VII-8B : Documents

Section VII-8B
Documents

1. List of Curve and Gradients

1. List of Curve and Gradients

Horizontal Curve Detail's PKG-C5

S.No.	Curve No.	DEGREE	RADIUS	DEF.ANGLE (Delta)	CANT {SE) (mm)	TANGENT LENGTH	Circular Curve Length(CCL	TRANSITION LENGTH	Vmax	TPTC 1	TPCC 1	TPCC 2	TPTC 2	TOTAL LENGTH
MAIN LINE UP-LINE														
1	1	0.5833	3000.0 m	3°12'01"	35mm	138.8m	57.5m	110.0m	160k mph	914.556	1024.556	1082.076	1192.076	277.52 m
2	2	0.53	3300.0 m	2°59'07"	35mm	136.0m	71.9m	100.0m	160k mph	1438.006	1538.006	1609.921	1709.921	271.915 m
3	3	1.394	1255.3 m	17°43'03"	165 mm	300.1m	176.6m	210.0m	155k mph	2653.331	2863.331	3039.907	3249.907	596.576 m
4	4	0.269	6500.0 m	0°46'58"	20mm	69.4m	38.8m	50.0m	160k mph	3792.02	3842.02	3880.821	3930.821	138.801 m
5	5	0.269	6500.0 m	0°46'58"	20mm	69.4m	38.8m	50.0m	160k mph	3989.656	4039.656	4078.457	4128.457	138.801 m
6	6	0.269	6500.0 m	0°46'58"	20mm	69.4m	38.8m	50.0m	160k mph	4352.458	4402.458	4441.258	4491.258	138.8m
7	7	0.269	6500.0 m	0°46'58"	20mm	69.4m	38.8m	50.0m	160k mph	4550.094	4600.094	4638.895	4688.895	138.094 m
8	8	0.269	6500.0 m	1°23'00"	15mm	108.5m	96.9m	60.0m	160k mph	5293.783	5353.783	5450.702	5510.702	216.783 m
9	9	0.233	7500.0 m	0°31'04"	15mm	58.9m	17.8m	50.0m	160k mph	6651.085	6701.085	6718.858	6768.858	117.773 m
10	10	0.269	6500.0 m	0°46'50"	15mm	74.3m	28.5m	60.0m	160k mph	7587.702	7647.702	7676.246	7736.246	148.544 m
11	11	0.269	6500.0 m	0°46'50"	15mm	74.3m	28.5m	60.0m	160k mph	7800.592	7860.592	7889.136	7949.136	148.544 m

Horizontal Curve Detail's PKG-C5

S.No.	Curve No.	DEGREE	RADIUS	DEF.ANGLE (Delta)	CANT {SE) (mm)	TANGENT LENGTH	Circular Curve Length(CCL	TRANSITION LENGTH	Vmax	TPTC 1	TPCC 1	TPCC 2	TPTC 2	TOTAL LENGTH
12	12	0.269	6500.0 m	0°46'50"	20mm	69.3m	38.5m	50.0m	160k mph	8118.271	8168.271	8206.816	8256.816	138.545 m
13	13	0.269	6500.0 m	0°46'50"	20mm	69.3m	38.5m	50.0m	160k mph	8331.16	8381.16	8419.705	8469.705	138.545 m
14	14	0.437	4000.0 m	4°53'31"	30mm	210.9m	261.5m	80.0m	160k mph	10283.73	10363.73	10625.24	10705.24	421.509 m
15	15	0.269	6500.0 m	0°46'50"	15mm	74.3m	28.5m	60.0m	160k mph	11050.05	11110.05	11138.59	11198.592	148.544 m
16	16	0.269	6500.0 m	0°46'50"	15mm	74.3m	28.5m	60.0m	160k mph	11262.93	11322.93	11351.48	11411.475	148.545 m
17	17	0.269	6500.0 m	0°51'14"	20mm	70.9m	51.9m	45.0m	160k mph	11685.34	11730.34	11782.21	11827.209	141.873 m
18	18	0.269	6500.0 m	0°51'14"	20mm	70.9m	51.9m	45.0m	160k mph	11879.92	11924.92	11976.79	12021.792	141.873 m
19	19	0.831	2105.3 m	26°30'21"	70mm	560.9m	843.8m	130.0m	160k mph	12070.03	12200.03	13043.84	13173.84	1103.807m
20	20	0.583	3000.0 m	33°19'13"	35mm	952.8m	1634.6m	110.0m	160k mph	15569.58	15679.58	17314.18	17424.179	1854.602m
21	21	1.093	1600.0 m	65°50'26"	125 mm	1116.1m	1678.2m	160.0m	160k mph	18098.26	18258.26	19936.45	20096.446	1998.182m
22	22	2	875.0 m	11°26'24"	130 mm	152.3m	43.9m	130.0m	120k mph	20270.6	20400.6	20444.53	20574.531	303.929 m
23	23	1.4	1250.0 m	83°49'48"	120 mm	1192.5m	1688.4m	140.0m	140k mph	21419.55	21559.55	23247.97	23387.965	1968.415m
MAIN LINE DOWN LINE														

