • | 12 | 1 | ı |
| esigning oital Rail | to | | ю | dmy2 21 | | | | |
| l report for d Haryana Orl | connectivity | uoj | ite | IS Classific | | CL | ı | |
| stigation, preparation of geotechnical rep nt in connection with construction of Har n Palwal to Harsana Kalan including con te of Haryana. | | | | Soil Description | | Brown yellowish, Hard, Silty clay of | low plasticity with gravel | |
| schnical ii embankr |) project 1 yrk in the | Te | (°) 15 | Corrected Value (V | 77 | 78 | 06 | I |
| ing geote is and for | r (HORC) IR netwo | ənleV | J | (N) (N) | 77 | 78 | 06 | I |
| Conduct of bridge | Corridor existing | (w) " | 1. | Depth from G | 26.50 | 28.00 29.50 | | 29.95 |
| Con Of bi Corr Corr exist | | ə | dÂ | T əlqms2 | SPT-10 | DS-2 | | |



| | 22 | | Compression Index (C,) | ı | , | | ı | , | ı | , | 0.1130 | ı | , | | | ı | , | ı | , | ı | ı | |
|---|---|--------------------|--|----------------|---------|--|---------|---------|-------------------------------------|----------------------------|--|--------|----------|---------|--|---------|---------|---------|---------|----------------|---|----------------|
| ef. Code | 544_21-3 | imeters | (53/ ₇ 200) 01 x ^W | , | | | | | | | 1.70 1.28 0.84 0.54 | | | | , | | | , | | | | , |
| R | SR- | ion Para | (cm ² /2ec) (cm ² /2ec) | , | , | | 1 | , | ı | | 9.51 6.36 5.22 4.01 | ı | | | | ı | | ı | | ı | ı | |
| Ŀ | 968 m | Consolidat | Pressure Pressure | | | | | | 1 | | 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0 | , | | | | | | ı | | | 1 | |
| R.] | (+)192. | U | Void Ratio (e_) | , | | | | | ı | | 0.665 | | | | | ı | | 1 | | ı | ı | , |
| | m | Â | Permeabilit (cm/sec) | , | , | | | | | | | ı | - | | | | - | ı | , | | | |
| | 114.308 | nre | seralling Press (kg/cm ²) | | | | | | | | | | | | | | | | | | | |
| s (E,N) | 3121 | xəp | Free Swell Inc (%) | , | 1 | | | | | | | ı | | | | | | ı | 1 | | | |
| ordinate | n | țth | Angle of Friction (\$) | ' | 26 | ' | 27 | - | 27 | - | 5 | ı | - | - | 9 | - | - | 1 | ' | - | - | |
| Ŭ | 5836.344 1 | ar Streng | Cohesion C (kg/cm²) | | 0.11 | | 0.10 | ' | 0.22 | ' | 1.19 | ' | | | 1.48 | ' | | ' | | ' | ' | |
| | 70 | She | ts9T to 9qYT | ' | DST | | DST | ' | DST | ' | UUT | ' | | | UUT | ' | | ' | | ' | ' | |
| nation pth | 00 m | ţţ | Specific Grav | | 2.65 | | 2.65 | | 2.66 | | 2.68 | | | | 2.67 | | | ı | | | | |
| Term | 30.(| (_e wə | Dry Density (g/ | | 1.51 | | 1.56 | | 1.60 | | 1.61 | ' | 1.61 | | 1.63 | , | 1.63 | | | , | | |
| Table | |) n.c | tsioM IsrutsN %) tnotnoD | | 13.46 | | 15.20 | | 17.64 | | 23.41 | | 23.80 | | 22.46 | | 22.30 | | | | | |
| f Water | 3.13 m | (_e wə, | Bulk Density (g/ | | 1.71 | | 1.80 | | 1.88 | | 1.99 | ı | 1.99 | | 2.00 | | 1.99 | ı | | | ı | |
| Depth o | | 0 | Shrinkage Limit | | | | | | | | , | | | | | | | | | | | |
| No. | ·Al | Limits % | Plasticity Index | | 9 | | 5 | | 7 | | 10 | | 11 | | 11 | | 11 | - | | 7 | | |
| B.H. | BH- | Atterberg | timi.I siterIA | | 20 | | 20 | - | 20 | - | 21 | | 22 | - | 21 | | 21 | | | 20 | | |
| e tion | lge | V | timi.I biupi.I | , | 26 | , | 25 | | 27 | - | 31 | , | 33 | | 32 | | 32 | | , | 27 | | |
| Chainag m.)/Loca | 16+231 Iajor Bri | | e Coarse | , | 0 | , | 0 | | 0 | 1 | 0 | , | 0 | | 2 | | 0 | ı | , | 0 | - | , |
| (k | N | etained | Q 9niA | ' | - | ' | 3 | ' | 5 | ' | 4 | ı | 5 | ' | 5 | | 9 | ı | ' | 10 | ı | , |
| | 1-2021 | 1 % wt 1 | Coarse | ' | - | ' | 2 | ' | 2 | ' | - | ı | 3 | ' | 2 | | 4 | ı | ' | 2 | ı | , |
| ring | 12-1 | stributio | Sand Medium | ' | 7 | ' | 9 | ' | 3 | ' | 5 | ı | L | ' | 4 | , | 5 | ı | ' | 4 | ı | , |
| tte of Bo | to | Size Dis | əniA | ' | 48 | ' | 51 | ' | 32 | ' | 28 | ı | 26 | ' | 31 | ı | 26 | ı | ' | 28 | ı | , |
| Dî | 1-2021 | Grain | માંડ | ' | 37 | ' | 33 | ' | 50 | ' | 52 | ı | 47 | ' | 45 | ' | 47 | ı | ' | 49 | ı | |
| | 11-1 | | Clay | 11-22-20 11-22 | 9 | 1 | 5 | 1000 | 8 | • | 10 | 1 | 12 | - | 11 | 1 | 12 | - | | 7 | • | |
| lesigning bital Rail | / to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | |
| l report for d Haryana Ori | connectivity | uo | IS Classificati | | SM-SC | , | SM-SC | | ML-CL | | CL | ï | CL | | CL | | CL | | | ML-CL | | |
| investigation, preparation of geotechnica kment in connection with construction of | from Palwal to Harsana Kalan including e state of Haryana. | | Soil Description | | | Greyish brown, Medium dense, Silty sand with clay | | | Greyish brown, Dense, Sandy silt of | low plasticity with gravel | | | | | Greyish brown, Hard, Silty clay of low plasticity with gravel | | | | | | Greyish brown, Very dense, Sandy silt of low plasticity with gravel | |
| otechnical Or emban | .C) project work in th | T | Corrected SP Value (N.) | ' | ' | 14 | , | 23 | ı | 32 | , | 39 | , | 32 | ' | 45 | , | 47 | ' | - (i | - (i | - |
| ucting gec 1ges and f | dor (HOR ng IR netv | ən[&] | (N) (N) | - | - | 11 | - |) 27 | - (|) 48 | - 0 | 0 39 | - 0 | 0 32 | - 0 | 0 45 | - 0 | 0 47 | - 0 | 0 100 (25cm | $0 \begin{array}{c} 100\\ (19 \text{cm} \end{array}$ | 0 100 (22cm |
| Condi of bric | ect Corris existin | (ɯ) " | I.Ə morî diqe Depth from G.L | 1 0.00 | -1 1.00 | -1 2.50 | -2 4.00 | -2 5.50 | -3 7.00 | -3 8.50 | -4 10.0 | 4 11.5 | -5 13.00 | -5 14.5 | -6 16.0 | -6 17.5 | -7 19.0 | -7 20.5 | ;* 22.0 | -8 22.5 | -9 23.5 | 10 25.0 |
| | 611 | ə | avT slqms2 | DS- | SQU | SPT. | SQU | SPT. | SQU | SPT | NDS | SPT | SQU | SPT. | NDS | SPT. | SQU | SPT. | SQU | SPT. | SPT | SPT- |



urbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated ided Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

| e | -22 | | τ | Compression (C) xəbnl | - | - | - | - | |
|--|---------------------------|-----------------------|-----------------------|--|--|----------------------------------|------------------------------------|-------|--|
| ef. Cod | 544_21 | ameters | | (53/ ₇ wo) ₇₋ 01 x [^] W | ı | I | I | I | |
| Я | SR- | ion Para | | (cw ₅ /2ec) | ı | I | I | ı | |
| .1 | 968 m | onsolidat | | Lressare | | | | | |
| R.I | (+)192. | 0 | (⁰ | 9) oita Ratio (e | ı | I | I | ı | |
| | ш | Á | ;) Jit | idsəmrə¶ əsv(mɔ) | | | | , | |
| | 114.308 | nre | (₇ ssa | ^r mɔ\ga) | | 1 | | ' | |
| s (E,N) | 3121 | хәр | ouj | Free Swell] (%) | | | | | |
| ordinate | u | th | (| Angle of Friction (\$ | 29 | I | I | I | |
| ŭ | 836.344 r | ar Streng | | Соћезіоп С (kg/cm²) | 0.18 | - | - | - | |
| | 705 | She | 1 | rs9T to 9qvT | DST+ | I | ı | ı | |
| nation pth | 0 m | ity | AB. | nD offiogR | 2.66 | | | | |
| Termi De | 30.0 | (_e wə | /B) | Dry Density (| 1.64 | - | - | | |
| : Table | |) n.e | tsi | oM latural Mo) tnotnoD | 19.00 | - | | 1 | |
| of Wateı | 3.13 m | (_e wə/ | B) | Bulk Density | 1.95 | ı | ı | I | |
| Depth | | % | | Shrinkage Limit | ' | ' | ' | ' | |
| . No. | I-A1 | g Limits ⁶ | | Plasticity Valasticity | 7 | ' | 7 | ' | |
| B.H | BH | Atterberg | 1 | imiJ siterI | 21 | ' | 20 | ' | |
| e tion | lge | 1 | 1 | imiJ biupiJ | 28 | | 27 | ' | |
| Chainag m.)/Loca | 16+231 Aajor Bri | | ravel | Coarse | 0 | ı | 0 | 1 | |
| (k | N | retained | 5 | Sine | 7 | 1 | 8 | ' | |
| | 1-2021 | n % wt | | Coarse | 1 | ı | 3 | ı | |
| Dring | 12-1 | stributio | Sand | muibəM | 9 | ı | 6 | ı | |
| ate of Bo | to | n Size Di | | əniA | 27 | ı | 29 | ı | |
| Q | 1-2021 | Graiı | | H IS | 51 | I | 44 | ı | |
| | 11-1 | | | Clay | 8 | - | 7 | - | |
| lesigning bital Rail | y to | | 100 | dmy2 21 | | | | | |
| al report for f Haryana Oi | g connectivit | uoj | its. | IS Classific | ML-CL | I | ML-CL | I | |
| stigation, preparation of geotechnical re 1t in connection with construction of Ha n Palwal to Harsana Kalan including con 1e of Haryana. | | | | Soil Description | | Greyish brown, Very dense, Sandy | silt of low plasticity with gravel | | |
| schnical ii r embankı |) project 1 wrk in the | Te | (°N IS | Corrected Value (V | 37 | 34 | 35 | I | |
| ting geote es and for | rr (HORC) IR netwo | ənlaV | L | (N) Observed SP7 | 89 | 80 | 87 | I | |
| Conduc of bridg | L Corrido existing | (w) " | 1.4 | Depth from C | 26.50 | 28.00 | 29.50 | 30.00 | |
| Duction | Project Cond existi | | đ٨ | T slqms2 | SPT-11 2 SPT-12 2 SPT-13 2 SPT-13 2 | | | | |



| e | -22 | ~ | Compression (.C) x9bn1 | , | , | , | | ı | | | | | | | | | | | | | 1 | , | |
|---|---|-------------------|---|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----------------------------------|---|-------|-------|-------|-------|---|--|
| tef. Cod | -544_21 | ameters | (537/ ² m2) ²⁻ 01 x ¹ M | - | | - | ı | | | | | | | | | - | | ' | | | | - | |
| Н | SR | tion Par | (cm ² /Sec) C ^x x 10 ⁻⁴ | ı | | | , | | | | | , | | | | ı | | , | | | | 1 | |
| Ľ. | .065 m | Consolidat | (kg/cm ²⁾ | | | | | | | | | | | | | | | | | | | | , |
| R. | (+)193 | | Void Ratio (e_) | - | | - | 1 | ı | | | | | | | | - | | 1 | ı | ı | | | ı |
| | m | Á | Permeabilit; (cm/sec) | | | | | | | | | | | | | | | | | | | , | |
| | 096.697 | nre | Swelling Press (kg/cm ²) | - | | - | ' | | | | | | | | | - | | | | | | - | |
| ; (E,N) | 3121 | xəj | Free Swell Inc (%) | - | | - | , | 1 | | | | , | , | , | , | - | ı | , | , | | | - | |
| rdinates | | Ч | Angle of Friction (\$) | | | 24 | , | 25 | | 26 | | s | , | 9 | , | 1 | | 5 | , | | | 27 | |
| Col | 376.865 m | r Strengt | Соћезіоп С (kg/cm²) | | | 0.20 | | 0.19 | | 0.20 | | 0.95 | | 1.31 | | | | 1.65 | | | | 0.18 | |
| | 705 | Shea | fs9T fo 9qYT | | | DST | | DST | | DST | | UUT | | UUT | | | | UUT | | | | DST | |
| nation oth | 0 m | ity | Specific Grav | | | 2.66 | | 2.67 | | 2.66 | | 2.68 | | 2.67 | | | | 2.68 | | | | 2.66 | , |
| Termii Dep | 30.0 | (_e wə | Dry Density (g/ | - | | 1.51 | | 1.55 | | 1.58 | | 1.59 | | 1.62 | | 1.62 | | 1.64 | | 1.64 | | 1.59 | |
| Table | |) nre | tsioM IsrutsN (%) tastaoD | | | 15.26 | | 17.26 | | 18.62 | | 24.41 | , | 23.10 | | 22.76 | | 22.89 | | 22.70 | | 20.16 | |
| f Water | 3.10 m | (_e wə | Bulk Density (g/ | | | 1.74 | , | 1.82 | | 1.87 | | 1.98 | , | 1.99 | , | 1.99 | | 2.02 | , | 2.01 | | 1.91 | |
| Depth o | | | Shrinkage Limit | | | | | | | | | | | | | | | | | | | | |
| No. | A2 | Limits % | Plasticity Index | | | 7 | | 7 | | 9 | | 11 | | 11 | | 10 | | 11 | | 11 | | 7 | |
| B.H. | BH | tterberg | timi.I siterla | | | 21 | | 20 | | 20 | | 20 | | 22 | | 20 | | 21 | | 22 | | 21 | |
| e tion | ge | V | timiJ binpiJ | - | | 28 | | 27 | | 26 | | 31 | | 33 | | 30 | | 32 | | 33 | | 28 | |
| Chainag n.)/Locat | 16+231 lajor Brid | | Coarse | | | 0 | | 0 | , | 0 | | 0 | | 0 | , | 0 | | 0 | , | - | , | 0 | |
| (kr | W | etained | 9niA | | ' | 1 | , | 3 | ' | 4 | | 4 | ' | 9 | ' | 5 | ' | 9 | | ٢ | ' | 9 | |
| | 1-2021 | n % wt r | Coarse | 1 | 1 | 1 | ' | 1 | , | 2 | , | 3 | , | 1 | , | 3 | | 2 | , | 1 | , | 2 | |
| ring | 12-1 | tributio | Sand muibəM | | , | L | ' | 9 | , | 9 | , | 5 | , | L | , | 4 | ' | 9 | , | ٢ | , | 9 | |
| ate of Bo | to | Size Dis | eniA | ' | ' | 30 | ' | 28 | ' | 31 | ' | 27 | ' | 28 | ' | 25 | ' | 26 | , | 28 | ' | 30 | |
| D | 1-2021 | Grain | માંડ | ' | ' | 53 | ' | 55 | ' | 51 | ' | 50 | ' | 46 | ' | 53 | ' | 49 | ' | 44 | ' | 48 | |
| | 11-1 | | Clay | • | • | 8 | ' | 7 | ' | 9 | ' | 11 | ' | 12 | ' | 10 | ' | 11 | | 12 | • | 8 | |
| designing bital Rail | y to | | lodmy2 21 | | | | | | | | | | | | | | | | | | | | |
| l report for 6 Haryana Or | connectivity | uo | IS Classificati | , | , | ML-CL | , | ML-CL | , | ML-CL | , | CL | , | CL | | CL | | CL | , | CL | | ML-CL | 1 |
| nvestigation, preparation of geotechnic ment in connection with construction o | from Palwal to Harsana Kalan includin; state of Haryana. | | Soil Description | | | | | | | | | | | | | Greyish brown, Very stif to Hard, | buy ciay of low plasticity with gravel | | | | | Greyish brown, Dense to very dense, conducing the of the other side mith | oality sill of low plasticity with gravel |
| echnical : r embank | project ork in the | T | AS betrected SP Value (N.) | ı | 13 | 1 | 14 | | 20 | ' | 24 | ' | 28 | ' | 40 | ' | 39 | ' | 46 | ' | 53 | 1 | 23 |
| ting geot es and fo | or (HORC ; IR netw | ənle/ | V TAS bəvnəsdO (V) | · | 8 | ' | 12 | | 23 | | 33 | ' | 28 | ' | 40 | ' | 39 | ' | 46 | | 53 | ' | 47 |
| Conduc of bridg | L Corrido existing | (w) · | Depth from G.L | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 | 11.50 | 13.00 | 14.50 | 16.00 | 17.50 | 19.00 | 20.50 | 22.00 | 23.50 | 25.00 | 26.50 | 28.00 |
| | Trujec | ə | qyT slqms2 | DS-1 | SPT-1 | UDS-1 | SPT-2 | UDS-2 | SPT-3 | UDS-3 | SPT-4 | UDS-4 | SPT-5 | UDS-5 | SPT-6 | 9-SQU | 7-TqS | UDS-7 | SPT-8 | UDS-8 | 6-TqS | 6-SQU | SPT-10 |



urbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated ided Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

| ions:- | bed Sample, SPT-Standard Penetration Test, UDS-Undistu | I Triaxial Shear Test, DST+ - Direct Shear Test on Remoul | |
|-----------------|--|---|--|
| Abbreviations:- | DS-Disturbed Sam | Undrained Triaxia | |