Horizontal Curve Detail's PKG-C5

S.No.	Curve No.	DEGREE	RADIUS	DEF.ANGLE (Delta)	CANT {SE) (mm)	TANGENT LENGTH	Circular Curve Length(CCL	TRANSITION LENGTH	Vmax	TPTC 1	TPCC 1	TPCC 2	TPTC 2	TOTAL LENGTH
24	1	2.058	850.0 m	40°11'22"	140 mm	380.08m	455.2m	140.0m	120k mph	-1610.95	-1470.95	-1015.76	-875.764	735.188 m
25	1	0.53	3300.0 m	3°12'01"	35mm	142.2m	84.3m	100.0m	160k mph	911.022	1011.022	1095.313	1195.313	284.291 m
26	2	0.583	3000.0 m	2°59'07"	35mm	133.2m	46.3m	110.0m	160k mph	1440.669	1550.669	1596.938	1706.938	266.269 m
27	3	1.367	1280.0 m	17°43'03"	160 mm	299.0m	194.5m	200.0m	155k mph	2653.518	2853.518	3048.006	3248.006	594.488 m
28	4	0.35	5000.0 m	1°23'00"	20mm	100.4m	40.7m	80.0m	160k mph	5300.34	5380.34	5421.054	5501.054	200.714 m
29	5	0.145	12000.0m	0°31'04"	10mm	69.2m	78.5m	30.0m	160k mph	6639.112	6669.12	6747.575	6777.575	138.463 m
30	6	0.5	3500.0 m	4°53'31"	30mm	199.5m	198.8m	100.0m	160k mph	10293.65	10393.65	10592.45	10692.451	398.805 m
31	7	0.836	2092.0 m	26°30'21"	70mm	557.7m	837.7m	130.0m	160k mph	12073.18	12203.18	13040.83	13170.832	1097.653
32	8	0.585	2990.0 m	33°19'13"	35mm	949.8m	1628.8m	110.0m	160k mph	15575.53	15685.53	17314.31	17424.314	1848.786m
33	9	1.093	1600.0 m	65°50'26"	125 mm	1116.1m	1678.2m	160.0m	160k mph	18096.37	18256.37	19934.55	20094.551	1998.183
34	10	2	875.0 m	11°26'24"	130 mm	152.3m	43.9m	130.0m	120k mph	20280.38	20410.38	20454.31	20584.305	303.929 m
35	11	1.405	1244.7 m	83°49'48"	120 mm	1187.7m	1680.7m	140.0m	140k mph	21414.17	21554.17	23234.83	23374.828	1960.656m

GRADIENT DETAIL'S OF PKG-C-5 (FROM CH:- -2.120 km to 12.00 km) - MAIN LINE							
S.NO	CHAINAGE KM		LENGTH (MTR)	Formation LEVEL		GRADIENT	RISE/FALL
	FROM	TO				1 IN	
1	-2115	-1795	320	203.181	203.439	1241	R
2	-1795	-1451	344	203.439	203.468	11862	R
3	-1451	-855	596	203.468	202.161	456	F
4	-855	-695	160	202.161	202.161	**LEVEL**	
5	-695	860	1555	202.161	203.494	1200	R
6	860	1769.999	909.999	203.494	209.290	156	R
7	1769.999	2089.999	320	209.290	207.868	225	F
8	2089.999	2409.999	320	207.868	205.803	155	F
9	2409.999	2984.869	574.87	205.803	202.318	165	F
10	2984.869	3404.782	419.913	202.318	202.731	1017	R
11	3404.782	3564.782	160	202.731	202.731	**LEVEL**	
12	3564.782	3964.782	400	202.731	202.969	1680	R
13	3964.782	4524.782	560	202.969	202.969	**LEVEL**	
14	4524.782	4814.742	289.96	202.969	201.575	208	F
15	4814.742	5684.782	870.04	201.575	207.188	155	R
16	5684.782	5824.782	140	207.188	207.188	**LEVEL**	
17	5824.782	6444.782	620	207.188	203.188	155	F
18	6444.782	6904.782	460	203.188	202.859	1398	F
19	6904.782	7564.782	660	202.859	202.659	3300	F
20	7564.782	8534.782	970	202.659	202.659	**LEVEL**	
21	8534.782	9164.782	630	202.659	198.53	155	F
22	9164.782	9484.782	320	198.53	199.452	347	R
23	9484.782	9594.782	110	199.452	199.452	**LEVEL**	

GRADIENT DETAIL'S OF PKG-C-5 (FROM CH:- -2.120 km to 12.00 km) - MAIN LINE							
S.NO	CHAINAGE KM		LENGTH (MTR)	Formation LEVEL		GRADIENT	RISE/FALL
	FROM	TO				1 IN	
24	9594.782	10984.782	1390	199.452	200.147	2002	R
25	10984.782	11429.782	445	200.147	203.018	155	R
26	11429.782	11759.782	330	203.018	203.018	**LEVEL**	
27	11759.782	12000	240.218	203.018	201.605	170	F
		Total Lenth	**14115**				
GRADIENT DETAIL'S OF PKG-C-5 (FROM CH:-18 km To 24.86 km) - MAIN LINE							
28	18020	18280	260	196.948	196.948	**LEVEL**	
29	18280	19900	1620	196.948	198.427	1095	R
30	19900	20100	200	198.427	199.64	165	R
31	20100	20420	320	199.64	199.64	**LEVEL**	
32	20420	20920	500	199.64	202.557	175	R
33	20920	21060	140	202.557	202.557	**LEVEL**	
34	21060	21380	320	202.557	204.663	152	R
35	21380	23400	2020	204.663	216.905	165	R
36	23400	23740	340	216.905	219.142	152	R
37	23740	24860	1120	219.142	225.93	165	R
		Total Lenth	**6840**				

2. List of Control Points

2. 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: -3.500 TO 0.0KM & 0.0KM TO 128 KM

Name	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
SCP-001	28°13'36.4461"N	77°16'42.8520"E	3124429.076	723596.755	196.397
SCP-002	28°15'27.5135"N	77°15'58.4447"E	3127825.599	722321.902	195.689
SCP-003	28°13'05.4037"N	77°14'44.3063"E	3123413.047	720382.185	194.341
SCP-004	28°15'11.3415"N	77°13'48.5273"E	3127261.925	718789.760	196.687
SCP-005	28°12'41.9039"N	77°12'26.1222"E	3122620.349	716627.351	197.059
SCP-006	28°14'56.7268"N	77°11'37.2212"E	3126746.576	715218.645	196.359
SCP-007	28°12'24.6069"N	77°10'31.7830"E	3122031.472	713518.954	199.057
SCP-008	28°14'55.5514"N	77°09'48.9907"E	3126657.269	712268.960	201.987
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
SCP-015	28°10'54.2284"N	77°01'21.9949"E	3118989.664	698572.831	195.675
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
SCP-032	28°24'51.7879"N	76°53'24.9249"E	3144561.072	685157.516	220.622
SCP-033	28°23'51.2766"N	76°50'47.9712"E	3142632.139	680914.651	225.660
SCP-034	28°26'27.1660"N	76°53'03.9408"E	3147488.043	684540.453	215.911
SCP-035	28°25'30.7392"N	76°50'25.8913"E	3145684.543	680266.856	219.896
SCP-036	28°28'09.7293"N	76°52'43.6735"E	3150636.520	683939.677	213.146
SCP-037	28°27'18.7550"N	76°50'07.4498"E	3149001.770	679714.292	220.146
SCP-038	28°29'42.9174"N	76°52'07.7145"E	3153489.785	682916.938	214.025
SCP-039	28°28'50.9803"N	76°49'32.4323"E	3151826.102	678718.550	213.476
SCP-040	28°31'23.0046"N	76°51'19.5862"E	3156550.370	681560.510	215.268
SCP-041	28°30'47.1215"N	76°48'49.0457"E	3155383.233	677484.549	215.147
SCP-042	28°32'46.8437"N	76°50'59.1405"E	3159122.525	680964.848	212.394
SCP-043	28°32'23.6956"N	76°48'04.3887"E	3158337.646	676225.734	213.962

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GCP's DATA OF CH: -3.500 TO 0.0KM & 0.0KM TO 128 KM

Name	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
SCP-044	28°34'35.6181"N	76°50'37.4479"E	3162461.747	680323.698	213.780
SCP-045	28°33'59.7877"N	76°48'05.0133"E	3161295.776	676198.247	213.144
SCP-046	28°35'59.9513"N	76°50'17.9686"E	3165049.567	679754.523	212.869
SCP-047	28°35'44.1280"N	76°47'29.6425"E	3164493.133	675188.989	214.385
SCP-048	28°37'43.7974"N	76°50'11.8125"E	3168243.616	679538.194	211.365
SCP-049	28°37'20.8988"N	76°47'30.9108"E	3167472.431	675178.822	214.849
SCP-050	28°39'17.6896"N	76°50'15.5662"E	3171135.407	679595.691	212.758
SCP-051	28°39'06.0639"N	76°47'27.7904"E	3170708.346	675045.557	214.564
SCP-052	28°40'55.5996"N	76°50'43.3817"E	3174160.974	680304.367	213.623
SCP-053	28°40'49.6516"N	76°48'01.1468"E	3173910.611	675903.203	215.232
SCP-054	28°42'14.8135"N	76°51'48.0932"E	3176626.699	682022.913	214.380
SCP-055	28°42'36.2269"N	76°48'38.2909"E	3177206.504	676861.708	216.294
SCP-056	28°43'50.5868"N	76°52'20.9630"E	3179588.863	682868.688	216.674
SCP-057	28°44'05.2133"N	76°49'30.4444"E	3179967.314	678235.110	217.989
SCP-058	28°45'20.6187"N	76°53'09.2286"E	3182380.992	684134.409	216.402
SCP-059	28°45'45.9842"N	76°50'09.3199"E	3183085.533	679242.048	216.272
SCP-060	28°46'41.4775"N	76°53'43.0935"E	3184884.691	685013.417	217.596
SCP-061	28°47'17.3471"N	76°51'03.6355"E	3185920.779	680671.588	217.009
SCP-062	28°48'07.7837"N	76°54'55.8970"E	3187573.140	686945.141	217.856
SCP-063	28°48'29.7793"N	76°51'48.2328"E	3188169.362	681846.040	217.275
SCP-064	28°48'51.5460"N	76°56'05.6169"E	3188950.935	688813.677	217.838
SCP-065	28°49'53.1214"N	76°52'53.7324"E	3190762.903	683581.309	219.203
SCP-066	28°50'11.2445"N	76°57'23.3871"E	3191438.920	690881.786	217.762
SCP-067	28°51'04.7927"N	76°54'23.5000"E	3193008.027	685979.239	221.407
SCP-068	28°51'14.1166"N	76°59'07.3306"E	3193421.178	693666.978	218.767
SCP-069	28°52'08.4648"N	76°55'34.7382"E	3194999.290	687878.141	220.724
SCP-070	28°52'28.2557"N	77°00'09.4122"E	3195731.814	695311.007	219.719
SCP-071	28°54'15.4471"N	76°58'21.5709"E	3198982.696	692333.931	220.614
SCP-072	28°52'56.4202"N	77°01'58.7477"E	3196649.269	698258.826	220.958
SCP-073	28°54'57.9790"N	77°00'31.7987"E	3200351.313	695839.495	221.410
SCP-074	28°53'49.8545"N	77°03'38.7018"E	3198341.028	700938.526	215.376
SCP-075	28°56'16.5033"N	77°00'52.0494"E	3202778.020	696346.884	219.178
SCP-076	28°56'07.1033"N	77°03'46.4922"E	3202570.002	701075.991	215.765
SCP-077	28°57'23.3942"N	77°01'26.8948"E	3204853.384	697255.295	216.508
SCP-078	28°57'31.0430"N	77°03'10.5149"E	3205137.209	700056.830	216.240
TCP-001	28°14'21.4725"N	77°17'04.9615"E	3125826.599	724173.443	195.708
TCP-002	28°14'24.3916"N	77°17'03.1045"E	3125915.511	724121.117	195.491
TCP-003	28°14'31.8093"N	77°16'32.4011"E	3126128.097	723279.756	195.881
TCP-004	28°14'34.4997"N	77°16'30.6949"E	3126210.050	723231.685	195.720
TCP-005	28°14'41.6562"N	77°15'50.0713"E	3126409.594	722120.073	196.165
TCP-006	28°14'44.7644"N	77°15'51.4560"E	3126505.985	722156.031	195.677
TCP-007	28°14'39.5700"N	77°15'27.8578"E	3126334.055	721515.695	196.141
TCP-008	28°14'40.9972"N	77°15'23.4000"E	3126375.726	721393.349	Not Found