| de | I-22 | s | U | Compression (.C) x9bnI | | - |
|---|--|---|-----------------------|---|-------------------------------------|--|
| Ref. Coc | R-544_21 | rameter | | (Tay/zmo) 2-01 x ^a W | | - |
| [| c of Boring Condinates (E,N) B.H. No. Depth of Water Table Cordinates (E,N) R.L. Ref. to 12-11-2021 16+231 BH-A2 3.10 m 30.00 m 705376.865 m 3121096.697 m (+)193.065 m SR-544 | | | (cw ₅ /2ec) C ^a x 10-4 | - | - |
| L. | .065 m | Consolida | | (kg/cm ²⁾ Pressure | | |
| R. | (+)193 | • | (⁰ | 9) oita Ratio (| - | - |
| | 7 m | Â | ;) (; | Permeabi 998/m9) | | |
| | 1096.697 | nre | (_z ssə | anilləw2 mə\ga) | | |
| s (E,N) | 312 | хәр | ouj | [[]9WZ 997] [[%) | | |
| ordinate | u | th th | (| fo algaA Priction (φ°) | | 1 |
| Co | 376.865 n | ır Streng | | Cohesion C (kg/cm²) | | |
| | 705. | Shea | 1 | rs9T fo 9qvT | - | - |
| ation th | ш | ity | AB. | nD offiogR | | |
| Termin: Dept | 30.00 | (_e wə | /മี) | Dry Density | | |
| Table | |) n.c | tsi %) | oM latural Mo) tnotnoD | | |
| f Water | 3.10 m | Plasticity Linits 2.1 Linits 3.0 Shrinkage 1 Shrinkage 1 Bulk Density (g/cm ³) 3.10 Bulk Density (g/cm ³) 1 Dry Density (g/cm ³) 1 Dry Density (g/cm ³) | | | | |
| Depth o | | | | Shrinkage JimiJ | | |
| No. | A2 | Limits % | | Plasticity Vabal | 7 | - |
| B.H. | BH- | tterberg | ļ | imiJ sitselA | 20 | |
| ion | ge | V | 1 | imiJ biupiJ | 27 | - |
| Chainage n.)/Locat | 16+231 ajor Brid | Coarse Liquid Limit | | | 2 | - |
| (kr | M | etained | Gr | əniA | 7 | ' |
| | 1-2021 | 1 % wt r | | Serse | 2 | - |
| ring | 12-1 | tribution | Sand | muibəM | 9 | |
| tte of Bo | to | Size Dis | | əniA | 32 | |
| Da | -2021 | Grain | | 11!S | 44 | ' |
| | 11-1 | | | Val | 7 | ' |
| ssigning ital Rail | to | | 100 | dmy2 2I | | |
| l report for de Haryana Orb | connectivity | uoj | ite: | offiseelD 81 | ML-CL | ı |
| nvestigation, preparation of geotechnica ment in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | | Soil Description | Greyish brown, Dense to very dense, | balluy sili ul low plasticity with gravel |
| echnical i r embank | () project ork in the | Te | (°N 15 | Corrected Value (f | 24 | ı |
| ting geot tes and for | or (HORC { IR netwo | ənlaV | L | (N) Observed SP | 53 | , |
| Conduc of bridg | Corrido existing | (ɯ) " | L. | Depth from C | 29.50 | 30.00 |
| Ducion | oplart | ə | đ٨ | T slqms2 | SPT-11 | DS-2 |





| e | -22 | | Compression Index (C,) | I | 1 | | | | | | I |
|---|---|--------------------|--|------|-------|-------|-------------------------------|------------------------------|-------|-------|-------|
| tef. Cod | -544_21 | ameters | (Tage | 1 | | | | | | | |
| ł | SR | tion Par | (cm ² /Sec) C ^x x 10-4 | | | | | | | | |
| Ľ. | .981 m | Consolida | (k&\cm ³⁾ Pressure | | | | | - | | | 1 |
| Я | (+)194 | | (09) oitrA bioV | | | | | - | | | |
| | Е | Â | Permeability (cm/sec) | | | | | ' | | | |
| |)569.349 | nre | Swelling Press (kg/cm ²) | | | | | | | | |
| s (E,N) | 312(| xəp | Free Swell Ind (%) | I | 1 | | , | | ı | | ı |
| rdinate | 5 | h | Angle of Friction (\$°) | , | | 25 | | | | 26 | ı |
| Co | 153.768 n | ar Streng | Sheer root from Control of the second | | | 0.20 | | | | 0.19 | ı |
| | 705 | Shea | Specific Gravity | | | DST | | - | | DST | |
| nation pth | 10 m | ity | унуга Сгауну Сресийс Сгауну | | ' | 2.66 | | | ' | 2.66 | ' |
| Termi De _l | 10.0 | (_e wo | Dry Density (g/d | | | 1.56 | | 1.55 | | 1.58 | |
| Table | |) nr.e | itsioM lautaN (%) tnotnoD | | | 16.23 | | 18.42 | | 19.10 | |
| of Water | 4.10 m | (_e wə, | Bulk Density (g/ | | | 1.81 | | 1.84 | | 1.88 | ı |
| Depth | | % | Shrinkage Limit | | | | | - | | | , |
| . No. | -cL | Limits 9 | Plasticity Index | ı | ' | 7 | ' | 9 | ' | 7 | ı |
| B.H | BH | Atterberg | Plastic Limit Er Basticity | | , | 20 | , | 20 | , | 21 | ı |
| e tion | lge | V | timi.I biupi.I | I | , | 27 | , | 26 | | 28 | ı |
| Chainag n.)/Loca | 16+815 linor Brid | | ave Coarse | | ' | 0 | ' | 0 | ' | 0 | ' |
| (kr | N | etained | Г | , | ' | 2 | ' | 1 | ' | 4 | ' |
| | 0-2021 | n % wt r | Coarse | | ' | 1 | , | 3 | ' | 5 | , |
| ring | 20-10 | stributio | S M M M M | ı | , | 3 | , | L | , | 2 | ı |
| ate of Bo | to | Size Dis | əniA | | , | 41 | ' | 38 | ' | 37 | |
| Ö | 0-2021 | Grain | માંડ | · | ' | 46 | ' | 45 | ' | 47 | ı |
| | 04-1 | | VaIJ | | - | 7 | • | 9 | , | 8 | |
| esigning vital Rail | r to | | lodmy2 21 | | | | | | | | |
| l report for d Haryana Ort | connectivity | uo | IS Classificati | | ı | ML-CL | ı | ML-CL | , | ML-CL | 1 |
| nvestigation, preparation of geotechnica ment in connection with construction of | from Palwal to Harsana Kalan including state of Haryana. | | Soil Description | | | | Brown, Medium dense to dense, | Sandy silt of low plasticity | | | |
| schnical i r embank |) project ark in the | T | Corrected SP Value (N _e) | 1 | 20 | 1 | 32 | 1 | 17 | 1 | 27 |
| ting geote es and for | r (HORC) IR netwo | ənlæ⁄ | V TAS byrysdO (N) | 1 | 13 | | 29 | ı | 19 | 1 | 43 |
| Conduct of bridge | Corrido existing | (w) | J.Ə morî diqəU | 0.00 | 1.00 | 2.50 | 4.00 | 5.50 | 7.00 | 8.50 | 10.00 |
| Ductor | rojec | ə | qvT əlqms2 | DS | SPT-1 | UDS-1 | SPT-2 | UDS-2 | SPT-3 | UDS-3 | SPT-4 |





| Kalan in the state of Haryana. | |
|--------------------------------|--|
| Harsana | |
| to | |
| al | |
| Palw | |
| project from | |
| $\widehat{\Omega}$ | |
| (HOR | |
| Corridor | |
| Ē | |
| \mathbb{R}^{3} | |
| tal | |
| Orbi | |
| iTI for Haryana | |
| Ċ | |

SR-544_21-22

Appendix – B2

| | | | | Depth of | | Chlorid | les (CI ⁻) | Sulphate (S | (0_3^{2-}) |
|-----------|--------------|----------------|---------------------------|----------------------------|------|---------|------------------------|-------------|--------------|
| Sr. No | Chainage Old | Chainage New | BH No. | collected sample (m) | Hq | (mg/kg) | (%) | (mg/kg) | (%) |
| 1. | 11+657 | 12+342 | CL | 2.25 | 7.41 | 88.69 | 0.0070 | 31.47 | 0.0031 |
| c | L07 - 21 | CLV 1 V 1 | 1 V | 2.5 | 8.27 | 72.14 | 0.0072 | 23.74 | 0.0024 |
| | 10/101 | 1474/2 | 14 | 11.50 | 8.91 | 68.12 | 0.0068 | 22.78 | 0.0023 |
| 6 | 151,441 | <i>L</i> C1 91 | υv | 2.25 | 7.82 | 65.45 | 0.0065 | 26.98 | 0.0027 |
| .с | 177441 | 10+12/ | $\mathbf{A}_{\mathbf{Z}}$ | 20.50 | 8.21 | 71.99 | 0.0072 | 21.78 | 0.0022 |
| ~ | 161043 | LCL 91 | ~ | 2.25 | 7.45 | 77.33 | 0.0077 | 31.55 | 0.0032 |
| ÷. | 10+042 | 107/2/ | 14 | 17.50 | 7.78 | 69.78 | 0.0070 | 36.98 | 0.0037 |
| v | 161,731 | 16,017 | C۷ | 2.5 | 7.45 | 66.55 | 0.0067 | 33.69 | 0.0034 |
| ر | 107201 | 10771/ | 77 | 20.50 | 7.88 | 74.99 | 0.0075 | 31.54 | 0.0031 |
| | | | | | | | | | |

RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

| | | | GRA | AIN SIZE DI | STRIBUTI | ON CURVES | 5 | | | | | |
|-------------------------|---|-------|---|--|---|--|---|---------------------------|-------------------------|------------------------|----------------|------|
| | Project Name | | Conducting geoto connection with connectivity to es | echnical investiga construction of Ha xisting IR network | tion, preparation aryana Orbital Ra k in the state of F | of geotechnical r ail Corridor (HOR Iaryana. | eport for designin C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm Ilan includ | ent in ling | |
| La | cation/Chaina | ge | 11+523 Minor B | ridge | | | | | | | | |
| | B.H. No. | | BH-CL | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | Fill | NE SAND | AEDIUM SAND | COARSE FIN | E GRAVEL | | ARSE AVEL | 100 | |
| | 0.50 | m | <u></u> 2.25 m | - | X− 3.00 m | - | - 5.25 m | - | 8.25 | m | | |
| | | | Grain Size | Distribution % | wt retained | | | | | 1 | | 1 |
| Depth | Cleri | C:14 | | Sand | | G | avel | D10 | D30 | D60 | Cu | Ce |
| - | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | | | | | |
| 0.50 m | 0.00 | 19.00 | 75.00 | 6.00 | 0.00 | 0.00 | 0.00 | 0.0309 | 0.1165 | 0.2168 | 7.02 | 2.03 |
| 2.25 m | 0.00 | 26.00 | 68.00 | 4.00 | 2.00 | 0.00 | 0.00 | 0.0175 | 0.0891 | 0.1945 | 11.12 | 2.33 |
| 5.00 III | 0.00 | 39.00 | 53.00 | 6.00 | 1.00 | 1.00 | 0.00 | 0.0281 | 0.1120 | 0.2137 | 18 39 | 2.09 |
| 8.25 m | 5.00 | 36.00 | 51.00 | 6.00 | 1.00 | 1.00 | 0.00 | 0.0064 | 0.0490 | 0.1339 | 23.07 | 1.71 |
| 0.23 M | 3.00 | 30.00 | 31.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.0004 | 0.0437 | 0.1403 | 23.07 | 1.99 |



| | | | GRAIN SIZE DISTRIBUTION CURVES | | | | | | | | | | | |
|-------------------------|---|---------|---|--|--|---|---|-----------------------------|-------------------------|------------------------|----------------|------|--|--|
| | Project Name | | Conducting geote connection with connectivity to ex | echnical investiga construction of H xisting IR networ | ation, preparation aryana Orbital Ra k in the state of H | of geotechnical re il Corridor (HOR aryana. | eport for designin C) project from P | ng of bridge Palwal to H | es and for arsana Ka | embankm alan includ | ent in ling | | | |
| L | ocation/Chaina | ge | 11+614 Minor B | ridge | | | | | | | | | | |
| | B.H. No. | | BH-CL | | | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | Fi | NE SAND M | IEDIUM SAND | COARSE FIN SAND | <pre>le gRAVEL</pre> | CO. GR | ARSE AVEL > | 100 | | | |
| | | =0.50 m | Grain Size | 2.25 m | wt retained | 5.25 m | | 8 | 25 m | | | | | |
| Depth | Clay | Silt | | Sand | | Gr | avel | D10 | D30 | D60 | Cu | Cc | | |
| | Ciay | | Fine | Medium | Coarse | Fine | Coarse | 0.0015 | 0.0275 | 0.0005 | | | | |
| 0.50 m | 6.00 | 47.00 | 40.00 | 7.00 | 0.00 | 0.00 | 0.00 | 0.0045 | 0.0270 | 0.0989 | 21.93 | 1.63 | | |
| 5.25 m | 7.00 | 55.00 | 28.00 | 6.00 | 2.00 | 2.00 | 0.00 | 0.0025 | 0.0198 | 0.0703 | 19.98 | 1.59 | | |
| 8.25 m | 7.00 | 52.00 | 30.00 | 6.00 | 3.00 | 2.00 | 0.00 | 0.0036 | 0.0214 | 0.0778 | 21.86 | 1.65 | | |
| | | | | | | | | | | | | | | |



| | | | GRA | AIN SIZE DI | STRIBUTIC | ON CURVES | | | | | | |
|-------------------------|---|-----------------|--|--|---|---|---|-----------------------------|---|-----------------------|---------------|------|
| | Project Name | | Conducting geoto connection with connectivity to ex- | echnical investiga construction of Ha xisting IR networl | tion, preparation aryana Orbital Ra k in the state of H | of geotechnical re il Corridor (HOR aryana. | eport for designin C) project from I | ng of bridge Palwal to H | es and for arsana Ka | embankm lan includ | ent in ing | |
| L | ocation/Chaina | ge | 11+657 Minor B | ridge | | | | | | | | |
| | B.H. No. | | BH-CL | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | FII | NE SAND M | EDIUM SAND | COARSE FII SAND | NE GRAVEL | CO. GR. I I I I I I I I I I I I I I I I I I I | ARSE AVEL > | | |
| | | | | - | | | | | | | | |
| | | - 0.50 m | - | 2.25 m | | 5.25 m | | 8 | 25 m | | | |
| | | | Grain Size | Distribution % | wt retained | | | | | | | |
| Depth | Clay | Silt | Fine | Sand Medium | Coarse | Gr Fine | avel Coarse | D10 | D30 | D60 | Cu | Ce |
| 0.50 m | 7.00 | 47.00 | 40.00 | 4.00 | 2.00 | 0.00 | 0.00 | 0.0037 | 0.0251 | 0.0946 | 25.92 | 1.82 |
| 2.25 m | 6.00 | 45.00 | 38.00 | 6.00 | 3.00 | 2.00 | 0.00 | 0.0046 | 0.0286 | 0.1101 | 24.09 | 1.62 |
| 5.25 m | 8.00 | 45.00 | 41.00 | 3.00 | 1.00 | 2.00 | 0.00 | 0.0030 | 0.0248 | 0.0986 | 33.09 | 2.09 |
| 8.25 m | 11.00 | 50.00 | 28.00 | 6.00 | 3.00 | 2.00 | 0.00 | - | 0.0163 | 0.0724 | - | - |



| | | | GRA | AIN SIZE DI | STRIBUTIO | ON CURVES | | | | | | |
|-------------------------|---|-----------------|---|--|---|---|---|-----------------------------|--|---|---------------|------|
| | Project Name | | Conducting geote connection with connectivity to ex | echnical investiga construction of Ha kisting IR network | tion, preparation aryana Orbital Ra k in the state of H | of geotechnical re iil Corridor (HOR laryana. | eport for designir C) project from I | ng of bridge Palwal to H | es and for arsana Ka | embankm Ilan includ | ent in ing | |
| Le | ocation/Chaina; | ge | 12+125 Minor B | ridge | | | | | | | | |
| | B.H. No. | | BH-CL | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | Fil 1 1 1 1 1 1 1 1 1 1 1 1 1 | NE SAND | 1 | COARSE FIN SAND | VE GRAVEL | CO GR 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | ARSE AVEL > I I I I I I I I I I I I I I I I I I I | | |
| | DEPTH: | | | G | Grain Size Millin | neters | | | | | | |
| | _ | - 1.00 m | -1 | -2.50 m | | - ≻- 5.50 m | | 8. | 50 m | | | |
| | | | Grain Size | Distribution % | wt retained | | | | | | | |
| Depth | Clay | Silt | Fine | Sand Medium | Coarse | Gr Fine | avel Coarse | D10 | D30 | D60 | Cu | Cc |
| 1.00 m | 0.00 | 24.00 | 67.00 | 5.00 | 3.00 | 1.00 | 0.00 | 0.0201 | 0.0970 | 0.2072 | 10.30 | 2.26 |
| 2.50 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 |
| 5.50 m | /.00 | 48.00 | 31.00 | /.00 | 3.00 | 4.00 | 0.00 | 0.0036 | 0.0238 | 0.0943 | 20.00 | 1.0/ |
| 0.30 m | 0.00 | 40.00 | 33.00 | 5.00 | 5.00 | 5.00 | 0.00 | 0.0029 | 0.0222 | 0.000/ | 30.09 | 1.89 |



| | | | GRA | AIN SIZE DI | STRIBUTI | ON CURVES | 5 | | | | | |
|-------------------------|---|--------|---|--|--|--|---|---------------------------|--|------------------------|----------------|------|
| | Project Name | | Conducting geot connection with connectivity to e | echnical investiga construction of Ha xisting IR networl | ition, preparatio aryana Orbital I k in the state of | n of geotechnical re Rail Corridor (HOR Haryana. | eport for designin C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm alan incluc | ent in ling | |
| L | ocation/Chaina | ge | 12+431 Minor B | ridge | | | | | | | | |
| | B.H. No. | | BH-CL | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | Fil 0.075 0.1 | NE SAND | MEDIUM SAND | COARSE FIN SAND | E GRAVEL | CO GR 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | ARSE AVEL | | |
| | | 1.00 r | n Groin Size | Distribution % | ▲ 4.00 m | | ~~~ 7 | '.00 m | | T | | I |
| Denth | | | Gi anii 3126 | Sand | i ctafficu | Gr | avel | D10 | D30 | D60 | Cu | Ce |
| Deptii | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | 1010 | 150 | 1,00 | Cu | CC |
| 1.00 m | 0.00 | 20.00 | 72.00 | 4.00 | 3.00 | 1.00 | 0.00 | 0.0281 | 0.1128 | 0.2171 | 7.73 | 2.09 |
| 4.00 m | 0.00 | 29.00 | 61.00 | 3.00 | 2.00 | 5.00 | 0.00 | 0.0141 | 0.0785 | 0.1926 | 13.61 | 2.26 |
| 7.00 m | 0.00 | 29.00 | 64.00 | 2.00 | 1.00 | 4.00 | 0.00 | 0.0143 | 0.0784 | 0.1861 | 13.05 | 2.32 |
| , in | 0.00 | =>.00 | 000 | 2.00 | 1.00 | 1.00 | 0.00 | | 0.0701 | | 10.00 | |



| | | | GRA | AIN SIZE DI | STRIBUTIO | ON CURVES | | | | | | |
|-------------------------|--|--------|--|--|---|---|---|---------------------------|-----------------------------------|-----------------------|----------------|------|
| | Project Name | | Conducting geote connection with connectivity to ex- | echnical investiga construction of Ha xisting IR network | tion, preparation aryana Orbital Rai c in the state of Ha | of geotechnical re il Corridor (HOR aryana. | eport for designin C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm lan includ | ent in ling | |
| Lo | ocation/Chaina | ze | 13+218 Minor B | ridge | | | | | | | | |
| | B.H. No. | - | BH-CL | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0.001 DEPTH: 0.50 | 2 m | SILT | Fil 0 0 0 0 0 0 0 0 0 0 0 0 0 | NE SAND M | EDIUM SAND | COARSE FIN SAND I I I I I I I I I I I I I I I I I I I | E GRAVEL | CO GR 0 0 0 0 0 | ARSE AVEL > I | 100 | |
| Depth | | | Grain Size | Distribution % v | wt retained | Gr | avel | D10 | D30 | D60 | Cu | Ce |
| Depth | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | 510 | 550 | 100 | Cu | |
| 0.50 m | 0.00 | 14.00 | 79.00 | 6.00 | 1.00 | 0.00 | 0.00 | 0.0508 | 0.1385 | 0.2338 | 4.61 | 1.62 |
| 2.25 m | 10.00 | 54.00 | 29.00 | 5.00 | 1.00 | 1.00 | 0.00 | 0.0020 | 0.0160 | 0.0656 | 32.81 | 1.96 |
| 5.25 m | 12.00 | 49.00 | 30.00 | 6.00 | 1.00 | 2.00 | 0.00 | - | 0.0154 | 0.0724 | - | - |
| 8.25 m | 7.00 | 50.00 | 30.00 | 7.00 | 4.00 | 2.00 | 0.00 | 0.0036 | 0.0225 | 0.0851 | 23.75 | 1.66 |
| 10.00 m | 8.00 | 48.00 | 33.00 | 6.00 | 2.00 | 3.00 | 0.00 | 0.0029 | 0.0222 | 0.0887 | 30.11 | 1.88 |



| | | | GRA | AIN SIZE DI | STRIBUT | ION CURVES | | | | | | |
|-------------------------|--|-------------------------|--|--|--|--|---|---------------------------|-----------------------------|-----------------------|---------------|----|
| | Project Name | | Conducting geoto connection with connectivity to e | echnical investiga construction of H xisting IR networ | tion, preparation aryana Orbital k in the state of | on of geotechnical re Rail Corridor (HOR 'Haryana. | eport for designin C) project from P | g of bridge alwal to H | es and for d larsana Kal | embankm lan includ | ent in ing | |
| Lo | ocation/Chaina | ge | 13+787 Major B | ridge | | | | | | | | |
| | B.H. No. | 8 | BH-A1 | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0.001 0.00 | | SILT | FI | NE SAND | MEDIUM SAND | COARSE FIN SAND I I I I I I I I I I I I I I I I I I I | E GRAVEL | | ARSE AVEL | | |
| | DEPTH: | | | | Frain Sizo Mill | imotors | | | | | | |
| | 1.00 m 20.50 m | -∎-2.50 m -€-24.00 m | | 00 m — | + | <u> </u> | m — | •14.50 m •35.50 m | - | <u>₩</u> 18.0 | 0 m 0 m | |
| Depth | Clay | Silt | E: | Sand | Correct | Gr | avel | D10 | D30 | D60 | Cu | Ce |
| 1.00 m | 16.00 | 65 00 | Fine 13.00 | Medium 5.00 | 1.00 | Fine 0.00 | 0.00 | - | 0.0075 | 0.0373 | - | - |
| 2.50 m | 13.00 | 55.00 | 23.00 | 4.00 | 3.00 | 2.00 | 0.00 | <u> </u> | 0.0120 | 0.0568 | - | - |
| 6.00 m | 12.00 | 53.00 | 24.00 | 6.00 | 3.00 | 2.00 | 0.00 | - | 0.0137 | 0.0630 | - | - |
| 8.50 m | 11.00 | 53.00 | 26.00 | 6.00 | 1.00 | 3.00 | 0.00 | - | 0.0150 | 0.0654 | - | - |
| 11.50 m | 12.00 | 52.00 | 24.00 | 7.00 | 1.00 | 4.00 | 0.00 | - | 0.0140 | 0.0651 | - | - |
| 14.50 m 18.00 m | 12.00 | 54.00 49.00 | 23.00 | 4.00 | 5.00 | 4.00 | 2.00 | - | 0.0134 | 0.0609 | - | - |
| 20.50 m | 13.00 | 49.00 | 20.00 | 6.00 | 1.00 | 5.00 | 0.00 | - | 0.0140 | 0.0097 | - | - |
| 24.00 m | 11.00 | 51.00 | 21.00 | 9.00 | 2.00 | 6.00 | 0.00 | - | 0.0156 | 0.0698 | - | - |
| 26.50 m | 12.00 | 48.00 | 23.00 | 7.00 | 4.00 | 5.00 | 1.00 | - | 0.0155 | 0.0750 | - | - |
| 29.50 m | 15.00 | 50.00 | 18.00 | 7.00 | 2.00 | 7.00 | 1.00 | - | 0.0110 | 0.0621 | - | - |
| 32.50 m | 16.00 | 51.00 | 16.00 | 4.00 | 3.00 | 10.00 | 0.00 | - | 0.0097 | 0.0574 | - | - |
| 35.50 m | 17.00 | 51.00 | 13.00 | 6.00 | 2.00 | 8.00 | 3.00 | - | 0.0087 | 0.0549 | - | - |
| 38.50 m | 16.00 | 53.00 | 15.00 | 5.00 | 2.00 | 9.00 | 0.00 | - | 0.0092 | 0.0536 | - | - |



| | | | GR | AIN SIZE DI | STRIBUT | ION CURVES | 5 | | | | | |
|-------------------------|---|----------------|---|--|--|--|---|-----------------------------|-------------------------|-----------------------|----------------|--------|
| | Project Name | | Conducting geot connection with connectivity to e | echnical investigation of Hatexisting IR network | tion, preparation aryana Orbital c in the state of | on of geotechnical ı Rail Corridor (HOF f Haryana. | report for designir RC) project from I | ng of bridge Palwal to H | es and for arsana Ka | embankm lan includ | ent in ling | |
| L | ocation/Chainag | ze | 13+787 Major B | ridge | | | | | | | | |
| | B.H. No. | | BH-P1 | 0 | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | 2 | SILT | Fit 0.075 0.1 | NE SAND | MEDIUM SAND | COARSE FIN SAND | NE GRAVEL | | ARSE AVEL > | 100 | |
| | −1.00 m −19.00 m | 4 .00 | 0 m 00 m | → 7.00 m | _ | ₩ 10.00 m 28.00 m | <u> </u> | 0 m 0 m | - | ► 16.00 - 37.00 | m | |
| | | | 0 | N (1) (1) (2) | | | | 1 | | | | |
| Depth | | _ | Grain Size | e Distribution % v Sand | wt retained | G | ravel | D10 | D30 | D60 | Cu | Ce |
| | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | | | | | |
| 1.00 m | 6.00 | 38.00 | 48.00 | 5.00 | 2.00 | 1.00 | 0.00 | 0.0049 | 0.0374 | 0.1367 | 27.73 | 2.08 |
| 4.00 m 7.00 m | 5.00 | 35.00 40.00 | 51.00 45.00 | 6.00 7.00 | 2.00 | 2.00 | 0.00 | 0.0066 | 0.0456 | 0.1541 | 23.53 | 2.06 |
| 10.00 m | 11.00 | 53.00 | 29.00 | 5.00 | 1.00 | 1.00 | 0.00 | - | 0.0151 | 0.0655 | - | - |
| 13.00 m | 13.00 | 55.00 | 24.00 | 3.00 | 2.00 | 3.00 | 0.00 | - | 0.0120 | 0.0569 | - | - |
| 16.00 m | 11.00 | 57.00 | 20.00 | 6.00 | 1.00 | 5.00 | 0.00 | - | 0.0135 | 0.0573 | - | - |
| 19.00 m | 12.00 | 51.00 | 23.00 | 4.00 | 3.00 | 6.00 | 1.00 | - | 0.0144 | 0.0674 | - | - |
| 22.00 m | 13.00 | 51.00 | 19.00 | 6.00 | 3.00 | 8.00 | 0.00 | - | 0.0130 | 0.0648 | - | - 1.83 |
| 28.00 m | 12.00 | 51.00 | 22.00 | 6.00 | 1.00 | 6.00 | 2.00 | - | 0.0143 | 0.0673 | - | - |
| 34.00 m | 13.00 | 51.00 | 20.00 | 5.00 | 2.00 | 9.00 | 0.00 | - | 0.0130 | 0.0648 | - | - |
| 37.00 m | 15.00 | 53.00 | 13.00 | 6.00 | 2.00 | 11.00 | 0.00 | - | 0.0101 | 0.0556 | - | - |



| 1 | | | GRA | AIN SIZE DIS | TRIBUTI | ON CURVES | | | | | | |
|---|--|--|---|--|---|--|--|--|---|---|---|--|
| | Project Name | | Conducting geote connection with connectivity to e | echnical investigation construction of Har xisting IR network i | on, preparation yana Orbital Ra in the state of H | of geotechnical re ail Corridor (HOR) Haryana. | port for designin C) project from l | ng of bridge Palwal to H | es and for e arsana Kal | embankme lan includ | ent in ing | |
| L | ocation/Chaina | ge | 13+787 Major B | ridge | | | | | | | | |
| | B.H. No. | 5- | BH-A2 | -0- | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 | | SILT | FINI | E SAND | MEDIUM SAND | COARSE FI | | | ARSE AVEL | | |
| | DEPTH: | | | Gr | ain Size Millir | neters | | | | | | |
| | 2.50 M | ───5.50 m | | oum — | | · · · · · · | | 10.00 | | A 22 C | ı m | |
| | 23.50 m | → 26.50 m | 29. | 50 m — * | - 32.50 m | → 14.50 → 35.50 | m — | - 18.00 m - 38.50 m | - | — 20.5 | | |
| Denth | 23.50 m | → 26.50 m | - <u>+</u> -29. Grain Size | 50 m ——————————————————————————————————— | - 32.50 m | → 14.50 → 35.50 | m — | = 18.00 m = 38.50 m | D30 | ● 20.5 ● 20.5 | <u> </u> | Ce |
| Depth | 23.50 m | | Grain Size | 50 m ——————————————————————————————————— | - 32.50 m t retained Coarse | → 14.50 → 35.50 | m — m — avel Coarse | – 18.00 m – 38.50 m – D10 | D30 | • 20.50 D60 | Cu | Ce |
| Depth 2.50 m | 23.50 m Clay 5.00 | → 26.50 m Silt 36.00 | Grain Size | 50 m 😽 Distribution % wr Sand Medium 6.00 | - 32.50 m t retained Coarse 0.00 | → 14.50 → 35.50 <u>Fine</u> 0.00 | m — m — Coarse 0.00 | - 18.00 m - 38.50 m D10 0.0065 | D30 | D60 0.1457 | Cu 22.56 | Cc 2.04 |
| Depth 2.50 m 5.50 m | 23.50 m Clay 5.00 6.00 | → 26.50 m Silt 36.00 39.00 | ← 29. Grain Size Fine 53.00 48.00 | 50 m | - 32.50 m t retained Coarse 0.00 2.00 | → 14.50 → 35.50 Fine 0.00 0.00 | m | - 18.00 m - 38.50 m D10 0.0065 0.0049 | D30 0.0438 0.0360 | D60 0.1457 0.1314 | Cu 22.56 26.96 | Cc 2.04 2.02 |
| Depth 2.50 m 5.50 m 8.50 m | 23.50 m Clay 5.00 6.00 11.00 | → 26.50 m Silt 36.00 39.00 58.00 56.00 | ← 29. Grain Size Fine 53.00 48.00 23.00 21.00 | 50 m | - 32.50 m - 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 | | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - | D30 0.0438 0.0360 0.0134 | D60 0.1457 0.1314 0.0557 | Cu 22.56 26.96 | Cc 2.04 2.02 |
| Depth 2.50 m 5.50 m 8.50 m 11.50 m 14.50 | 23.50 m Clay 5.00 6.00 11.00 12.00 | → 26.50 m Silt 36.00 39.00 58.00 55.00 52.00 | Grain Size Fine 53.00 48.00 23.00 21.00 25.00 | 50 m | - 32.50 m - 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 1.00 | → 14.50 → 35.50 Fine 0.00 0.00 2.00 3.00 4.00 | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - - | D30 0.0438 0.0360 0.0134 0.0130 | D60 0.1457 0.1314 0.0557 0.0569 | Cu 22.56 26.96 - | Cc 2.04 2.02 - |
| Depth 2.50 m 5.50 m 8.50 m 11.50 m 14.50 m 18.00 m | 23.50 m Clay 5.00 6.00 11.00 12.00 11.00 13.00 | → 26.50 m Silt 36.00 39.00 58.00 55.00 55.00 55.00 | Grain Size Fine 53.00 48.00 23.00 21.00 25.00 20.00 | 50 m | = 32.50 m = 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 1.00 2.00 | | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - - - - | D30 0.0438 0.0360 0.0134 0.0130 0.0130 | D60 0.1457 0.1314 0.0557 0.0589 0.0653 0.0653 | Cu 22.56 26.96 - - | Cc 2.04 2.02 - - |
| Depth 2.50 m 5.50 m 8.50 m 11.50 m 14.50 m 18.00 m 20.00 m | 23.50 m Clay 5.00 6.00 11.00 12.00 13.00 13.00 | → 26.50 m Silt 36.00 39.00 55.00 55.00 55.00 51.00 | Grain Size Fine 53.00 48.00 23.00 21.00 25.00 20.00 22.00 | 50 m | = 32.50 m = 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 2.00 1.00 | | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - - - - - | D30 0.0438 0.0360 0.0134 0.0130 0.0150 0.0119 0.0142 | D60 0.1457 0.1314 0.0557 0.0589 0.0653 0.0663 | Cu 22.56 26.96 - - - | Cc 2.04 2.02 - - - |
| Depth 2.50 m 5.50 m 8.50 m 11.50 m 14.50 m 18.00 m 20.50 m 23.50 m | 23.50 m Clay 5.00 6.00 11.00 12.00 11.00 13.00 12.00 10.00 | → 26.50 m Silt 36.00 39.00 55.00 55.00 51.00 51.00 | Grain Size Fine 53.00 48.00 23.00 21.00 25.00 20.00 22.00 24.00 | 50 m | - 32.50 m - 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 1.00 2.00 1.00 2.00 1.00 | | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - - - - - - - - - - - - - | D30 0.0438 0.0360 0.0134 0.0130 0.0150 0.0119 0.0170 0.0173 | D60 0.1457 0.0557 0.0589 0.0653 0.0567 0.0774 | Cu 22.56 26.96 - - - - 36.21 | Cc 2.04 2.02 - - - - - - - 2.00 |
| Depth 2.50 m 5.50 m 11.50 m 14.50 m 18.00 m 20.50 m 23.50 m 26.50 m | 23.50 m Clay 5.00 6.00 11.00 12.00 11.00 13.00 12.00 10.00 11.00 | → 26.50 m Silt 36.00 39.00 55.00 55.00 51.00 51.00 51.00 50.00 | ← 29. Grain Size Fine 53.00 48.00 23.00 21.00 25.00 20.00 22.00 24.00 20.00 20.00 | 50 m | - 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 1.00 2.00 1.00 2.00 3.00 | | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - - - - - - 0.0020 - - - - - - - - - - - - - | D30 0.0438 0.0360 0.0134 0.0130 0.0150 0.0119 0.0143 0.0170 | D60 0.1457 0.1314 0.0557 0.0589 0.0653 0.0567 0.0673 0.0773 | Cu 22.56 26.96 - - - 36.21 | Cc 2.04 2.02 - - - 2.00 |
| Depth 2.50 m 5.50 m 8.50 m 11.50 m 14.50 m 20.50 m 23.50 m 26.50 m 29.50 m | 23.50 m Clay 5.00 6.00 11.00 12.00 11.00 13.00 12.00 10.00 11.00 12.00 | → 26.50 m Silt 36.00 39.00 55.00 55.00 51.00 51.00 51.00 51.00 | ← 29. Grain Size Fine 53.00 48.00 23.00 21.00 25.00 20.00 22.00 24.00 20.00 19.00 | 50 m *** Distribution % wr Sand Medium 6.00 5.00 7.00 6.00 5.00 7.00 6.00 7.00 6.00 7.00 6.00 7.00 6.00 7.00 6.00 7.00 6.00 7.00 6.00 7.00 6.00 7.00 7 | - 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 1.00 2.00 1.00 | | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - - - 0.0020 - - - | D30 0.0438 0.0360 0.0134 0.0130 0.0150 0.019 0.0143 0.0170 0.0142 | D60 0.1457 0.1314 0.0557 0.0653 0.0653 0.0673 0.0724 0.0723 0.0673 | Cu 22.56 26.96 - - - - 36.21 - | Cc 2.04 2.02 - - - 2.00 - |
| Depth 2.50 m 5.50 m 8.50 m 11.50 m 14.50 m 20.50 m 23.50 m 29.50 m 32.50 m | 23.50 m Clay 5.00 6.00 11.00 12.00 13.00 12.00 10.00 11.00 12.00 13.00 | → 26.50 m Silt 36.00 39.00 55.00 55.00 51.00 51.00 51.00 51.00 | ← 29. Grain Size 53.00 48.00 23.00 21.00 25.00 20.00 22.00 24.00 20.00 19.00 21.00 | 50 m *** Distribution % wr Sand Medium 6.00 5.00 5.00 7.00 6.00 5.00 7.00 6.00 7.00 6.00 7.00 6.00 3.00 | - 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 3.00 1.00 2.00 | → 14.50 → 35.50 Fine 0.00 2.00 3.00 4.00 5.00 6.00 7.00 9.00 11.00 10.00 | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - - - - 0.0020 - - - - - - - - - - - - - | D30 0.0438 0.0360 0.0134 0.0150 0.0150 0.0150 0.0170 0.0143 0.0170 0.0142 0.0131 | D60 0.1457 0.1314 0.0557 0.0653 0.0567 0.0673 0.0724 0.0723 0.0673 0.0673 | Cu 22.56 26.96 - - - - - 36.21 - - | Cc 2.04 2.02 - - - 2.00 - - - |
| Depth 2.50 m 5.50 m 8.50 m 11.50 m 14.50 m 20.50 m 23.50 m 32.50 m 32.50 m | 23.50 m Clay 5.00 6.00 11.00 12.00 11.00 12.00 10.00 11.00 12.00 13.00 12.00 13.00 12.00 | → 26.50 m Silt 36.00 39.00 55.00 55.00 51.00 51.00 51.00 51.00 51.00 51.00 48.00 | Grain Size Fine 53.00 48.00 23.00 21.00 25.00 20.00 24.00 20.00 24.00 20.00 21.00 21.00 21.00 21.00 | 50 m | - 32.50 m - 32.50 m t retained Coarse 0.00 2.00 1.00 1.00 2.00 1.00 2.00 3.00 1.00 2.00 2.00 2.00 2.00 | → 14.50 → 35.50 Fine 0.00 0.00 2.00 3.00 4.00 5.00 6.00 7.00 9.00 11.00 10.00 8.00 | m | = 18.00 m = 38.50 m D10 0.0065 0.0049 - - - 0.0020 - - - - - - - - - - - - - | D30 0.0438 0.0360 0.0134 0.0130 0.0143 0.0150 0.0143 0.0170 0.0143 0.0170 0.0155 | D60 0.1457 0.1314 0.0557 0.0589 0.0653 0.0567 0.0673 0.0724 0.0723 0.0673 0.0673 | Cu 22.56 26.96 - - - - - - - - - - - - - - - - - - - | Cc 2.04 2.02 - - - 2.00 - - - - - - - |