MNEC CONSULTANTS PVT. LTD. NAGPUR

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GCP's DATA OF CH: -3.500 TO 0.0KM & 0.0KM TO 128 KM

Name	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
TCP-009	28°14'22.8380"N	77°14'47.5059"E	3125798.484	720425.198	193.702
TCP-010	28°14'24.9307"N	77°14'44.4561"E	3125861.366	720340.856	196.727
TCP-011	28°14'12.4058"N	77°14'14.8903"E	3125460.859	719541.942	199.405
TCP-012	28°14'13.5342"N	77°14'12.0740"E	3125494.176	719464.519	201.634
TCP-013	28°13'59.2918"N	77°13'39.5906"E	3125039.395	718586.984	198.195
TCP-014	28°14'01.9557"N	77°13'39.2400"E	3125121.226	718575.914	198.430
TCP-015	28°13'55.9121"N	77°13'06.5504"E	3124918.807	717688.075	197.517
TCP-016	28°13'58.7470"N	77°13'08.8851"E	3125007.247	717750.128	197.410
TCP-017	28°13'53.0806"N	77°12'22.8038"E	3124809.844	716496.941	196.123
TCP-018	28°13'51.4889"N	77°12'19.9521"E	3124759.428	716420.082	195.463
TCP-019	28°13'49.7602"N	77°11'42.0994"E	3124687.455	715389.010	203.244
TCP-020	28°13'53.9024"N	77°11'42.2949"E	3124815.066	715392.031	202.674
TCP-021	28°13'46.4748"N	77°11'07.7481"E	3124569.371	714454.265	199.417
TCP-022	28°13'49.4997"N	77°11'10.4701"E	3124663.830	714526.798	198.613
TCP-023	28°13'43.8074"N	77°10'30.7988"E	3124469.114	713448.329	196.569
TCP-024	28°13'46.6952"N	77°10'30.9754"E	3124558.100	713451.546	196.610
TCP-025	28°13'40.8173"N	77°09'55.9613"E	3124360.042	712500.137	194.890
TCP-026	28°13'44.4734"N	77°09'55.7117"E	3124472.471	712491.318	195.313
TCP-027	28°13'38.8686"N	77°09'11.9039"E	3124278.630	711299.984	195.052
TCP-028	28°13'41.2280"N	77°09'13.0688"E	3124351.827	711330.452	195.221
TCP-029	28°13'36.4332"N	77°08'44.0730"E	3124190.186	710542.504	195.381
TCP-030	28°13'38.5058"N	77°08'41.1399"E	3124252.574	710461.405	195.885
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
TCP-047	28°10'44.0971"N	77°04'38.8322"E	3118768.558	703947.028	194.012
TCP-049	28°10'45.7448"N	77°04'04.6722"E	3118803.354	703014.397	196.986
TCP-050	28°10'47.3044"N	77°04'04.1586"E	3118851.126	702999.570	191.383
TCP-051	28°10'51.3667"N	77°03'23.5326"E	3118957.332	701889.325	195.797
TCP-052	28°10'53.9021"N	77°03'25.6299"E	3119036.346	701945.208	191.911

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GCP's DATA OF CH: -3.500 TO 0.0KM & 0.0KM TO 128 KM

Name	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
TCP-053	28°11'01.6934"N	77°02'51.9934"E	3119260.655	701023.701	195.171
TCP-054	28°11'03.8249"N	77°02'56.0714"E	3119328.149	701133.819	191.919
TCP-055	28°11'23.8532"N	77°02'22.5241"E	3119929.247	700208.451	204.928
TCP-056	28°11'24.8968"N	77°02'26.9602"E	3119963.405	700328.898	196.307
TCP-057	28°12'01.8109"N	77°02'33.8636"E	3121102.891	700498.028	211.829
TCP-058	28°11'57.1647"N	77°02'37.9469"E	3120961.745	700611.793	205.087
TCP-059	28°12'28.9448"N	77°02'37.3175"E	3121939.734	700578.131	293.483
TCP-060	28°12'31.5563"N	77°02'39.7458"E	3122021.241	700642.990	293.567
TCP-061	28°12'49.2444"N	77°02'09.6693"E	3122551.915	699813.695	279.754
TCP-062	28°12'53.1437"N	77°02'12.1593"E	3122673.087	699879.573	280.937
TCP-063	28°13'03.6003"N	77°01'33.0531"E	3122977.089	698807.880	274.423
TCP-064	28°13'07.3919"N	77°01'35.4993"E	3123094.921	698872.627	274.485
TCP-065	28°13'03.9204"N	77°01'07.3722"E	3122975.253	698107.496	273.065
TCP-066	28°13'06.7684"N	77°01'04.6873"E	3123061.702	698032.829	272.484
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