| | | | GRA | AIN SIZE DI | STRIBUTIO | ON CURVES | 5 | | | | | |
|-------------------------|---|-------|--|--|---|--|---|-----------------------------|-------------------------|-----------------------|---------------|------|
| | Project Name | | Conducting geote connection with connectivity to ex- | echnical investiga construction of Ha xisting IR network | tion, preparation aryana Orbital Ra < in the state of H | of geotechnical r il Corridor (HOR aryana. | eport for designin C) project from F | ng of bridge Palwal to H | es and for arsana Ka | embankm lan includ | ent in ing | |
| Lo | ocation/Chaina | ge | 13+917 Minor B | ridge | | | | | | | | |
| | B.H. No. | 8 | BH-CL | · | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: 0.50 | m | SILT | | NE SAND | IEDIUM SAND | A.75 | <pre>#E GRAVEL</pre> | CO/ GR | ARSE | | |
| | | | | | | | | | | | | |
| De d | | | Grain Size | Distribution % | wt retained | ~ | | D10 | D20 | DZA | C | C |
| Depth | Clay | Silt | Fine | Sand Medium | Coarse | Gi Fine | avel Coarse | 010 | D30 | D00 | Cu | Ce |
| 0.50 m | 7.00 | 46.00 | 40.00 | 6.00 | 1.00 | 0.00 | 0.00 | 0.0037 | 0.0258 | 0.0991 | 27.01 | 1.84 |
| 2.25 m | 19.00 | 71.00 | 5.00 | 4.00 | 1.00 | 0.00 | 0.00 | - | 0.0053 | 0.0280 | - | - |
| 5.25 m | 7.00 | 47.00 | 36.00 | 5.00 | 1.00 | 4.00 | 0.00 | 0.0036 | 0.0248 | 0.0964 | 26.45 | 1.76 |
| 8.25 m | 11.00 | 50.00 | 28.00 | 6.00 | 2.00 | 3.00 | 0.00 | - | 0.0163 | 0.0724 | - | - |
| 10.00 m | 12.00 | 54.00 | 25.00 | 3.00 | 2.00 | 4.00 | 0.00 | - | 0.0134 | 0.0610 | - | - |



| | | | GRA | AIN SIZE DI | STRIBUTIC | ON CURVES | 5 | | | | | |
|-------------------------|---|-------|--|--|---|---|---|---------------------------|-------------------------|---|---------------|------|
| | Project Name | | Conducting geoto connection with connectivity to e | echnical investiga construction of Ha xisting IR network | tion, preparation aryana Orbital Ra < in the state of H | of geotechnical re il Corridor (HOR aryana. | eport for designin C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm lan includ | ent in ing | |
| L | ocation/Chaina | ge | 14+072 Minor B | ridge | | | | | | | | |
| | B.H. No. | 2 | BH-CL | 0 | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: 0.50 | m | SILT | | NE SAND | EDIUM SAND | COARSE FIN SAND I I I I I I I I I I I I I I I I I I I | E GRAVEL | CO, GR | ARSE AVEL > 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | | |
| | | | | | | | | | - | - | - | |
| Douth | | | Grain Size | Distribution % | wt retained | ~ | | D10 | D20 | DCA | C | C- |
| Depth | Clay | Silt | Fine | Sand Medium | Coarse | Gr | avel Coarse | D10 | D30 | D60 | Cu | Ce |
| 0.50 m | 5.00 | 37.00 | 51.00 | 7.00 | 0.00 | 0.00 | 0.00 | 0.0063 | 0.0419 | 0.1434 | 22.63 | 1.93 |
| 2.25 m | 16.00 | 71.00 | 10.00 | 3.00 | 0.00 | 0.00 | 0.00 | | 0.0070 | 0.0321 | - | - |
| 5.25 m | 11.00 | 52.00 | 25.00 | 7.00 | 1.00 | 4.00 | 0.00 | - | 0.0153 | 0.0676 | - | - |
| 8.25 m | 12.00 | 53.00 | 23.00 | 6.00 | 1.00 | 5.00 | 0.00 | - | 0.0137 | 0.0629 | - | - |
| 10.00 m | 11.00 | 54.00 | 21.00 | 7.00 | 3.00 | 4.00 | 0.00 | - | 0.0145 | 0.0631 | - | - |



| | | | GRA | AIN SIZE DI | STRIBUTIC | ON CURVES | | | | | | |
|-------------------------|---|-----------------|---|--|--|---|---|---------------------------|-------------------------|---|---------------|------|
| | Project Name | | Conducting geote connection with connectivity to ex | echnical investiga construction of Ha kisting IR network | tion, preparation aryana Orbital Ra k in the state of Ha | of geotechnical re il Corridor (HOR aryana. | eport for designin C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm lan includ | ent in ing | |
| L | ocation/Chaina; | ge | 14+415 Minor B | ridge | | | | | | | | |
| | B.H. No. | | BH-CL | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | | NE SAND M | EDIUM SAND | COARSE FIN SAND | E GRAVEL | | ARSE AVEL > 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | | |
| | | - 0.50 m | Grain Size | 2.25 m | wt retained | 5 .25 m | | 8. | 25 m | | | |
| Depth | Clay | Silt | | Sand | | Gr | avel | D10 | D30 | D60 | Cu | Cc |
| 0.50 | C.0.2 | 40.00 | Fine | Medium | Coarse | Fine | Coarse | 0.0045 | 0.02(1 | 0.0054 | 21.21 | 1.60 |
| 0.50 m | 6.00 | 48.00 | 38.00 | 7.00 | 1.00 | 0.00 | 0.00 | 0.0045 | 0.0261 | 0.0954 | 21.31 | 1.60 |
| 5.25 m | 8.00 | 53.00 | 28.00 | 7.00 | 1.00 | 3.00 | 0.00 | 0.0029 | 0.0192 | 0.0725 | 24.95 | 1.75 |
| 8.25 m | 7.00 | 53.00 | 30.00 | 5.00 | 3.00 | 2.00 | 0.00 | 0.0035 | 0.0209 | 0.0750 | 21.16 | 1.64 |
| | | | | | | | | | | | | |



| | | | GRA | AIN SIZE DIS | STRIBUTIC | ON CURVES | 5 | | | | | |
|-------------------------|---|-------|--|---|---|--|---|---------------------------|-------------------------|-----------------------|---------------|------|
| | Project Name | | Conducting geote connection with connectivity to ex- | echnical investigat construction of Ha xisting IR network | ion, preparation ryana Orbital Ra in the state of H | of geotechnical r il Corridor (HOR aryana. | eport for designin C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm lan includ | ent in ing | |
| Le | cation/Chaina | ge | 15+259 Minor B | ridge | | | | | | | | |
| | B.H. No. | 8 | BH-CL | Č. | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | FIN | IE SAND M | EDIUM SAND | COARSE FIN SAND | E GRAVEL | CO. GR | ARSE AVEL | 100 | |
| | 0.50 | m | <u>−</u> 2.25 m | | K− 4.50 m | - | -5.25 m | - | 8.25 | n | | |
| | | | Grain Size | Distribution % w | t retained | | | 1 | | | | |
| Depth | Clav | Silt | | Sand | | Gr | avel | D10 | D30 | D60 | Cu | Cc |
| 0.50 | | 52.00 | Fine | Medium | Coarse | Fine | Coarse | 0.000 | 0.0215 | 0.0775 | | 1 |
| 0.50 m | 7.00 | 52.00 | 32.00 | 6.00 | 2.00 | 1.00 | 0.00 | 0.0036 | 0.0215 | 0.07/7 | 21.83 | 1.67 |
| 2.25 m | 0.00 | 55.00 | 35.00 | 4.00 | 3.00 | 0.00 | 0.00 | 0.0043 | 0.0222 | 0.0750 | 1/.5/ | 1.52 |
| 4.30 m | 0.00 | 56.00 | 30.00 | 5.00 | 1.00 | 1.00 | 0.00 | 0.0029 | 0.0184 | 0.0080 | 23.49 | 1./3 |
| 3.23 m | 12.00 | 30.00 | 22.00 | 6.00 | 2.00 | 4.00 | 2.00 | - | 0.0159 | 0.0392 | - | - |
| 8.23 M | 12.00 | 49.00 | 20.00 | 0.00 | 2.00 | 3.00 | 2.00 | - | 0.0155 | 0.0723 | - | - |



| | | | GRA | IN SIZE DI | STRIBUTIO | ON CURVES | | | | | | |
|-------------------------|---|-----------------|---|--|---|--|-------------------------------------|-------------------------------|-------------------------|------------------------|---------------|------|
| | Project Name | | Conducting geote connection with c connectivity to ex | chnical investiga construction of Ha isting IR networl | tion, preparation aryana Orbital Ra k in the state of H | of geotechnical r il Corridor (HOR aryana. | eport for desigr C) project fron | ning of bridge Palwal to H | es and for arsana Ka | embankm Ilan includ | ent in ing | |
| L | ocation/Chaina | ge | 15+416 Minor Br | idge | | | | | | | | |
| | B.H. No. | | BH-CL | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | Fil 1 1 1 1 1 1 1 1 1 1 1 1 1 | NE SAND | IEDIUM SAND | COARSE SAND | | CO. GR | ARSE AVEL | | |
| | | - 0.50 m | | -2.25 m | wt retained | 5.25 m | | 8. | 25 m | | | |
| Depth | a | 6 1 1 | | Sand | | Gr | avel | D10 | D30 | D60 | Cu | Cc |
| | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | | | | | |
| 0.50 m | 7.00 | 53.00 | 32.00 | 5.00 | 2.00 | 1.00 | 0.00 | 0.0035 | 0.0210 | 0.0750 | 21.15 | 1.65 |
| 2.25 m | 5.00 | 55.00 | 32.00 | 5.00 | 3.00 | 0.00 | 0.00 | 0.0053 | 0.0234 | 0.0750 | 14.25 | 1.39 |
| 8.25 m | 9.00 | 51.00 | 32.00 | 6.00 | 1.00 | 1.00 | 0.00 | 0.0035 | 0.0190 | 0.0082 | 31 20 | 1.00 |
| 0.4J III | 2.00 | 51.00 | 52.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.0024 | 0.0109 | 0.0750 | 51.20 | 1.77 |



| 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 | | | 15+441 Maior Bridge | | | | | | | | | | |
| B.H. No. | | | BH-A1 | | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0.001 DEPTH: 20 m - 4.00 | 22 0 m - 7.00 | SILT | FI | NE SAND | MEDIUM SAND 5 1 1 1 1 1 1 1 1 1 1 1 | m 222.00 | NE GRAVEL | CO. GR | ARSE AVEL | 100 8.00 m | | |
| | | | Grain Size | Distribution % | wt retained | | | 1 | 1 | 1 | 1 | 1 | |
| Depth | Cl | 6. 7 . | | Sand | | Gi | avel | D10 | D30 | D60 | Cu | Cc | |
| - | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | | | | | | |
| 1.00 m | 5.00 | 37.00 | 51.00 | 6.00 | 1.00 | 0.00 | 0.00 | 0.0063 | 0.0419 | 0.1431 | 22.59 | 1.94 | |
| 4.00 m | 10.00 | 46.00 | 28.00 | 7.00 | 3.00 | 5.00 | 1.00 | 0.0020 | 0.0198 | 0.0911 | 45.53 | 2.16 | |
| 7.00 m | 12.00 | 51.00 | 26.00 | 5.00 | 1.00 | 5.00 | 0.00 | - | 0.0145 | 0.0674 | - | - | |
| 10.00 m | 11.00 | 46.00 | 30.00 | 6.00 | 1.00 | 4.00 | 2.00 | - | 0.0183 | 0.0856 | - | - | |
| 13.00 m | 12.00 | 44.00 | 28.00 | 8.00 | 3.00 | 5.00 | 0.00 | - | 0.0178 | 0.0915 | - | - | |
| 16.00 m | 13.00 | 48.00 | 24.00 | 6.00 | 2.00 | 7.00 | 0.00 | - | 0.0143 | 0.0723 | - | - | |
| 19.00 m | 11.00 | 43.00 | 30.00 | 7.00 | 3.00 | 6.00 | 0.00 | - | 0.0202 | 0.1015 | - | - | |
| 22.00 m | 11.00 | 47.00 | 28.00 | 7.00 | 1.00 | 6.00 | 0.00 | - | 0.0177 | 0.0817 | - | - | |
| 25.00 m | 12.00 | 46.00 | 26.00 | 6.00 | 1.00 | 9.00 | 0.00 | - | 0.0166 | 0.0821 | - | - | |
| 28.00 m | 10.00 | 41.00 | 30.00 | 4.00 | 5.00 | 10.00 | 0.00 | 0.0020 | 0.0236 | 0.1214 | 60.70 | 2.30 | |



| 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 | | | 15+441 Major Bridge | | | | | | | | | |
| B.H. No. | | | BH-A2 | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: 50 m $\rightarrow 5.50$ | 22 0 m - 8.50 | SILT | FI 0.075 0.1 0.1 0.1 | NE SAND M | neters | COARSE FIN SAND I I I I I I I I I I I I I I I I I I I | e GRAVEL | CO/ GR 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | ARSE AVEL | 9.50 m | |
| Denth | | | Grain Size | Distribution % | wt retained | G | avol | D10 | D30 | D60 | Cu | Ce |
| Deptn | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | 510 | 1000 | 1.00 | Cu | |
| 2.50 m | 12.00 | 68.00 | 13.00 | 5.00 | 1.00 | 1.00 | 0.00 | - | 0.0102 | 0.0404 | - | - |
| 5.50 m | 14.00 | 61.00 | 15.00 | 5.00 | 1.00 | 3.00 | 1.00 | - | 0.0096 | 0.0452 | - | - |
| 8.50 m | 13.00 | 57.00 | 18.00 | 6.00 | 2.00 | 4.00 | 0.00 | - | 0.0114 | 0.0531 | - | - |
| 11.50 m 14 50 m | 12.00 | 57.00 | 20.00 | 6.00 3.00 | 1.00 | 5.00 | 0.00 | - | 0.0135 | 0.0573 | - | - |
| 17.50 m | 13.00 | 61.00 | 14.00 | 5.00 | 1.00 | 5.00 | 1.00 | - | 0.0125 | 0.0469 | - | - |
| 20.50 m | 11.00 | 60.00 | 16.00 | 3.00 | 4.00 | 6.00 | 0.00 | - | 0.0127 | 0.0521 | - | - |
| 23.50 m | 12.00 | 60.00 | 15.00 | 6.00 | 1.00 | 6.00 | 0.00 | - | 0.0116 | 0.0502 | - | - |
| 26.50 m | 12.00 | 53.00 | 20.00 | 7.00 | 1.00 | 7.00 | 0.00 | - | 0.0136 | 0.0628 | - | - |
| 29.50 m | 13.00 | 55.00 | 17.00 | 4.00 | 3.00 | 8.00 | 0.00 | - | 0.0118 | 0.0565 | - | - |