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Name	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
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
TCP-111	28°22'02.9073"N	76°52'34.6907"E	3139341.245	683871.380	241.589
TCP-112	28°22'00.6212"N	76°52'31.1157"E	3139269.359	683775.137	242.421
TCP-113	28°22'32.3873"N	76°52'22.6854"E	3140243.606	683530.415	236.713
TCP-114	28°22'32.8678"N	76°52'26.6861"E	3140260.089	683639.103	236.489
TCP-115	28°23'07.6321"N	76°52'09.8221"E	3141323.059	683163.386	234.031
TCP-116	28°23'09.1365"N	76°52'10.2919"E	3141369.565	683175.457	232.909
TCP-117	28°23'34.0880"N	76°52'06.0418"E	3142135.820	683047.847	229.442
TCP-118	28°23'33.2265"N	76°52'11.0570"E	3142111.419	683184.774	229.522
TCP-119	28°24'06.5670"N	76°52'07.5751"E	3143136.224	683074.072	224.365
TCP-120	28°24'08.5433"N	76°52'07.5499"E	3143197.047	683072.441	223.715
TCP-121	28°24'44.9666"N	76°52'05.2477"E	3144317.248	682992.383	219.192
TCP-122	28°24'43.9123"N	76°52'08.2088"E	3144286.044	683073.473	218.608
TCP-123	28°25'12.0360"N	76°51'58.2550"E	3145147.538	682789.158	216.629
TCP-124	28°25'12.2561"N	76°52'01.6202"E	3145155.733	682880.630	216.485
TCP-125	28°25'44.3761"N	76°51'51.2001"E	3146140.046	682581.747	215.537
TCP-126	28°25'44.5441"N	76°51'55.0849"E	3146146.859	682687.377	215.975
TCP-127	28°26'14.6158"N	76°51'43.6273"E	3147067.689	682361.278	217.239
TCP-128	28°26'12.3380"N	76°51'47.4057"E	3146999.166	682465.168	218.938
TCP-129	28°26'52.0371"N	76°51'34.8424"E	3148215.885	682104.440	214.765
TCP-130	28°26'53.6477"N	76°51'38.0460"E	3148266.810	682190.830	213.613
TCP-131	28°27'22.0923"N	76°51'27.8475"E	3149138.096	681899.839	213.026
TCP-132	28°27'23.6537"N	76°51'29.6618"E	3149186.920	681948.452	212.382
TCP-133	28°27'36.8392"N	76°51'38.4657"E	3149596.499	682181.669	213.633
TCP-134	28°27'37.9196"N	76°51'45.7131"E	3149632.812	682378.301	213.769
TCP-135	28°27'59.5240"N	76°51'23.4804"E	3150288.477	681763.240	212.754
TCP-136	28°27'58.2345"N	76°51'26.5012"E	3150250.052	681846.023	213.531
TCP-137	28°28'36.0083"N	76°51'16.7447"E	3151408.700	681562.683	212.211
TCP-138	28°28'35.7799"N	76°51'20.2138"E	3151403.127	681657.146	212.179

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Name	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
TCP-139	28°28'57.6830"N	76°51'05.8799"E	3152071.330	681256.893	212.880
TCP-140	28°28'57.1481"N	76°51'10.2363"E	3152056.693	681375.628	212.816
TCP-141	28°29'18.8721"N	76°50'53.4692"E	3152718.372	680909.323	212.975
TCP-142	28°29'19.3493"N	76°50'57.6049"E	3152734.791	681021.569	212.681
TCP-143	28°29'54.7526"N	76°50'31.4879"E	3153813.651	680294.586	214.680
TCP-144	28°29'57.1221"N	76°50'30.5123"E	3153886.183	680266.936	214.588
TCP-145	28°30'22.3772"N	76°50'20.6217"E	3154659.458	679986.076	214.211
TCP-146	28°30'22.6226"N	76°50'23.7880"E	3154668.329	680072.053	214.134
TCP-147	28°30'53.1741"N	76°50'08.1171"E	3155602.235	679631.563	213.177
TCP-148	28°30'54.2896"N	76°50'11.2711"E	3155637.887	679716.790	212.908
TCP-149	28°31'22.3387"N	76°49'56.0802"E	3156494.973	679290.586	213.433
TCP-150	28°31'25.2632"N	76°49'57.6593"E	3156585.651	679332.140	213.002
TCP-151	28°31'59.1200"N	76°49'43.5444"E	3157621.968	678932.518	212.454
TCP-152	28°31'59.1272"N	76°49'46.9756"E	3157623.614	679025.787	212.229
TCP-153	28°32'26.7740"N	76°49'35.6755"E	3158469.951	678705.642	213.086
TCP-154	28°32'26.4983"N	76°49'39.8166"E	3158463.179	678818.333	Not Found
TCP-155	28°32'53.9751"N	76°49'28.0246"E	3159304.084	678484.932	213.040
TCP-156	28°32'53.1025"N	76°49'30.9652"E	3159278.440	678565.266	212.970
TCP-157	28°33'37.0758"N	76°49'21.9955"E	3160628.310	678300.880	214.384
TCP-158	28°33'34.0657"N	76°49'24.3878"E	3160536.643	678367.307	Not Found
TCP-159	28°34'06.2658"N	76°49'23.8031"E	3161527.582	678336.328	215.035
TCP-160	28°34'06.5116"N	76°49'27.5806"E	3161536.712	678438.865	215.232
TCP-161	28°34'44.1302"N	76°49'21.6178"E	3162692.219	678259.204	215.717
TCP-162	28°34'44.0011"N	76°49'24.6126"E	3162689.483	678340.641	215.278
TCP-163	28°35'09.5370"N	76°49'13.4355"E	3163470.908	678024.983	214.889
TCP-164	28°35'07.6456"N	76°49'17.6162"E	3163414.415	678139.459	214.612
TCP-165	28°35'49.0434"N	76°49'01.9172"E	3164682.237	677693.567	215.457
TCP-166	28°35'47.6889"N	76°49'04.9767"E	3164641.806	677777.317	215.564
TCP-167	28°36'14.8728"N	76°48'53.1968"E	3165473.723	677444.596	216.920
TCP-168	28°36'17.7457"N	76°48'53.0803"E	3165562.109	677440.090	216.659
TCP-169	28°36'53.6286"N	76°48'52.3007"E	3166666.338	677402.156	212.887
TCP-170	28°36'53.5674"N	76°48'55.5844"E	3166665.807	677491.379	213.297
TCP-171	28°37'16.7159"N	76°48'48.6339"E	3167375.501	677291.779	215.681
TCP-172	28°37'17.3314"N	76°48'51.6175"E	3167395.675	677372.528	214.707
TCP-173	28°37'46.6093"N	76°48'43.5742"E	3168293.597	677140.405	214.187
TCP-174	28°37'47.1935"N	76°48'46.5660"E	3168312.814	677221.386	213.926
TCP-175	28°38'15.6349"N	76°48'45.4960"E	3169187.860	677179.049	213.600
TCP-176	28°38'15.2158"N	76°48'48.5079"E	3169176.200	677261.038	213.400
TCP-177	28°38'52.6530"N	76°48'49.2286"E	3170328.894	677263.120	212.775
TCP-178	28°38'50.3688"N	76°48'51.5203"E	3170259.526	677326.417	212.786
TCP-179	28°39'32.7743"N	76°48'58.6038"E	3171567.785	677498.914	212.932
TCP-180	28°39'34.3510"N	76°49'01.8370"E	3171617.653	677585.962	213.008
TCP-181	28°39'57.4882"N	76°49'07.1922"E	3172332.083	677720.515	214.640