| 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. | | | | | | | | | | |
| L | ocation/Chaina | 0e | 16+042 Major Bridge | | | | | | | | | | |
| B.H No | | | BH-A1 | | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 DEPTH: | | SILT | | IE SAND | MEDIUM SAND | COARSE FINI SAND | e gravel | | ARSE AVEL | | | |
| -∎-2.25 m × 6.00 m -9.00 m -10.00 m +11.50 m 14.50 m -17.50 m -23.50 m 23.50 m 26.50 m -29.50 m | | | | | | | | | | | | | |
| Depth | Clay | Silt | Fine | Sand Medium | Coarse | Gr | avel Coarse | D10 | D30 | D60 | Cu | Ce | |
| 2.25 m | 5.00 | 35.00 | 54.00 | 2.00 | 3.00 | 1.00 | 0.00 | 0.0066 | 0.0458 | 0.1485 | 22.58 | 2.15 | |
| 6.00 m | 6.00 | 37.00 | 50.00 | 3.00 | 2.00 | 2.00 | 0.00 | 0.0050 | 0.0391 | 0.1390 | 27.78 | 2.20 | |
| 9.00 m | 4.00 | 23.00 | 64.00 | 5.00 | 2.00 | 2.00 | 0.00 | 0.0125 | 0.0867 | 0.2007 | 16.06 | 3.00 | |
| 10.00 m | 6.00 | 54.00 | 31.00 | 5.00 | 1.00 | 2.00 | 1.00 | 0.0043 | 0.0221 | 0.0750 | 17.39 | 1.51 | |
| 11.50 m | 7.00 | 58.00 | 25.00 | 4.00 | 3.00 | 3.00 | 0.00 | 0.0035 | 0.0185 | 0.0640 | 18.38 | 1.54 | |
| 14.50 m | 10.00 | 59.00 | 24.00 | 2.00 | 1.00 | 4.00 | 0.00 | 0.0020 | 0.0143 | 0.0561 | 28.04 | 1.81 | |
| 17.50 m | 12.00 | 58.00 | 21.00 | 3.00 | 1.00 | 5.00 | 0.00 | - | 0.0122 | 0.0536 | - | - | |
| 20.50 m | 11.00 | 55.00 | 23.00 | 4.00 | 1.00 | 5.00 | 1.00 | - | 0.0142 | 0.0611 | - | - | |
| 23.50 m | 12.00 | 49.00 | 24.00 | 5.00 | 3.00 | 7.00 | 0.00 | - | 0.0152 | 0.0723 | - | - | |
| 26.50 m | 11.00 | 48.00 | 21.00 | 7.00 | 4.00 | 8.00 | 1.00 | - | 0.0168 | 0.0784 | - | - | |
| 29.50 m | 10.00 | 53.00 | 20.00 | 4.00 | 2.00 | 11.00 | 0.00 | 0.0020 | 0.0160 | 0.0676 | 33.78 | 1.91 | |


| | | | GRA | AIN SIZE DI | STRIBUTIC | ON CURVES | | | | | | |
|-------------------------|--|------------------|---|--|---|---|---|---------------------------|-------------------------|-----------------------|----------------|------|
| | Project Name | | Conducting geot connection with connectivity to e | echnical investiga construction of Ha xisting IR network | tion, preparation aryana Orbital Ra c in the state of H | of geotechnical re iil Corridor (HOR laryana. | eport for designin C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm lan includ | ent in ling | |
| L | ocation/Chaina | σe | 16+042 Maior B | ridge | | | | | | | | |
| L | B H No | ge | BH-A2 | inage | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0.001 DEPTH: 0 m - 4.00 m | n — X — 7.00 m - | SILT | FII | NE SAND | 16.00 m \rightarrow 19 | COARSE FIN SAND I I I I I I I I I I I I I I I I I I I | E GRAVEL | | MRSE AVEL | 28.00 m | |
| Depth | | | Grain Size | Distribution % v Sand | wt retained | Gr | avel | D10 | D30 | D60 | Cu | Cc |
| | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | <u> </u> | | | | |
| 1.00 m | 5.00 | 34.00 | 55.00 | 5.00 | 1.00 | 0.00 | 0.00 | 0.0067 | 0.0479 | 0.1530 | 22.80 | 2.24 |
| 4.00 m | 3.00 | 43.00 | 44.00 | 7.00 | 3.00 | 0.00 | 0.00 | 0.0092 | 0.0381 | 0.1303 | 14.16 | 1.21 |
| 7.00 m | 4.00 | 45.00 | 40.00 | 8.00 | 2.00 | 1.00 | 0.00 | 0.0071 | 0.0331 | 0.1189 | 16.76 | 1.30 |
| 7.50 m | 4.00 | 32.00 | 58.00 | 5.00 | 1.00 | 0.00 | 0.00 | 0.0090 | 0.0559 | 0.1636 | 18.26 | 2.13 |
| 10.00 m | 12.00 | 60.00 | 20.00 | 3.00 | 4.00 | 1.00 | 0.00 | - | 0.0118 | 0.0505 | - | - |
| 13.00 m | 11.00 | 61.00 | 18.00 | 3.00 | 5.00 | 2.00 | 0.00 | - | 0.0125 | 0.0508 | - | - |
| 16.00 m | 13.00 | 59.00 | 18.00 | 4.00 | 1.00 | 5.00 | 0.00 | - | 0.0109 | 0.0500 | - | - |
| 19.00 m | 12.00 | 55.00 | 20.00 | 5.00 | 2.00 | /.00 | 0.00 | - | 0.0127 | 0.0570 | - | - |
| 22.00 m | 12.00 | 50.00 | 1/.00 | 5.00 | 3.00 | 0.00 | 2.00 | - | 0.0129 | 0.0587 | - | - |
| 25.00 m | 13.00 | 55.00 | 19.00 | /.00 | 2.00 | 9.00 | 0.00 | - | 0.0133 | 0.06/1 | - | - |
| 28.00 m | 12.00 | 55.00 | 16.00 | 6.00 | 5.00 | /.00 | 1.00 | - | 0.0128 | 0.0586 | - | - |



| | | | GRA | AIN SIZE DI | ISTRIBUTI | ON CURVES | 5 | | | | | |
|-------------------------|---|------------------|--|--|--|---|---|----------------------------|-------------------------|------------------------|----------------|----------|
| | Project Name | | Conducting geoto connection with connectivity to e | echnical investiga construction of H xisting IR networ | ation, preparatio aryana Orbital F k in the state of | n of geotechnical 1 Rail Corridor (HOF Haryana. | eport for designin C) project from l | ng of bridg Palwal to H | es and for arsana Ka | embankm Ilan incluc | ent in ling | |
| L | ocation/Chaina | ge | 16+231 Major B | ridge | | | | | | | | |
| | B.H. No. | 8 | BH-A1 | U U | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0.001 DEPTH: 20 m 4.00 | 22 0 m * 7.00 | SILT | FI | NE SAND | MEDIUM SAND | m → 22.50 | NE GRAVEL | CO. GR | ARSE AVEL | 0.50 m | |
| | | | Grain Size | Distribution % | wt retained | | | | | | | |
| Depth | Clav | Silt | | Sand | ~ | G | avel | D10 | D30 | D60 | Cu | Cc |
| 1.00 | 6.00 | 27.00 | Fine | Medium | Coarse | Fine | Coarse | 0.0050 | 0.0200 | 0 1 4 2 7 | 20 50 | 2.14 |
| 1.00 m | 5.00 | 37.00 | 48.00 | /.00 | 2.00 | 1.00 | 0.00 | 0.0050 | 0.0390 | 0.142/ | 28.59 | 2.14 |
| 4.00 m | 3.00 | 50.00 | 32.00 | 3.00 | 2.00 | 5.00 | 0.00 | 0.0008 | 0.0498 | 0.1038 | 24.30 | 2.20 |
| 7.00 m | <u>8.00</u> | 52.00 | 32.00 28.00 | 5.00 | 2.00 | 3.00 | 0.00 | 0.0029 | 0.0209 | 0.0809 | 27.03 | 1.85 |
| 13.00 m | 12.00 | 32.00 47.00 | 26.00 | 7.00 | 3.00 | 4.00 | 0.00 | 0.0020 | 0.0161 | 0.0700 | | 2.01 |
| 16.00 m | 11.00 | 45.00 | 31.00 | 4.00 | 2.00 | 5.00 | 2.00 | + - | 0.0101 | 0.0781 | H- | + |
| 19.00 m | 12.00 | 45.00 | 26.00 | 5.00 | 2.00 | 6.00 | 2.00 | + - | 0.0150 | 0.0897 | H- | <u> </u> |
| 22.50 m | 7.00 | 49.00 | 20.00 | 4.00 | 2.00 | 10.00 | 0.00 | 0.0036 | 0.0230 | 0.0781 | 25.12 | 1.63 |
| 26.50 m | 8.00 | 51.00 | 27.00 | 6.00 | 1.00 | 7 00 | 0.00 | 0.0029 | 0.0201 | 0.0779 | 26.69 | 1 78 |
| 29.50 m | 7.00 | 44.00 | 29.00 | 9.00 | 3.00 | 8.00 | 0.00 | 0.0029 | 0.0261 | 0 1242 | 33 70 | 1.70 |
| 49.30 III | 7.00 | 44.00 | 49.00 | 2.00 | 3.00 | 0.00 | 0.00 | 0.0057 | 0.0200 | 0.1242 | 55.70 | 1.37 |



| | | | GRA | AIN SIZE DI | STRIBUTI | ON CURVES | | | | | | |
|-------------------------|---|----------------------|---|--|---|--|---|-----------------------------|---|-----------------------|----------------|------|
| | Project Name | | Conducting geot connection with connectivity to e | echnical investiga construction of H xisting IR networ | tion, preparation aryana Orbital Ra k in the state of F | of geotechnical r ail Corridor (HOR Iaryana. | eport for designin C) project from F | ig of bridge Palwal to H | es and for arsana Ka | embankm lan includ | ent in ling | |
| L | ocation/Chaina | ge | 16+231 Major B | ridge | | | | | | | | |
| | B.H. No. | 8 | BH-A2 | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0.001 DEPTH: 50 m $\rightarrow 5.50$ | 2 2 0 m ← 8.50 | SILT | Fi 0.075 0.1 0.075 0.1 | NE SAND | meters | COARSE FIN SAND I I I I I I I I I I I I I I I I I I I | le GRAVEL | CO, GR I I I I I I I I I I I I I I I I I I | ARSE AVEL | 9.50 m | |
| Donth | | | Grain Size | Distribution % | wt retained | C. | evol | D10 | D30 | D60 | Cu | Ce |
| Depti | Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | 510 | 150 | 100 | Cu | |
| 2.50 m | 8.00 | 53.00 | 30.00 | 7.00 | 1.00 | 1.00 | 0.00 | 0.0029 | 0.0193 | 0.0726 | 24.94 | 1.77 |
| 5.50 m | 7.00 | 55.00 | 28.00 | 6.00 | 1.00 | 3.00 | 0.00 | 0.0035 | 0.0199 | 0.0703 | 19.98 | 1.59 |
| 8.50 m | 6.00 | 51.00 | 31.00 | 6.00 | 2.00 | 4.00 | 0.00 | 0.0044 | 0.0237 | 0.0847 | 19.35 | 1.52 |
| 11.50 m | 11.00 | 50.00 | 27.00 | 5.00 | 3.00 | 4.00 | 0.00 | - | 0.0162 | 0.0724 | - | - |
| 14.50 m | 12.00 | 46.00 | 28.00 | 7.00 | 1.00 | 6.00 | 0.00 | - | 0.0167 | 0.0818 | - | - |
| 17.50 m | 10.00 | 53.00 | 25.00 | 4.00 | 3.00 | 5.00 | 0.00 | 0.0020 | 0.0163 | 0.0677 | 33.84 | 1.95 |
| 20.50 m | 11.00 | 49.00 | 26.00 | 6.00 | 2.00 | 6.00 | 0.00 | - | 0.0166 | 0.0750 | - | - |
| 23.50 m | 12.00 | 44.00 | 28.00 | 7.00 | 1.00 | 7.00 | 1.00 | - | 0.0178 | 0.0914 | - | - |
| 26.50 m | 8.00 | 48.00 | 30.00 | 6.00 | 2.00 | 6.00 | 0.00 | 0.0029 | 0.0220 | 0.0898 | 30.50 | 1.84 |
| 29.50 m | 7.00 | 44.00 | 32.00 | 6.00 | 2.00 | 7.00 | 2.00 | 0.0037 | 0.0270 | 0.1177 | 31.87 | 1.68 |



| | | | GRA | AIN SIZE DI | STRIBUTI | ON CURVES | | | | | | |
|-------------------------|---|----------------|---|---|--|--|---|---------------------------|--|------------------------|----------------|------|
| | Project Name | | Conducting geot connection with connectivity to e | technical investiga construction of H existing IR network | ation, preparation aryana Orbital Ra k in the state of F | of geotechnical r ail Corridor (HOR Iaryana. | eport for designin C) project from P | g of bridge alwal to H | es and for arsana Ka | embankm alan incluc | ent in ling | |
| L | ocation/Chaina | ge | 16+815 Minor B | Bridge | | | | | | | | |
| | B.H. No. | | BH-CL | | | | | | | | | |
| Percent Finer By Weight | CLAY 100 90 80 70 60 50 40 30 20 10 0 0.001 | | SILT | Fi | NE SAND | | COARSE FIN SAND | | CO GR 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | ARSE | 100 | |
| | DEPTH: | | | G | Grain Size Millin | neters | | | | | | |
| | | 2.50 r | n Groin Circ | ■ Distribution ⁹ / | ★-5.50 m | | 8 | 3.50 m | | T | | |
| Donth | | 1 | Grain Size | Soud | wt retained | C | aval | D10 | D20 | D60 | Cu | Ca |
| Depth | Clay | Silt | Fino | Sand | Coarso | Gr | Coarso | DIO | D30 | D00 | Cu | Ce |
| 2.50 m | 7.00 | 46.00 | 41.00 | 3.00 | 1 00 | 2 00 | 0.00 | 0.0037 | 0.0259 | 0.0984 | 26 79 | 1.86 |
| 5.50 m | 6.00 | 45.00 | 38.00 | 7.00 | 3.00 | 1.00 | 0.00 | 0.0046 | 0.0286 | 0.1103 | 24.13 | 1.62 |
| 0.50 | 8.00 | 47.00 | 37.00 | 2.00 | 2.00 | 4.00 | 0.00 | 0.0030 | 0.0231 | 0.0915 | 30.94 | 1.97 |



APPENDIX – C (ANALYSIS & RECOMENDATION)

| Appendix No. | ITEMS |
|--------------|---|
| C-1 | SAMPLE CALCULATION FOR COMPUTATION OF LIOUEFACTION POTENTIAL |
| C-2 | SAMPLE CALCULATION FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR RAFT FOUNDATION |
| C-3 | SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN COMPRESSION & UPLIFT |
| C-4 | SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN LATERAL |



| | | r | _ | | _ | | | | | |
|------------|----------------------|---|--------------|--------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | | Conclusion | Liquefiable | Liquefiable | Non Liquefiable | Non Liquefiable | Non Liquefiable | Non Liquefiable | Non Liquefiable | Non Liquefiable |
| | | FOS | 0.48 | 0.62 | 1.59 | 7 | 7 | - | - | -^ |
| | | CRR _{MW} | 0.157 | 0.201 | 0.508 | AN | ٨A | ٨A | ٨A | AN |
| | | Kα | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | | Κα | - | + | - | 1 | + | Ļ | Ļ | |
| | 0.00 | Кw | 1.19 | 1.19 | 1.19 | 1.19 | 1.19 | 1.19 | 1.19 | 1.19 |
| | d for | CRR _{M=7.5} | 0.131 | 0.169 | 0.426 | AN | AN | NA | NA | AN |
| | considere m):- | (N1) _{60CS} | 12.02 | 15.84 | 29.31 | 31.79 | 32.01 | 36.19 | 37.30 | 40.50 |
| | e depth nalysis (| 8 | 1.12 | 1.12 | 1.08 | 1.08 | 1.20 | 1.20 | 1.20 | 1.20 |
| | er Table ai | ۵ | 4.39 | 4.39 | 3.61 | 3.61 | 5.00 | 5.00 | 5.00 | 5.00 |
| 18 | Wat | SPT Correct ed (N1)60 | 6.8 | 10.2 | 23.8 | 26.1 | 22.5 | 26.0 | 26.9 | 29.6 |
| SO BS-1 | | Stress Normaliz ation Factor(C | 1.70 | 1.70 | 1.70 | 1.54 | 1.32 | 1.18 | 1.08 | 1.02 |
| & RD! | 3.00m | C ₆₀ | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 5-2015 | e upto= | Critical Stress Ratio (CSR) | 0.326 | 0.324 | 0.320 | 0.314 | 0.309 | 0.304 | 0.300 | 0.292 |
| er IRC:7 | Liquefiabl | Effective Overburd en (σ'₀), t/m² | 0.45 | 1.36 | 2.73 | 4.16 | 5.59 | 7.02 | 8.45 | 9.42 |
| vsis as pe | 3H-CL | Total Dverburd en Press (o.), t/m ² | 0.95 | 2.86 | 5.73 | 8.66 | 11.59 | 14.52 | 17.45 | 19.42 |
| on Analy | 40.:- I | Stress Reduction (Coefficien (t (rd) | 0.996 | 0.989 | 0.977 | 0.966 | 0.954 | 0.943 | 0.931 | 0.907 |
| iquefacti | BH N | Fine F Content C (%) | 26 | 26 | 20 | 20 | 39 | 39 | 41 | 41 |
| Li | | Liquefaction Check for Cohesive Strata | | | | | | | Liquefiable | Liquefiable |
| | | Strata Type | Cohesionless | Cohesionless | Cohesionless | Cohesionless | Cohesionless | Cohesionless | Cohesive | Cohesive |
| | 1+523 | Moisture Content @ 100% saturation | | | | | | | 26.78 | 26.78 |
| | | Plastic ity Index (%) | | | | | | | 5.00 | 5.00 |
| | | Plastic Limit (%) | | | | | | | 20.00 | 20.00 |
| | | Liquid Limit (%) | | | | | | | 25.00 | 25.00 |
| | | Subme rged Densit y (t/m ³) | 0.91 | 0.91 | 0.95 | 0.95 | 0.95 | 0.95 | 0.97 | 0.97 |
| | | Saturate d Density (t/m ³) | 1.91 | 1.91 | 1.95 | 1.95 | 1.95 | 1.95 | 1.97 | 1.97 |
| | ge (Km) | Observe d SPT Value | 4 | 9 | 14 | 17 | 17 | 22 | 25 | 29 |
| | Chaina | Depth Below G.L. (z) in m | 0.50 | 1.50 | 3.00 | 4.50 | 6.00 | 7.50 | 9.00 | 10.00 |

| Calcul | ation of SBC for shallow found | dations as per IS | : 6403 - 1981 | |
|--|---|--|--|-------------------|
| | DATA | | CH. (KM) :- | 12+431 |
| | | | BH NO. :-] | BH-CL |
| Type of | footing | | | |
| 1 | Continuous Strip | | | |
| 2 | Rectangular | | Square | 3 |
| 3 | Square | | | |
| 4 | Circular | | | |
| Angle of | internal friction (ϕ^{o}) | | | 31.00 |
| Cohesio | n (c in t/m²) | | | 0.00 |
| Void rati | o (e), e = (G. γ_w/γ_d)-1 | | | 0.70 |
| Directior | of load with vertical (°) | | | 0.0 |
| Density | of foundation soil (t/m³) γ _{bulk} | | | 1.74 |
| Depth of | water table(m) | | | 0.00 |
| Factor o | fsafety | | | 2.50 |
| S.no. | Depth (m) of footing (D _f) below EC | GL Width (m) | | |
| 1 | 1.00 | 3.70 | | |
| 2 | 1.50 | 3.70 | | |
| 3 | 2 00 | 3 70 | | |
| Assump NOTE: ⁻ 6403 : 1 | tions and formula used in calculation as The type of failure used for bearing capa 981, Page No. 9, Table No. 3). | per IS:6403-1981 are city analysis depends i | given below - upon the value of vo | vid ratio (see IS |
| The ultir 8) | nate net bearing capacity in case of gene | eral shear failure is give | en by (from IS 6403 | : 1981, page No |
| | $q_d = c N_c s_c d_c i_c + q (N_q-1) s_q d_q i_q + (1/2)$ | 2) B $\gamma N_{\gamma} s_{\gamma} d_{\gamma} i_{\gamma} W'$ | | |
| The ultir | nate net bearing capacity in case of local | l shear failure is given | by (from IS 6403 : 1 | 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 γ N' $_\gamma$ s $_\gamma$ d $_\gamma$ i_γ | W' | |
| Where, | d. = 1+ 0.2 (D/B)*SOBT(N.) | | | |
| | $d_c = d_c = 1$ for $\phi < 10^{\circ}$ | | (from IS 6403 · 1 | 981 nage No. 9) |
| | $d_q = d_{\gamma} = 1.60 \psi < 10^{\circ}$ $d_r = d_r = 1 \pm 0.1 (D_r/B)^* SOBT(N_r)$ for | | (11011110-0400-1-1 | 501, page 110. 5) |
| | $N_{\phi} = \tan^2(\pi/4 + \phi/2)$ | ψ×ισ | | |
| | $\boldsymbol{\phi}'$ is friction angle for local shear failure | $e = \tan^{-1} (0.67 \tan \phi)$ | | |
| <u>OUTPU</u> | <u>r</u> | | | |
| The com interpola criteria. | puter aided results for shear failure crite ted values of bearing capacity obtaine | eria are tabulated below ed from general and lo | v. The results are ocal shear failure | |



| Bearing | capacity facto | rs : (from IS 6 | 6403 : 1981, pag | e No. 8, Table N | <u>lo. 1)</u> | |
|-----------------|-----------------------------|---------------------------|-----------------------------------|-------------------|----------------------------|--------------------------------------|
| | | 01.00 | 7 | | | 01.00 |
| φ | | 31.00 | | φ | | 21.93 |
| IN _C | | 32.67 | | | | 16.80 |
| N _q | | 20.63 | | N _q | | 7.76 |
| Νγ | | 25.99 | | N΄γ | | 7.06 |
| Shape fa | actors : (from I | S 6403 : 1981 | <u>, page No. 8, Ta</u> | ble No. 2) | | |
| S.no. | Width(m) | | | Sc | Sa | Sγ |
| 1 | 3.70 | | | 1.30 | 1.20 | 0.80 |
| 2 | 3.70 | | | 1.30 | 1.20 | 0.80 |
| 3 | 3.70 | | | 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 fa | ctors : (from IS | 6403 : 1981. | page No. 9) | | | |
| | ···· | | <u>p-g</u> | | | |
| S.no. | Depth(m) | Width(m) | | dc | d_q | d_{γ} |
| 1 | 1.00 | 3.70 | | 1.10 | 1.05 | 1.05 |
| 2 | 1.50 | 3.70 | | 1.14 | 1.07 | 1.07 |
| 3 | 2.00 | 3.70 | | 1.19 | 1.10 | 1.10 |
| Inclination | on factors : (fro | om IS 6403 : [·] | 1981, page No. 9 | <u>9)</u> | | |
| | 1 (1 (2 2) 2 | | 1 (1 (a a a a a a a a a a | | | |
| | $i_c = (1 - \alpha / 90)^2$ | | $i_q = (1 - \alpha / 90)^2$ | | | $i_{\gamma} = (1 - \alpha / \phi)^2$ |
| | 1.00 | | 1.00 | | | 1.00 |
| Water ta | ble factor : (fro | om IS 6403 : 1 | 981, page No. 9 | <u>))</u> | | |
| S.no. | Depth(m) | Width(m) | | Z _w /B | | W' |
| 1 | 1.00 | 3.70 | | -0.27 | | 0.50 |
| 2 | 1.50 | 3.70 | | -0.41 | | 0.50 |
| 3 | 2.00 | 3.70 | | -0.54 | | 0.50 |
| Safe Bea | aring Capacity | | | | | |
| | | | | | | |
| S.no. | Depth(m) | Width(m) | | | SBC in (t/m ²) | |
| | | | | General shear | Local shear | Recommended |
| 1 | 1.00 | 3.70 | | 21.40 | 6.35 | 10.01 |
| 2 | 1.50 | 3.70 | | 25.64 | 7.78 | 12.13 |
| 3 | 2.00 | 3.70 | | 30.05 | 9.28 | 14.34 |
| | | | | | | |



| -CL | Corrected Total (mm) tnemeltte2 | | | 25.00 | | | | | | | 25.00 | | | | | 25.00 | | |
|------------|--|---------|------|-------|---|---|---|--|---------|---|----------|------|--|---------|--|-------|-------|--|
| BH | Rigidity Factor | | | 1.00 | | | | | | | 1.00 | | | | | 1.00 | | |
| NO. :- | Depth Factor | | | 0.93 | | | | | | | 0.88 | | | | | 0.84 | | |
| BH | Total Settlement (mm) | 26.86 | | | | | | | 28.27 | | | | | 29.83 | | | | |
| | -noN ni tnəməlttəč Cohesive Soil Si (mm) | 26.86 | | | | | | | 28.27 | | | | | 29.83 | | | | |
| 12+431 | 264116ment (mm) for 10 t/m2 (from IS:8009 (Part ۱), Fig. 9, Page NO. 17) | 9.35 | | | | | | | 9.35 | | | | | 9.35 | | | | |
| (KM): | Influence Factor (I) | 0.9400 | | | | | | | 0.9400 | | | | | 0.9400 | | | | |
| | Water Table Correction Factor | 0.50 | | | | | | | 0.50 | | | | | 0.50 | | | | |
| | əuleV-V əşərəvA | 30 | | | | | | | 30 | | | | | 30 | | | | |
| 976 | Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2) | 1.437 | | | | | | | 1.512 | | | | | 1.595 | | | | |
| Part-1 | Dispersed Breadth (m) | 3.700 | | | | | | | 3.700 | | | | | 3.700 | | | | |
| R 8009 I | Dispersed Length (m) | 3.70 | | | | | | | 3.70 | | | | | 3.70 | | | | |
| S PE | (m)ssənyəidT rəys | 5.55 | | | | | | | 5.55 | | | | | 5.55 | | | | |
| A NC | (m) Breadth | | | 3.70 | | | | | | | 3.70 | | | | | 3.70 | | |
| ATI | (m) Lêngth | | | 3.70 | | | | | | | 3.70 | | | | | 3.70 | | |
| LCUL | Stress at Foundation level (Kg/Cm2) | | | 1.44 | | | | | | | 1.51 | | | | | 1.60 | | |
| r ca | Layer Thickness | 5.55 | | | | | | | 5.55 | | | | | 5.55 | | | | |
| IEN | от (m) | 6.55 | | | | | | | 7.05 | | | | | 7.55 | | | | |
| TLEN | (m) From | 1.00 | | | | | | | 1.50 | | | | | 2.00 | | | | |
| SET | (m) Depth below FGL | | | 1.00 | • | • | • | | 1 | 1 | 1.50 | | | | | 2.00 | 1 | |
| | rayer | Layer 1 | | | | | | | Layer 1 | | | | | Layer 1 | | | | |



| | | | NAME OI | F PROJE | :CT:- "G | TI for Ha | Iryana Ol | rbital Ra | il Corrid | lor (HOR | C) projec | t from P | alwal to | Harsana | Kalan in | the stat | e of Hary | /ana." | | | |
|---------------------------|---------------------------------|-------------------------------|-------------------------|--------------------|-----------|------------------|----------------------|----------------------|------------------|----------------------|--------------------|-----------|--------------------|----------------------------|-------------|-----------------------|--------------|------------------|-----------------|---------------|-------|
| Length of | Pile below c | ut of leve | <u>-</u> | 20.00 m | | | Bore | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia | of pile = 1 | .00 m | Cut-o | off Level = | 2.00 m | below EGL | |
| Restricting | PD to 15D | | Water Tał analysis = | ble depth : = | considere | d for | 0.00 m | | | | Scou | r Depth = | Non-scour | able | | - | iquefactio | n Depth = | N | | |
| Dia. of | Cut-off | Soil Is | ayers | | L L | roperties o | f layers/for | Skin Frictic | uc | | | For End | Bearing | | | | | | | | |
| Pile | Depth | from | đ | υ | Ø | × | σ | γeff | ٩L | pd (s.f) | Pd (e.b) | γeff | υ | ø | Nc | Nq | Ŋ | As/cm | Ap | ds | Qp |
| (m) | (m) | (m) | (m) | kg/cm ² | deg | | | gm/cc | сш | kg/cm ² | kg/cm ² | gm/cc | kg/cm ² | deg | | | | cm ² | cm ² | Ŧ | Ŧ |
| 1.00 | 2.00 | 0.00 2.00 | 2:00 2:50 8:50 | 0.23 | 4 4 | 1.00 | 1.00 | 0.65 0.65 0.93 | 200 50 | 0.07 0.15 0.44 | | | | | | | | 314.29 314.29 | | 3.78 87 49 | |
| 1.00 | | 8.50 | 11.50 | 0.70 | 2 | 1.00 | 0.65 | 0.95 | 300 | 0.87 | | | | | | | | 314.29 | | 50.35 | |
| 1.00 | | 11.50 | 14.50 15.00 | 0.88 | ഗധ | 1.00 | 0.51 | 0.97 | 300 | 1.15 | | | | | | | | 314.29 314.29 | | 51.56 9.09 | |
| 1.00 | | 15.00 | 22.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 200 | 1.35 | 1.35 | 0.98 | 1.02 | 9 | 6 | 1.72 | 0.57 | 314.29 | 7857.14 | 127.86 | 90.54 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | 330.14 | 90.54 |
| | | | | | | Qu,com | =.d | qs + Qp | | | | | - | Qu,uplift = | 0) | afe Frictio | nal Resista | ance + Weig | ght of Pile | | |
| | | | | | | Qa,com Qa,com | п. П. П. С. | (330.14 + 168.27 | 90.54) / 2. T | i Q | | | | Qa,uplift = Qa,uplift = | 0 | 30.14/3 + 149.32 T | - 39.27 - | | | | |
| | | | | | Say | Qa,com | =.d | 168.00 | | | | | | ⊇a,uplift = | | 149.00 T | | | | | |
| *FOS for V **FOS for L | ertical Capac Jplift Capacit | ity of pile i y of pile =∶ | n compres 3.0 | ision = 2.5 | | | | | | | | | | | | | | | | | |

| | | | VAME OF | F PROJE | ст:- "G | ll for Hai | ryana Or | bital Rail | Corrido | or (HORG | c) projec | t from Pa | alwal to I | Harsana | Kalan in | the stat | e of Hary | yana." | | | |
|---------------------------|--------------------------------|------------------------------|-------------------------|--------------------|-----------|-------------|------------|--------------|------------|--------------------|--------------------|-----------|--------------------|-------------|-------------|--------------|-------------|-----------------|-----------------|---------------|-------|
| Length of | Pile below c | sut of leve | <u> </u> | 22.00 m | | | Bore | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia | of pile = ` | .00 m | Cut-o | off Level = | 2.00 m | below EGI | |
| Restricting | PD to 15D | | Water Tal analysis : | ble depth = | considere | d for | 0.00 m | | | | Scoul | r Depth = | Non-scoura | able | | _ | iquefactio | on Depth = | NL | | |
| Dia. of | Cut-off | Soil I. | ayers | | đ | operties of | layers/for | Skin Frictio | L. | | | For End | Bearing | | | | | | | | |
| Pile | Depth | from | þ | υ | Ø | × | α | γeff | ٦L | (f.s) bq | Pd (e.b) | γeff | υ | ø | Nc | Νq | Ŋ | As/cm | Ap | sb | g |
| (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 | 000 | | | 00 | 0.65 | 200 | 0.07 | | | | | | | | | | Î | |
| 1.00 | _ | 2.00 | 2.50 | 0.23 | 4 | 1.00 | 1.00 | 0.65 | 20 | 0.15 | | | | | | | | 314.29 | | 3.78 | |
| 1.00 | | 2.50 | 8.50 | 0.49 | 4 | 1.00 | 0.88 | 0.93 | 600 | 0.44 | | | | | | | | 314.29 | | 87.49 | |
| 1.00 | _ | 8.50 | 11.50 | 0.70 | 5 | 1.00 | 0.65 | 0.95 | 300 | 0.87 | | | | | | | | 314.29 | | 50.35 | |
| 1.00 | | 11.50 | 14.50 | 0.88 | 5 | 1.00 | 0.51 | 0.97 | 300 | 1.15 | | | | | | | | 314.29 | | 51.56 2.25 | |
| 1.00 | _ | 14.50 | 15.00 | 1.02 | 9 0 | 1.00 | 0.43 | 0.98 | 09 | 1.32 | 10 | 0 | 00 | (| | c r | [| 314.29 | | 9.09 | |
| 1.00 | | 15.00 | 24.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 006 | 1.35 | 1.35 | 0.98 | 1.02 | 9 | ი | 1.72 | 0.57 | 314.29 | 7857.14 | 164.40 | 90.54 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | 366.67 | 90.54 |
| | | | | | | Qu,com | =.0 | qs + Qp | | | | | U | Qu,uplift = | 0, | Safe Frictio | nal Resista | ance + Weiç | ght of Pile | | |
| | | | | | | Qa,com | =. | (366.67 + 9 | 90.54)/2.9 | 5 | | | 0 | Qa,uplift = | ., | 366.67 / 3 + | + 43.2 | | | | |
| | | | | | | Qa,com | =.0 | 182.88 | F | | | | 0 | Qa,uplift = | | 165.42 T | | | | | |
| | | | | | Say | Qa,com | = d | 182.00 | | | | | | a,uplift = | | 165.00 T | | | | | |
| *FOS for V **FOS for I | /ertical Capa Uplift Capaci | city of pile ty of pile = | in compres 3.0 | ssion = 2.5 | | | | | | | | | | | | | | | | | |

| | | | VAME OI | F PROJE | CT:- "G | TI for Ha | ryana Or | bital Rai | I Corrido | or (HORC | C) project | t from Pa | alwal to l | Harsana | Kalan in | the stat | e of Hary | yana." | | | |
|--|-------------------------------|---|---|--|-----------|---|--|--|------------------------------------|--|--------------------|-------------|--------------------|----------------------------|-------------|----------------------------|------------------------|--|-----------------|--|-------|
| Length of | Pile below c | cut of leve | <u> </u> | 24.00 m | | | Bore | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia | of pile = 1 | .00 m | Cut-o | off Level = | 2.00 m | below EGI | |
| Restricting | PD to 15D | | Water Ta analysis : | ble depth = | considere | ed for | 0.00 m | | | | Scour | r Depth = | Non-scoura | able | | - | iquefactio | on Depth = | NL | | |
| Dia. of | Cut-off | Soil | ayers | | | roperties of | f layers/for | Skin Frictic | n | | | For End | Bearing | | | | | | | | |
| Pile | Depth | from | to | υ | ø | × | σ | γeff | ٦L | pd (s.f) | Pd (e.b) | γeff | c | ø | Nc | Nq | Ny | As/cm | Ap | ds | 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 1.00 1.00 1.00 1.00 1.00 | | 2.00 2.50 11.50 14.50 15.00 25.50 25.50 | 2.50 8.50 11.50 14.50 15.00 26.00 26.00 | 0.23 0.49 0.70 0.88 1.02 1.02 1.42 | 445000 | 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 | 1.00 0.88 0.65 0.51 0.43 0.33 0.33 | 0.65 0.93 0.97 0.98 0.98 0.98 | 50 600 300 50 50 50 | 0.15 0.44 0.87 1.15 1.35 1.35 | - 33 | 8 6 0 | 1.02 | ω | Ø | 1.22 | 0.57 | 314.29 314.29 314.29 314.29 314.29 314.29 314.29 | 7857.14 | 3.78 87.49 50.35 9.09 9.14 9.14 | 90.54 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | 403.21 | 90.54 |
| | | | | | | Qu,com Qa,com | п. п. п. | qs + Qp (403.21 + : | 90.54)/2.4 | 5 | | | 0 0 | Qu,uplift = Qa,uplift = | 0 4 | afe Frictio 03.21 / 3 + | nal Resista + 47.12 | ance + Weig | jht of Pile | | |
| | | | | | | Qa,com | =.q | 197.50 | г | | | | 0 | Ωa,uplift = | | 181.53 T | | | | | |
| | | | | | Say | Qa,com | =.q | 197.00 | | | | | 0 | la,uplift = | | 181.00 T | | | | | |
| *FOS for V **FOS for L | ertical Capa Jplift Capaci | city of pile ty of pile = | in compres 3.0 | ssion = 2.5 | | | | | | | | | | | | | | | | | |