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GCP's DATA OF CH: -3.500 TO 0.0KM & 0.0KM TO 128 KM

Name	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
TCP-182	28°39'59.9709"N	76°49'08.1020"E	3172408.883	677744.052	214.623
TCP-183	28°40'33.8436"N	76°49'17.1206"E	3173455.299	677972.991	Not Found
TCP-184	28°40'31.5333"N	76°49'19.8702"E	3173385.319	678048.720	212.801
TCP-185	28°41'04.4049"N	76°49'27.2132"E	3174400.233	678232.594	213.359
TCP-186	28°41'04.2513"N	76°49'30.3003"E	3174396.785	678316.466	213.092
TCP-187	28°41'29.5545"N	76°49'39.7592"E	3175179.610	678561.293	213.916
TCP-188	28°41'27.5136"N	76°49'42.9392"E	3175118.110	678648.570	213.692
TCP-189	28°41'53.0101"N	76°49'49.7887"E	3175905.806	678822.443	Not Found
TCP-190	28°41'51.8793"N	76°49'52.7202"E	3175872.217	678902.544	Not Found
TBM-8	-	-	-	-	216.022
TBM-8A	-	-	-	-	217.141
TCP-191	28°42'19.5156"N	76°50'08.3889"E	3176729.472	679314.720	Not Found
TCP-192	28°42'20.5735"N	76°50'13.0258"E	3176763.975	679440.061	215.715
TCP-195	28°43'19.8012"N	76°50'45.7135"E	3178600.869	680298.954	216.671
TCP-196	28°43'22.2933"N	76°50'47.7586"E	3178678.441	680353.259	216.732
TCP-200	28°44'11.8367"N	76°50'57.1896"E	3180207.496	680585.502	215.863
TCP-201	28°44'13.7696"N	76°50'54.5753"E	3180265.895	680513.649	220.736
TCP 202	28°44'47.4517"N	76°51'13.3781"E	3181310.657	681007.658	215.773
TCP-203	28°44'47.5267"N	76°51'10.5601"E	3181311.774	680931.172	219.196
TCP-204	28°45'15.6253"N	76°51'28.8014"E	3182184.445	681412.544	216.728
TCP-205	28°45'16.6182"N	76°51'26.4624"E	3182214.019	681348.618	Not Found
TCP-206	28°45'43.3746"N	76°51'47.4539"E	3183046.560	681905.163	216.724
TCP-207	28°45'44.3337"N	76°51'45.3902"E	3183075.208	681848.723	217.837
TCP-208	28°46'12.1697"N	76°52'07.8621"E	3183941.643	682444.818	217.157
TCP-209	28°46'14.1830"N	76°52'04.6579"E	3184002.256	682356.937	224.242
TCP-210	28°46'41.2891"N	76°52'23.5045"E	3184844.706	682854.974	216.705
TCP-211	28°46'41.6254"N	76°52'19.6773"E	3184853.423	682751.014	221.517
TCP-212	28°47'06.9931"N	76°52'37.2627"E	3185641.839	683215.626	217.137
TCP-213	28°47'09.6905"N	76°52'34.8052"E	3185723.824	683147.670	217.713
TCP-215	28°47'41.2724"N	76°52'50.8038"E	3186702.875	683566.159	218.645
TCP-216	28°48'06.7675"N	76°53'11.9801"E	3187496.799	684127.937	217.848
TCP-217	28°48'09.9565"N	76°53'10.7518"E	3187594.440	684093.076	220.428
TCP-220	28°48'57.1791"N	76°54'00.9431"E	3189069.798	685430.755	218.322
TCP-221	28°48'57.2345"N	76°53'58.0967"E	3189070.271	685353.560	218.610
TCP-222	28°49'22.3693"N	76°54'27.4414"E	3189856.759	686136.712	218.018
TCP-223	28°49'22.3876"N	76°54'23.7163"E	3189855.699	686035.717	217.864
TCP-224	28°49'43.8176"N	76°54'51.4390"E	3190527.485	686776.639	218.273
TCP-225	28°49'45.4980"N	76°54'49.0279"E	3190578.160	686710.444	221.500
TCP-226	28°50'05.7997"N	76°55'18.5617"E	3191216.053	687500.936	217.993
TCP-227	28°50'08.2738"N	76°55'16.9260"E	3191291.499	687455.364	224.763
TCP-228	28°50'28.8356"N	76°55'45.1844"E	3191936.893	688211.065	218.895
TCP-229	28°50'29.7194"N	76°55'43.2143"E	3191963.232	688157.225	221.779
TCP-230	28°50'50.6845"N	76°56'12.8509"E	3192621.702	688949.996	219.059

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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: -3.500 TO 0.0KM & 0.0KM TO 128 KM