| | | | VAME OI | F PROJE | ст:- "G | TI for Ha | ryana Oı | bital Rai | l Corrido | or (HORC | C) project | t from Pa | alwal to F | Harsana | Kalan in | the stat | e of Hary | yana." | | | |
|---------------------------|--------------------------------|------------------------------|----------------------|--------------------|-----------|--------------|--------------|--------------|-----------|--------------------|--------------------|-------------|--------------------|-------------|-------------|--------------|-------------|-----------------|-----------------|-----------|--------|
| Length of | Pile below c | cut of leve | <u> </u> | 26.00 m | | | Bore | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia (| of pile = 1 | .00 m | Cut-o | off Level = | 2.00 m | below EGI | |
| Restricting | PD to 15D | | Water Ta analysis | ble depth = | considere | d for | 0.00 m | | | | Scour | r Depth = 1 | Von-scours | able | | - | iquefactio | on Depth = | NL | | |
| Dia. of | Cut-off | Soil I | ayers | | | roperties of | f layers/for | Skin Frictic | uc | | | For End I | Bearing | | | | | | | | |
| Pile | Depth | from | to | υ | Ø | × | α | γeff | ٦L | pd (s.f) | Pd (e.b) | γeff | υ | Ø | Nc | Nq | Ny | As/cm | Ap | ds | Qp |
| (m) | (m) | (m) | (u) | kg/cm ² | deg | | | gm/cc | сш | kg/cm ² | kg/cm ² | gm/cc | kg/cm ² | deg | | | | cm ² | cm ² | t | t |
| 1.00 1.00 | 2.00 | 0.00 2.00 | 2.00 2.50 | 0.23 | 4 | 1.00 | 1.00 | 0.65 0.65 | 200 50 | 0.07 0.15 | | | | | | | | 314.29 | | 3.78 | |
| 1.00 | | 2.50 | 8.50 | 0.49 | 4 | 1.00 | 0.88 | 0.93 | 600 | 0.44 | | | | | | | | 314.29 | | 87.49 | |
| 1.00 | | 8.50 | 11.50 | 0.70 | 5 | 1.00 | 0.65 | 0.95 | 300 | 0.87 | | | | | | | | 314.29 | | 50.35 | |
| 1.00 | | 11.50 | 14.50 | 0.88 | 5 | 1.00 | 0.51 | 0.97 | 300 | 1.15 | | | | | | | | 314.29 | | 51.56 | |
| 1.00 | | 14.50 | 15.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 50 | 1.32 | | | | | | | | 314.29 | | 9.09 | |
| 1.00 | | 15.00 | 25.50 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 1050 | 1.35 | | | | | | | | 314.29 | | 191.80 | |
| 1.00 | | 25.50 | 28.00 | 1.42 | 5 | 1.00 | 0.33 | 1.01 | 250 | 1.35 | 1.35 | 1.01 | 1.42 | ى ک | 6 | 1.57 | 0.45 | 314.29 | 7857.14 | 45.70 | 117.21 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | - | - | | | 439.77 | 117.21 |
| | | | | | | Qu,com | р.= | qs + Qp | | | | | 5 | Qu,uplift = | 0) | Safe Frictio | nal Resista | ance + Weig | ght of Pile | | |
| | | | | | | Qa,com | =.d | (439.77 + | 117.21)/2 | 2.5 | | | J | Ωa,uplift = | 7 | 139.77/3+ | + 51.05 | | | | |
| | | | | | | Qa,com | н. П. | 222.79 | г | | | | J | Qa,uplift = | | 197.64 T | L | | | | |
| | | | | | Say | Qa,com | =:d | 222.00 | | | | | G | la,uplift = | | 197.00 T | | | | | |
| *FOS for V **FOS for l | ertical Capa Jplift Capacit | city of pile ty of pile = | in compres 3.0 | ssion = 2.5 | | | | | | | | | | | | | | | | | |

| | | | VAME OF | F PROJE | CT:- "G | TI for Ha | ryana Or | bital Rai | il Corrido | or (HORC | c) projec | t from Pa | alwal to F | Harsana | Kalan in | the stat | e of Har | yana." | | | |
|---------------------------|--------------------------------|--------------------------------|-------------------------|--------------------|-----------|-------------|--------------|--------------|------------|--------------------|--------------------|-----------|--------------------|-------------|-------------|--------------|-------------|-----------------|-----------------|-----------|--------|
| Length of | Pile below (| cut of leve | <u> </u> | 28.00 m | | | Bore | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia | of pile = ` | .00 m | Cut-o | off Level = | 2.00 m | below EGI | |
| Restricting | PD to 15D | | Water Tal analysis : | ble depth = | considere | ed for | 0.00 m | | | | Scoul | r Depth = | Non-scour | able | | - | iquefactic | on Depth = | NL | | |
| Dia. of | Cut-off | Soil | ayers | | Ē | roperties o | f layers/for | Skin Fricti | uc | | | For End | Bearing | | | | | | | | |
| Pile | Depth | from | to | С | Ø | k | α | γeff | AL | (J.s) pd | Pd (e.b) | γeff | с | Ø | Nc | Nq | Ny | As/cm | Ap | ds | 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 1.00 | 2.00 | 0.00 2.00 | 2.00 2.50 | 0.23 | 4 | 1.00 | 1.00 | 0.65 0.65 | 200 50 | 0.07 0.15 | | | | | | | | 314.29 | | 3.78 | |
| 1.00 | | 2.50 | 8.50 | 0.49 | 4 | 1.00 | 0.88 | 0.93 | 600 | 0.44 | | | | | | | | 314.29 | | 87.49 | |
| 1.00 | | 8.50 | 11.50 | 0.70 | 5 | 1.00 | 0.65 | 0.95 | 300 | 0.87 | | | | | | | | 314.29 | | 50.35 | |
| 1.00 | | 11.50 | 14.50 | 0.88 | 5 | 1.00 | 0.51 | 0.97 | 300 | 1.15 | | | | | | | | 314.29 | | 51.56 | |
| 1.00 | | 14.50 | 15.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 50 | 1.32 | | | | | | | | 314.29 | | 9.09 | |
| 1.00 | | 15.00 | 25.50 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 1050 | 1.35 | | | | | | | | 314.29 | | 191.80 | |
| 1.00 | | 25.50 | 29.50 | 1.42 | 5 | 1.00 | 0.33 | 1.01 | 400 | 1.35 | | | | | | | | 314.29 | | 73.12 | |
| 1.00 | | 29.50 | 30.00 | 2.56 | 5 | 1.00 | 0.26 | 1.04 | 50 | 1.35 | 1.35 | 1.01 | 1.42 | 5 | 6 | 1.57 | 0.45 | 314.29 | 7857.14 | 12.32 | 117.21 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | 1 | | | | | | 479.50 | 117.21 |
| | | | | | | Qu,com | p.= | qs + Qp | | | | | 0 | Qu,uplift = | | safe Frictio | nal Resista | ance + Weig | lht of Pile | | |
| | | | | | | Qa,com | =. d | (479.5 + 1 | 17.21)/2. | 5 | | | J | 2a,uplift = | | 179.5/3+ | 54.98 | | | | |
| | | | | | | Qa,com | п. П. | 238.69 | F | | | | ~ | Qa,uplift = | | 214.81 7 | L_ | | | | |
| | | | | | Say | Qa,com | =:di | 238.00 | | | | | | la,uplift = | | 214.00 T | | | | | |
| *FOS for V **FOS for I | ∕ertical Capa Uplift Capaci | icity of pile ity of pile = | in compres 3.0 | ssion = 2.5 | | | | | | | | | | | | | | | | | |

| GL | | | Qp | t | 197.83 | 197.83 | | | | |
|----------------------|-------------------------|--------------|----------|--------------------|--|--------|-------------|----------------------------|-------------|----------------|
| below E | | | sb | ÷ | 3.78 87,49 50.35 51.56 9.09 9.09 61.58 61.58 | 528.76 | | | | |
| 2.00 m | NL | | Ap | cm ² | 7857.14 | | ght of Pile | | | |
| yana. off Level = | on Depth = | | As/cm | cm ² | 314.29 314.29 314.29 314.29 314.29 314.29 314.29 | | ance + Wei | | | |
| Cut- | Liquefacti | | Ny | | 0.45 | | onal Resist | + 58.9 T | ⊢ | |
| 1.00 m | | | Νq | | 1.57 | | Safe Fricti | 528.76/3 235.16 | 235.00 | |
| of pile = | | | Nc | | J | | | | | |
| Dia | able | | Ø | deg | ى | | Qu,uplift = | Qa,uplift = Qa,uplift = | 2a,uplift = | |
| | Non-scour | Bearing | υ | kg/cm ² | 5.56 | | | ŕ | | |
| | r Depth = | For End | γeff | gm/cc | 1.04 | | | | | |
| 13+787 | Scoul | | Pd (e.b) | kg/cm ² | 1.35 | | | | | |
| Ch. (KM) | | | pd (s.f) | kg/cm ² | 0.07 0.15 0.44 0.87 1.35 1.35 1.35 1.35 1.35 | | | 5 | | |
| BH-A1 | | u | AL | cm | 200 50 600 300 50 400 255 250 | | | 197.83)/2 T | | |
| Hole No = | | Skin Frictic | γeff | gm/cc | 0.65 0.65 0.93 0.97 0.98 0.98 0.98 0.98 1.01 1.04 | | qs + Qp | (528.76 + 290.64 | 290.00 | |
| Bore | 0.00 m | f layers/for | α | | 1.00 0.88 0.51 0.43 0.43 0.33 0.33 | | ш. Ц | II. II. d. d. | =. d | |
| | d for | operties of | ĸ | | 1.00 1.00 1.00 1.00 1.00 1.00 | | Qu,com | Qa,com Qa,com | Qa,com | |
| | considere | Ē | Ø | deg | 4400000 | | | | Say | |
| 30.00 m | ble depth . = | | υ | kg/cm ² | 0.23 0.70 0.88 1.02 2.56 2.56 2.56 | | | | | sion = 2.5 |
| " | Water Tał analysis = | ayers | to | (m) | 2.00 2.50 11.50 14.50 25.50 22.50 32.00 32.00 | | | | | n compres |
| ut of level | | Soil lé | from | (m) | 0.00 2.00 8.50 14.50 25.50 29.50 29.50 | | | | | sity of pile i |
| Pile below c | PD to 15D | Cut-off | Depth | (m) | 5.00 | | | | | ertical Capac |
| Length of | Restricting | Dia. of | Pile | (m) | 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 | | | | | *FOS for V |

| | | 2 | IAME OF | - PROJE | CT:- "G1 | ll for Har | 'yana Or | bital Rail | Corrido | r (HORC | () project | t from Pa | alwal to F | Harsana | Kalan in | the stat | e of Hary | yana." | | | |
|--------------------------|----------------------------------|---------------------------------|--|--------------------------------------|-------------------|--------------------|--|---|--------------------------------|--------------------------------------|--------------------|--------------|--------------------|----------------------------|-------------|----------------------|-------------|--|-----------------|--|--------|
| Length o | f Pile below c | ut of level | <u> </u> | 20.00 m | | | Bore h | lole No = | 3H-A1 | Ch. (KM) | 13+787 | | | Dia | of pile = 1 | .20 m | Cut-o | off Level = | 2.00 m | below EGI | |
| Restrictin | g PD to 15D | | Water Tał analysis = | ole depth - = | considere | d for | 0.00 m | | | | Scour | Depth = 1 | Von-scoura | able | | - | iquefactio | on Depth = | NL | | |
| Dia. of | Cut-off | Soil la | ayers | | ٦. | operties of | layers/for : | Skin Frictio | F | | | For End I | Bearing | | | | | | | | |
| Pile | Depth | from | to | υ | Ø | × | σ | γeff | ٦L | pd (s.f) | Pd (e.b) | γeff | υ | ø | Sc | Nq | Ŋ | As/cm | Ap | sb | g |
| (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 1.20 1.20 1.20 1.20 | | 2.00 2.50 11.50 18.00 | 2.50 8.50 11.50 18.00 22.00 22.00 | 0.23 0.49 0.88 1.02 1.02 | 44 °C 2000 | 1.00 | 1.00 0.88 0.65 0.51 0.43 0.43 | 0.65 0.93 0.97 0.98 0.98 | 50 600 330 350 400 | 0.15 0.45 1.15 1.64 1.64 | 6. 48 | 8 6. C | 1.02 | ω | თ | 1.72 | 0.57 | 377.14 377.14 377.14 377.14 377.14 377.14 | 11314.29 | 4.53 104.99 60.42 78.42 92.35 92.35 | 136.16 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |] | 402.59 | 136.16 |
| | | | | | | Qu,comp | ш. С | qs + Qp | | | | | 0 | Qu,uplift = | 0) | afe Frictio | nal Resista | ance + Weiç | ght of Pile | | |
| | | | | | | Qa,comp Qa,comp | =. | (402.59 + ⁻ 215.50 ⁻ | 136.16) / 2. Γ | υ | | | 0 0 | λa,uplift = λa,uplift = | 4 | 02.59/3+ 190.74 T | - 56.55 | | | | |
| | | | | | Say | Qa,com | = d | 215.00 | | | | | 0 | la,uplift = | | 190.00 T | | | | | |
| *FOS for ' **FOS for | Vertical Capac Uplift Capacit | city of pile i y of pile = ; | n compres 3.0 | sion = 2.5 | | | | | | | | | | | | | | | | | |

| | | | IAME OI | F PROJE | CT:- "G | rl for Hai | 'yana Or | bital Rail | Corrido | ır (HORC |) project | t from Pa | alwal to F | Harsana | Kalan in | the stat | e of Hary | yana." | | | |
|-------------------------|---------------------------------|----------------------------------|-------------------------|--------------------|-----------|-------------|--------------|--------------|-----------|--------------------|--------------------|-------------|--------------------|-------------|-------------|-------------|---------------------|-----------------|-----------------|-----------|--------|
| Length of | Pile below c | sut of level | <u> </u> | 22.00 m | | | Bore H | lole No = E | 3H-A1 | Ch. (KM) | 13+787 | | | Dia 6 | of pile = 1 | .20 m | Cut-o | off Level = | 2.00 m | below EGI | |
| Restricting | PD to 15D | | Water Tal analysis : | ble depth - = | considere | d for | 0.00 m | | | | Scour | . Depth = h | Von-scoura | ble | | - | iquefactio | on Depth = | NL | | |
| Dia. of | Cut-off | Soil Is | ayers | | Ē | operties of | layers/for : | Skin Frictio | L | | | For End I | Bearing | | | | | | | | |
| Pile | Depth | from | to | c | Ø | k | α | γeff | ٩٢ | pd (s.f) | Pd (e.b) | γeff | c | ø | Nc | Nq | Ny | As/cm | Ap | ds | 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 1.20 | 2.00 | 0.00 2.00 | 2.00 2.50 | 0.23 | 4 | 1.00 | 1.00 | 0.65 0.65 | 200 50 | 0.07 0.15 | | | | | | | | 377.14 | | 4.53 | |
| 1.20 | | 2.50 | 8.50 | 0.49 | 4 | 1.00 | 0.88 | 0.93 | 600 | 0.44 | | | | | | | | 377.14 | | 104.99 | |
| 1.20 | | 8.50 | 11.50 | 0.70 | 5 | 1.00 | 0.65 | 0.95 | 300 | 0.87 | | | | | | | | 377.14 | | 60.42 | |
| 1.20 | | 11.50 | 14.50 | 0.88 | 5 | 1.00 | 0.51 | 0.97 | 300 | 1.15 | | | | | | | | 377.14 | | 61.88 | |
| 1.20 | | 14.50 | 18.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 350 | 1.47 | | | | | | | | 377.14 | | 78.42 | |
| 1.20 | | 18.00 | 24.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 600 | 1.64 | 1.64 | 0.98 | 1.02 | 9 | 6 | 1.72 | 0.57 | 377.14 | 11314.29 | 138.52 | 136.16 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | 448.76 | 136.16 |
| | | | | | | Qu,comp | =.0 | qs + Qp | | | | | 0 | ðu,uplift = | 0) | afe Frictio | nal Resist <i>a</i> | ance + Weiç | ght of Pile | | |
| | | | | | | Qa,com | =.0 | (448.76 + 1 | 136.16)/2 | .5 | | | 0 | la,uplift = | ч | 48.76/3+ | - 62.2 | | | | |
| | | | | | | Qa,com | | 233.97 | F | | | | 0 | àa,uplift = | | 211.79 T | | | | | |
| | | | | | Say | Qa,com | =:d | 233.00 | | | | | G | a,uplift = | | 211.00 T | | | | | |
| *FOS for \ **FOS for | /ertical Capa Uplift Capacit | city of pile i ty of pile = : | n compres 3.0 | ssion = 2.5 | | | | | | | | | | | | | | | | | |

| | | | NAME O | F PROJE | ECT:- "G | TI for Ha | ryana O | rbital Rai | l Corride | or (HORG | C) projec | t from Pa | alwal to H | Harsana | Kalan in | the stat | e of Hary | /ana." | | | |
|---------------------------|--------------------------------|--------------------------------|----------------------|--------------------|----------|-------------|--------------|---------------|-----------|--------------------|--------------------|-----------|--------------------|-------------|-------------|-------------|-------------|-----------------|-----------------|-----------|--------|
| Length of | Pile below (| cut of leve | = | 24.00 m | | | Bore | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia o | of pile = 1 | .20 m | Cut-o | ff Level = | 2.00 m | below EGI | |
| Restricting | PD to 15D | | Water Ta analysis | lble depth = | consider | ed for | 0.00 m | | | | Scoul | r Depth = | Von-scoura | able | | - | iquefactio | n Depth = I | ٦L | | |
| Dia. of | Cut-off | Soil | ayers | | Ľ. | roperties o | f layers/for | · Skin Fricti | uc | | | For End | Bearing | | | | | | | | |
| Pile | Depth | from | to | υ | Ø | × | α | γeff | AL | pd (s.f) | Pd (e.b) | γeff | c | ø | Nc | Nq | Ny | As/cm | Ap | ds | 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 1.20 | 2.00 | 0.00 2.00 | 2.00 2.50 | 0.23 | 4 | 1.00 | 1.00 | 0.65 0.65 | 200 50 | 0.07 0.15 | | | | | | | | 377.14 | | 4.53 | |
| 1.20 | | 2.50 | 8.50 | 0.49 | 4 | 1.00 | 0.88 | 0.93 | 600 | 0.44 | | | | | | | | 377.14 | | 104.99 | |
| 1.20 | | 8.50 | 11.50 | 0.70 | 5 | 1.00 | 0.65 | 0.95 | 300 | 0.87 | | | | | | | | 377.14 | | 60.42 | |
| 1.20 | | 11.50 | 14.50 | 0.88 | 5 | 1.00 | 0.51 | 0.97 | 300 | 1.15 | | | | | | | | 377.14 | | 61.88 | |
| 1.20 | | 14.50 | 18.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 350 | 1.47 | | | | | | | | 377.14 | | 78.42 | |
| 1.20 | | 18.00 | 25.50 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 750 | 1.64 | | | | | | | | 377.14 | | 173.15 | |
| 1.20 | | 25.50 | 26.00 | 1.42 | 5 | 1.00 | 0.33 | 1.01 | 50 | 1.64 | 1.64 | 0.98 | 1.02 | 9 | 6 | 1.72 | 0.57 | 377.14 | 11314.29 | 11.45 | 136.16 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | 494.85 | 136.16 |
| | | | | | | Qu,com | =.q | qs + Qp | | | | | 0 | λu,uplift = | 0) | afe Frictio | nal Resista | ince + Weig | ht of Pile | | |
| | | | | | | Qa,com | =.d | (494.85 + | 136.16)/2 | 2.5 | | | 0 | λa,uplift = | 4 | 94.85/3+ | - 67.86 | | | | |
| | | | | | | Qa,com | =. d | 252.40 | F | | | | 0 | λa,uplift = | | 232.81 T | | | | | |
| | | | | | Say | Qa,con | =.d | 252.00 | | | | | 0 | a,uplift = | | 232.00 T | | | | | |
| *FOS for V **FOS for (| ʻertical Capa Uplift Capaci | icity of pile ity of pile = | in compre: 3.0 | ssion = 2.5 | | | | | | | | | | | | | | | | | |