Name	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
TCP-231	28°50'51.5664"N	76°56'11.1237"E	3192648.087	688902.738	219.080
TCP 232	28°51'12.4342"N	76°56'39.3405"E	3193302.986	689656.989	218.126
TCP 233	28°51'13.0106"N	76°56'36.5176"E	3193319.479	689580.191	218.099
TCP-234	28°51'35.5539"N	76°57'05.4444"E	3194026.323	690352.753	218.728
TCP-235	28°51'37.3748"N	76°57'03.2061"E	3194081.380	690291.173	218.866
TCP-236	28°51'58.9139"N	76°57'33.2424"E	3194757.862	691094.216	217.924
TCP-237	28°51'59.5617"N	76°57'29.5754"E	3194776.164	690994.517	217.805
TCP-238	28°52'20.6429"N	76°57'58.0973"E	3195437.924	691756.669	220.381
TCP-239	28°52'21.9951"N	76°57'55.1679"E	3195478.233	691676.601	220.347
TCP-240	28°52'43.2460"N	76°58'23.3823"E	3196145.129	692430.245	219.634
TCP-241	28°52'44.8674"N	76°58'22.4457"E	3196194.621	692404.039	219.585
TCP-242	28°53'04.5385"N	76°58'49.6071"E	3196812.457	693129.879	Not Found
TCP-243	28°53'06.7052"N	76°58'48.4196"E	3196878.622	693096.591	219.843
TCP-244	28°53'27.6906"N	76°59'15.9857"E	3197537.151	693832.638	219.331
TCP-245	28°53'29.6655"N	76°59'15.8042"E	3197597.866	693826.699	219.700
TCP-246	28°53'39.0276"N	76°59'52.7637"E	3197902.911	694823.168	219.418
TCP-247	28°53'41.4429"N	76°59'52.7141"E	3197977.243	694820.573	219.356
TCP-248	28°53'48.1373"N	77°00'41.0308"E	3198205.471	696126.059	220.279
TCP-249	28°53'50.0922"N	77°00'40.7153"E	3198265.508	696116.491	219.686
TCP-250	28°53'51.8361"N	77°01'02.9349"E	3198329.424	696717.533	219.796
TCP-251	28°53'53.8396"N	77°01'02.9790"E	3198391.123	696717.677	219.670
TCP-252	28°53'59.0604"N	77°01'41.7943"E	3198569.796	697766.474	220.626
TCP-253	28°54'01.1271"N	77°01'40.0906"E	3198632.632	697719.231	Not Found
TCP-254	28°54'05.4704"N	77°02'14.8846"E	3198782.507	698659.522	222.576
TCP-255	28°54'07.7889"N	77°02'14.9287"E	3198853.906	698659.488	222.387
TCP-256	28°54'11.9954"N	77°02'47.9907"E	3198998.839	699552.910	Not Found
TCP-257	28°54'13.9564"N	77°02'47.9454"E	3199059.188	699550.640	220.173
TCP-258	28°54'35.6726"N	77°03'19.9205"E	3199742.728	700405.242	213.919
TCP-259	28°54'35.6407"N	77°03'17.6883"E	3199740.697	700344.791	Not Found
TCP 260	28°55'07.1089"N	77°03'06.5866"E	3200704.252	700027.285	213.548
TCP-261	28°55'06.6600"N	77°03'04.1751"E	3200689.301	699962.205	213.333
TCP-262	28°55'37.0488"N	77°02'52.3390"E	3201619.289	699625.434	215.014
TCP-263	28°55'36.4479"N	77°02'50.5823"E	3201599.968	699578.176	215.152
TCP-264	28°56'07.9988"N	77°02'36.2805"E	3202564.591	699174.062	216.020
TCP-265	28°56'06.3488"N	77°02'33.4393"E	3202512.464	699097.997	215.420
TCP-266	28°56'37.4916"N	77°02'22.9390"E	3203466.311	698797.109	215.340
TCP-267	28°56'36.0575"N	77°02'20.2303"E	3203420.898	698724.520	215.133

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3. List of Charted Utilities

3. List of Charted Utilities

Ref. Sub-Clause 10.45 & 10.46, Appendix 10, Section VII-9: Appendices, Part 2 Employer's Requirements)

3.1.1 Type A-Overground Electrical Crossings

a) Overhead Electrical Crossings: LT and HT (up to 33 KV)

LT/HT Crossings in C-5 Section		
S.No.	**Type of crossings**	**Chainage No.**
1	11kV HT Parallel	(-) 1+500 to (-)2+200
2	11kV HT Crossing	(-) 1+280
3	11kV HT Crossing	-900
4	11kV HT Crossing	-320
5	11kV HT Crossing	0+130
6	LT Crossing	0+820
7	11kV HT Crossing	0+920
8	11kV HT Crossing	0+900
9	11kV HT Crossing	1+100
10	LT Crossing	1+400
11	11kV HT Crossing	1+500
12	11kV HT Crossing	1+600
13	11kV HT Crossing	1+700
14	LT Crossing	1+900
15	11kV HT Crossing	2+150
16	LT Crossing	2+180
17	LT Crossing	2+260
18	11kV HT Crossing	2+300
19	11kV HT Crossing	2+400
20	LT Crossing	2+470
21	11kV HT Crossing	2+800
22	11kV HT Crossing	3+200
23	11kV HT Crossing	3+300
24	11kV HT Crossing	4+150

LT/HT Crossings in C-5 Section		
S.No.	**Type of crossings**	**Chainage No.**
25	11kV HT Crossing	4+150
26	11kV HT Crossing	3+600
27	11kV HT Crossing	3+500
28	11kV HT Crossing	5+150
29	LT Crossing	5+800
30	11kV HT Crossing	6+100
31	11kV & LT Crossing	6+600
32	11kV HT Crossing	6+900
33	11kV HT Crossing	7+100
34	11kV HT Crossing	8+500
35	11kV HT Crossing	10+000
36	11kV HT Crossing	11+200
37	11kV HT Crossing	11+200
38	11kV HT Crossing	14+050
39	11kV HT Crossing	16+400
40	11kV HT Crossing	16+500
41	11kV HT Crossing	16+700
42	11kV & LT Crossing	19+450
43	11kV HT Crossing	19+600
44	11kV & LT Crossing	20+300
45	11kV & LT Crossing	20+220
46	11kV HT Crossing	20+500
47	11kV HT Crossing	20+700
48	11kV HT Crossing	22+300
49	11kV HT Crossing	22+400
50	11kV HT Crossing	22+420
51	11kV HT Crossing	22+800