| | | | VAME O | F PROJE | :CT:- "G | TI for Ha | ryana Oı | bital Rail | l Corrido | or (HORC | c) project | t from Pá | alwal to ł | Harsana | Kalan in | the stat | e of Hary | /ana." | | | |
|---------------------------|--------------------------------|------------------------------|----------------------|--------------------|-----------|-------------|--------------|--------------|-----------|--------------------|--------------------|-----------|--------------------|-------------|-------------|--------------|-------------|-----------------|-----------------|-----------|--------|
| Length of | Pile below c | cut of leve | <u> </u> | 26.00 m | | | Bore | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia | of pile = 1 | .20 m | Cut-o | ff Level = | 2.00 m | below EGI | |
| Restricting | PD to 15D | | Water Ta analysis | ble depth = | considere | ed for | 0.00 m | | | | Scour | r Depth = | Non-scour | able | | L | iquefactio | n Depth = | NL | | |
| Dia. of | Cut-off | Soil I. | ayers | | | roperties o | f layers/for | Skin Frictio | Ľ | | | For End | Bearing | | | | | | | | |
| Pile | Depth | from | to | υ | Ø | k | α | γeff | ٩L | pd (s.f) | Pd (e.b) | γeff | c | Ø | Nc | Nq | Ny | As/cm | Ap | ds | 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 1.20 | 2.00 | 0.00 2.00 | 2.00 2.50 | 0.23 | 4 | 1.00 | 1.00 | 0.65 0.65 | 200 50 | 0.07 0.15 | | | | | | | | 377.14 | | 4.53 | |
| 1.20 | | 2.50 | 8.50 | 0.49 | 4 | 1.00 | 0.88 | 0.93 | 600 | 0.44 | | | | | | | | 377.14 | | 104.99 | |
| 1.20 | | 8.50 | 11.50 | 0.70 | 5 | 1.00 | 0.65 | 0.95 | 300 | 0.87 | | | | | | | | 377.14 | | 60.42 | |
| 1.20 | | 11.50 | 14.50 | 0.88 | 5 | 1.00 | 0.51 | 0.97 | 300 | 1.15 | | | | | | | | 377.14 | | 61.88 | |
| 1.20 | | 14.50 | 18.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 350 | 1.47 | | | | | | | | 377.14 | | 78.42 | |
| 1.20 | | 18.00 | 25.50 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 750 | 1.64 | | | | | | | | 377.14 | | 173.15 | |
| 1.20 | | 25.50 | 28.00 | 1.42 | 2 | 1.00 | 0.33 | 1.01 | 250 | 1.64 | 1.64 | 1.01 | 1.42 | 5 | 6 | 1.57 | 0.45 | 377.14 | 11314.29 | 57.27 | 174.06 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | 540.66 | 174.06 |
| | | | | | | Qu,com | р.= | qs + Qp | | | | | 0 | Qu,uplift = | 0) | safe Frictio | nal Resista | ance + Weig | pht of Pile | | |
| | | | | | | Qa,com | =.d | (540.66 + ' | 174.06)/2 | 2.5 | | | J | Ωa,uplift = | C) | 40.66/3+ | - 73.51 | | | | |
| | | | | | | Qa,com | ш. Ц | 285.89 | F | | | | 0 | Qa,uplift = | | 253.73 T | | | | | |
| | | | | | Say | Qa,corr | =:d | 285.00 | _ | | | | | la,uplift = | | 253.00 T | | | | | |
| *FOS for V **FOS for L | ertical Capa Jplift Capacit | city of pile ty of pile = | in compret 3.0 | ssion = 2.5 | | | | | | | | | | | | | | | | | |

| | | | NAME OI | F PROJE | :CT:- "G | TI for Ha | ryana Or | bital Rai | l Corride | or (HORG | c) projec | t from Pa | alwal to H | Harsana | Kalan in | the stat | e of Har | yana." | | | |
|-------------------------|--------------------------------|--------------------------------|----------------------|--------------------|----------|-------------|--------------|--------------|-----------|--------------------|--------------------|-----------|--------------------|-------------|-------------|--------------|-------------|-----------------|-----------------|-----------|--------|
| Length of | Pile below | cut of leve | = | 28.00 m | | | Bore | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia | of pile = ` | .20 m | Cut-o | ett Level = | 2.00 m | below EGI | |
| Restricting | PD to 15D | | Water Ta analysis | ble depth = | consider | ed for | 0.00 m | | | | Scoul | r Depth = | Non-scoura | able | | _ | iquefactic | on Depth = | ٦L | | |
| Dia. of | Cut-off | Soil | layers | | L. | roperties o | f layers/for | Skin Frictic | u | | | For End | Bearing | | | | | | | | |
| Pile | Depth | from | to | υ | ø | * | α | γeff | ٦L | pd (s.f) | Pd (e.b) | γeff | c | Ø | Nc | Nq | Ny | As/cm | Ap | ds | 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 1.20 | 2.00 | 0.00 2.00 | 2.00 2.50 | 0.23 | 4 | 1.00 | 1.00 | 0.65 0.65 | 200 50 | 0.07 0.15 | | | | | | | | 377.14 | | 4.53 | |
| 1.20 | | 2.50 | 8.50 | 0.49 | . 4 | 1.00 | 0.88 | 0.93 | 600 | 0.44 | | | | | | | | 377.14 | | 104.99 | |
| 1.20 | | 8.50 | 11.50 | 0.70 | ى · | 1.00 | 0.65 | 0.95 | 300 | 0.87 | | | | | | | | 377.14 | | 60.42 | |
| 1.20 | | 11.50 | 14.50 | 0.88 | 5 | 1.00 | 0.51 | 0.97 | 300 | 1.15 | | | | | | | | 377.14 | | 61.88 | |
| 1.20 | | 14.50 | 18.00 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 350 | 1.47 | | | | | | | | 377.14 | | 78.42 | |
| 1.20 | | 18.00 | 25.50 | 1.02 | 9 | 1.00 | 0.43 | 0.98 | 750 | 1.64 | | | | | | | | 377.14 | | 173.15 | |
| 1.20 | | 25.50 | 29.50 | 1.42 | 5 | 1.00 | 0.33 | 1.01 | 400 | 1.64 | | | | | | | | 377.14 | | 91.63 | |
| 1.20 | | 29.50 | 30.00 | 2.56 | 5 | 1.00 | 0.26 | 1.04 | 50 | 1.64 | 1.64 | 1.01 | 1.42 | 5 | 6 | 1.57 | 0.45 | 377.14 | 11314.29 | 15.26 | 174.06 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | 590.28 | 174.06 |
| | | | | | | Qu,com | p.= | qs + Qp | | | | | 0 | Qu,uplift = | 0, | safe Frictio | nal Resista | ance + Weig | lht of Pile | | |
| | | | | | | Qa,com | =.d | (590.28 + | 174.06)/2 | 2.5 | | | 0 | 2a,uplift = | | 90.28/3- | + 79.17 | | | | |
| | | | | | | Qa,corr | щ. | 305.74 | F | | | | 0 | λa,uplift = | | 275.93 J | L | | | | |
| | | | | | Say | Qa,con | =:d | 305.00 | | | | | 0 | la,uplift = | | 275.00 1 | | | | | |
| *FOS for \ **FOS for | ∕ertical Capa Uplift Capaci | icity of pile ity of pile = | in compret 3.0 | ssion = 2.5 | | | | | | | | | | | | | | | | | |

| International contractional contractiona contracticona contractional contractional contractional contract | | - | NAME OF | - PROJE | CT:- "G | TI for Hai | ryana Or | bital Rai | l Corrido | or (HORG | () project | t from Pa | alwal to | Harsana | Kalan in | the stat | e of Har | yana." | | | |
|---|----------------|---|---|--------------------|-----------|---|--|--|--|--------------------|--------------------|-----------|--------------------|----------------------------|-------------|------------------------------------|--------------|--|-----------------|--|--------|
| Description Concription | - | v cut of leve | | 30.00 m | : | : | Bore F | Hole No = | BH-A1 | Ch. (KM) | 13+787 | | | Dia | of pile = 、 | .20 m | Cut-o | off Level = | 2.00 m | below EG | |
| I Solityees Properties of hyper (Sympol Shiff Filter) Fer End Beam No | | | Water Tal analysis : | ble depth . = | considere | ed for | 0.00 m | | | | Scour | r Depth = | Non-scour: | able | | - | -iquefactio | on Depth = | NL | | |
| 1 1 0 0 0 1 0 | ₩ | Soil | ayers | | P | roperties of | ayers/for : | Skin Frictio | u | | | For End | Bearing | | | | | | | | |
| 1 | ے | from | to | υ | Ø | × | σ | γeff | ۵L | pd (s.f) | Pd (e.b) | γeff | υ | Ø | Nc | Νq | Ŷ | As/cm | Ap | sb | Qp |
| 0 | | (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 | ÷ | ÷ |
| G51.34 290.15 Qu,comp.= qs + Qp Qu,comp.= qs + Qp Qa,comp.= (651.34 + 290.15)/2.5 Qa,comp.= 376.60 T Qa,uplift= 301.94 T Say Qa,comp.= 376.00 T Qa,uplift= 301.94 T station = 2.5 20.00 T Qa,uplift= 301.00 T | | 2.00 2.50 11.50 18.00 25.55 29.50 29.50 | 2.50 2.50 11.50 14.50 28.50 29.50 29.50 29.50 29.50 22.50 22.50 22.50 22.50 | 0.23 | 4400000 | 0.1 1.00 1.00 1.00 1.00 1.00 1.00 1.00 | 1.00 0.65 0.51 0.43 0.33 0.26 | 0.65 0.93 0.97 0.98 0.98 1.04 | 50 600 3300 350 400 250 | 0.015 | 1.64 | 1. 40. | 5.56 | ى م | Ø | 1.57 | 0.45 | 377.14 377.14 377.14 377.14 377.14 377.14 377.14 | 11314.29 | 4.53 104.99 61.88 61.88 78.42 91.63 76.32 76.32 | 290.15 |
| Qu,comp: qs + Qp Qu,uplift= Safe Frictional Resistance + Weight of Pile Qa,comp: (651.34 + 290.15)/2.5 Qa,uplift= 651.34/3 + 84.82 Qa,comp: 376.60 T Qa,uplift= 651.34/3 + 84.82 Say Qa,comp: 376.60 T Qa,uplift= 651.34/3 + 84.82 Capacity of pile in compression = 2.5 376.00 T Qa,uplift= 301.94 T Datacity of pile = 3.0 Another and a state and a | | - | | | | | | | | | - | | | | | | | | | 651.34 | 290.15 |
| Qa,comp.= (651.34 + 290.15)/2.5 Qa,uplift = (651.34 / 3 + 84.82) Qa,comp.= 376.60 T Qa,uplift = (301.94 T) Say Qa,comp.= 376.00 T Qa,uplift = (301.94 T) Capacity of ple in compression = 2.5 376.00 T Qa,uplift = (301.00 T) and of ple = 3.0 A A (A) (A) | | | | | | Qu,com | =.c | qs + Qp | | | | | | Qu,uplift = | 0, | safe Frictic | nal Resist | ance + Wei | ght of Pile | | |
| Say Qa,comp.= 376.00 T Qa,uplift = 301.00 T Capacity of pile in compression = 2.5 and the state in the | | | | | | Qa,com Qa,com | ш. Ш. С | (651.34 + ; 376.60 ⁻ | 290.15)/2 Т | | | | | Qa,uplift = Qa,uplift = | 0 | 51.34 / 3 - 301.94 ⁻ | + 84.82 Г | | | | |
| Capacity of pile in compression = 2.5 apacity of pile = 3.0 | | | | | Say | Qa,com | = d | 376.00 | | | | | | 2a,uplift = | | 301.00 | | | | | |
| | ll Cap Capa | acity of pile city of pile = | in compres 3.0 | sion = 2.5 | | | | | | | | | | | | | | | | | |

| | Later | al Loa | d capacity of Pile | | | |
|---|--------------------------|----------|--|---|------------------|--------------------|
| | | | BH-A1 | | | |
| | | Ch. (| KM): 13+787 | | | |
| | | | | | | |
| Type of Strata = Clayey | | | | | | |
| Le = Embedded Length of Pile in Mete | r = | 22.000 | m Fck = 35.0 N/mm^2 | D | = 100 | cm |
| Bed level | 0.0 m | | | | | |
| Pile cap bottom level | -2.0 m | | | | | |
| E = Young's Modulus of Pile (Kg/cm ²) | | = | 5000 F _{ck} N/mm ² | = | 295803.99 | Kg/cm ² |
| I = Moment of Inertia (cm^2) | | = | πxD ⁴ /64 | = | 4908738.5 | cm ⁴ |
| c = weighted mean of cohesion along th | e length of pile f | from the | top of scour depth to bottom of pile | = | 0.690 | Kg/cm ² |
| q _u = Unconfined Compression Strength | | = | 2 x c | = | 1.380 | Kg/cm ² |
| k ₁ = Modulus of Subgrade Reaction for c | ohesive soil (fro | m Table | 4) | = | 2.484 | kg/cm ³ |
| К = | | = | k ₁ x0.3/(1.5xB) | = | 0.497 | kg/cm ³ |
| | | | EI | | | |
| R, Relative stiffness factor in Preloaded Cla | ıy R | = | A KD | = | 413.5 | cm |
| For Long Pile If L _e > 3.5R | | | ٦ | | | |
| L1 = | | | | = | 0.000 | cm |
| L ₁ | | | | = | 0.00 | |
| R | | | | | | |
| For Fixed Head Pile | | | | | | |
| L _f | | | | = | 2.000 Fro | m Fig. 4 |
| R | | | | | | |
| Lf | | | | = | 826.95 cm | |
| Equivalent length of cantilever L= | L1+L _F : 0.00 | + | 826.94777 | = | 826.95 cm | |
| Y = Pile Head Deflection (Cm) | | = | $\frac{Q(L_1 + L_F)^3}{12 \text{ El}}$ (for fixed Head pile) | | | |
| | | | Q = Lateral Load in Kg | | 45400.04 | |
| Lateral Load For Pile Head Deflection | on 0.5 cm | | Q | = | 15406.04 Kg | |
| | | | | = | 15.4 T | |



| | Latera | al Loa | d capacity of Pile | | | |
|---|--------------------------|---------|--|---|------------------|--------------------|
| | | | BH-A1 | | | |
| | | Ch. (| KM): 13+787 | | | |
| | | | | | | |
| Type of Strata = Clayey | | | | | | |
| Le = Embedded Length of Pile in Mete | r = 2 | 22.000 | m Fck = 35.0 N/mm^2 | D | = 120 | cm |
| Bed level | 0.0 m | | | | | |
| Pile cap bottom level | -2.0 m | | | | | |
| E = Young's Modulus of Pile (Kg/cm ²) | | = | $5000 \overline{F_{ck}} N/mm^2$ | = | 295803.99 | Kg/cm ² |
| I = Moment of Inertia (cm^2) | | = | π xD ⁴ /64 | = | 10178760.2 | cm ⁴ |
| c = weighted mean of cohesion along the | ne length of pile fi | rom the | top of scour depth to bottom of pile | = | 0.690 | Kg/cm ² |
| q _u = Unconfined Compression Strength | | = | 2 x c | = | 1.380 | Kg/cm ² |
| k ₁ = Modulus of Subgrade Reaction for o | cohesive soil (fror | n Table | 4) | = | 2.484 | kg/cm ³ |
| К = | | = | k ₁ x0.3/(1.5xB) | = | 0.414 | kg/cm ³ |
| | | | EI | | | |
| R, Relative stiffness factor in Preloaded Cla | ay R | = | <u>4</u> КD | = | 496.2 | cm |
| For Long Pile If L _e > 3.5R | | | 1 | | | |
| L1 = | | | | = | 0.000 | cm |
| L1 | | | | = | 0.00 | |
| R | | | | | | |
| For Fixed Head Pile | | | | | | |
| L _f | | | | = | 2.000 Froi | m Fig. 4 |
| R | | | | | | |
| Lf | | | | = | 992.34 cm | |
| Equivalent length of cantilever L= | L1+L _F : 0.00 | + | 992.33732 | = | 992.34 cm | |
| | | | | | | |
| Y = Pile Head Deflection (Cm) | | = | $\frac{Q(L_1 + L_F)^3}{12 \text{ FI}}$ (for fixed Head pile) | | | |
| | | | Q = lateral load in Ko | | | |
| Lateral Load For Pile Head Deflecti | on 0.5 cm | | | = | 18487 24 Ka | |
| | 0.0 0.11 | | ~ | _ | 18.5 T | |
| | | | | - | 10.0 | |



7. APPROVED MANUFACTURES/SUPPLIERS LIST

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. | Details of Materials/ | | Manufacturer's Name | | | |
|-------|----------------------------------|-----|--|--|--|--|
| No. | Products | | | | | |
| 1. | Cement | OPC | ACC, Ultratech, Ambuja, JK Lakshmi, JSW, Orient Cement, JK Cement, Lafrage, Wonder | | | |
| | | PSC | DALMIA, JSW | | | |
| 2. | Reinforcement Bars | | Prequified 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 | | Prequified 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.

Section VII-8: Tender Drawings and Documents

UNDERTAKING

Name of Contract: Category of work: Date of start of work: Date of completion of work:

This is to certify that work of (Category to be mentioned) at

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)

Manufacturer Representative (Stamp and Signature) Executing agency Representative

(Stamp and Signature) Contractor Representative