LT/HT Crossings in C-5 Section		
S.No.	**Type of crossings**	**Chainage No.**
52	11kV HT Crossing	22+900
53	33kV HT Crossing	19+450
54	33kV HT Crossing	19+520
55	33kV HT Crossing	19+525
56	33kV HT Crossing	19+700
57	33kV HT Crossing	19+710
58	33kV HT Crossing	19+720
59	33kV HT Crossing	19+730
60	33kV HT Parallel	20+300 - 21+000

b) EHT (above 33 KV)

EHT Crossings in C-5 Section		
S.No.	**Type of crossings**	**Chainage No.**
1	Electrical EHT-220 KV BTPS-Alwar	815-815
2	Electrical EHT-400 KV Prithla - Kaderpur Line	3070-3070
3	Electrical EHT-400 KV Ballabhgarh - Agra Line	5676-5676
4	Electrical EHT-220 KV Gurgaon-Rangala Rajpur line	16850-16850
5	Electrical EHT-220 KV Sec-72-Rangala Rajpur LILO line (IMT Sohna)	19950-19950
6	Electrical EHT-66 KV Sohna-Nuh Nagina line	20500-20500

4. Indicative List of Existing Structures to be Dismantled

4. Indicative List of Existing Structures to be Dismantled.

(Ref. Sub-Clause 10.14, Appendix 10, Section VII-9: Appendices, Part 2 – Employer's Requirements)

Structures in Main Line							
S. No.	Type of Structure	Chainage (in m)	District	Sub Division	Length of Obstruction to be considered (in m)	Chainage	
						From	To
1	Tubewell with one room	-1015	Palwal	Palwal	20		
2	Water Pipe Line	-821	Palwal	Palwal	20		
3	Boundary wall	-730	Palwal	Palwal	140	-730	-640
4	Bore well	-555	Palwal	Palwal	20		
5	Bore Well	-530	Palwal	Palwal	20		
6	Bore Well	-250	Palwal	Palwal	20		
7	Bore Well	-225	Palwal	Palwal	20		
8	Open Well	-215	Palwal	Palwal	20		
9	Shamshan Ghat/Boundary wall	-90	Palwal	Palwal	100	-174	-90
10	Bore well	0	Palwal	Palwal	20		
11	Bore well	140	Palwal	Palwal	20		
12	Tubewell with one room	800	Palwal	Palwal	20		
13	Tubewell with one room	1585	Palwal	Palwal	20		
14	Village Habitation at Mandpuri Village	1640 to 1800	Palwal	Palwal	160		
15	Bore well	4450	Palwal	Palwal	20		
16	House/Structure	4535	Palwal	Palwal	60		
17	Tubewell with one room	6485	Gurugram	Sohna	20		
18	Bore well	6595	Gurugram	Sohna	20		
19	Hand Pump	6681	Gurugram	Sohna			
20	Bore well	7265	Gurugram	Sohna	20		
21	Bore well	7280	Gurugram	Sohna	20		
22	Bore well	7570	Gurugram	Sohna	20		
23	Bore well	7630	Gurugram	Sohna	20		

Structures in Main Line							
S. No.	**Type of Structure**	**Chainage (in m)**	**District**	**Sub Division**	**Length of Obstruction to be considered (in m)**	**Chainage**	
						From	**To**
24	Bore well with Room	7715	Gurugram	Sohna	20		
25	Bore well	9230	Gurugram	Sohna	20		
26	IOCL Pipe Lines	9537	Gurugram	Sohna	20		
27	Open well	11135	Gurugram	Sohna	20		
28	Structure/Room	11165	Gurugram	Sohna	40		
29	Structure/Bhumiya	11215	Gurugram	Sohna	20		
30	Boundary wall,Farm house	11615	Gurugram	Sohna	185	11615	11800
31	Structue/Room	18310	Nuh	Indri	40		
32	Bore well	18900	Nuh	Indri	20		
33	Water tank and Room	20985	Nuh	Indri	40		
34	Water Pile Line	20985	Nuh	Indri	675	20985	21660
35	Kabristan/Boundary wall	21420	Nuh	Indri	140	21420	21560
36	Small Hut	21580	Nuh	Indri	10		
37	Bore well/Handpump	24120	Nuh	Indri	20		
38	Structure/Teen shed Factory	24180	Nuh	Indri	60		
32	Small Hut	24280	Nuh	Indri	20		

5. Approved Manufactures/Suppliers List

5. 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 the Engineer.

The list of approved makes for products and materials is given below. Other equivalent manufacturers may also be considered with prior approval of the Engineer, if found conforming to all standards. Such requests should be made with all documents to the Engineer at least 45 days before the material is required and any order shall be placed only after receiving the written approval of the Engineer.

S. No.	Details of Materials/ Products	Manufacturer's Name
1.	Cement	ACC, Ultratech, Ambuja Cements, JK Lakshmi, JSW, JK Cement, Lafarge, Shree Cement, Birla Cement, Grasim
2.	Reinforcement Bars	SAIL, JSW STEEL, TATASTEEL, RINL, JSPL
3.	Epoxy	FOSROC, SIKA QUALCRETE, BASF, CICO, MC–BAUCHEMIE, MAPEI, CHRYSO, Huntsman Advanced Materials
4.	Expansion Joints for Viaduct	Prequalified Manufacturers as per RDSO's latest approved list
5.	Admixtures	FOSROC, SIKA, MC-BAUCHEMIE, CHRYSO, MAPEI, CICO
6.	Pile Integrity Testing	CIMEC, Geodynamics, AIMIL, CBRI, Pile Dynamic, CEGTH, FUGRO
7.	*Anchor Fastener	HILTI, FISHER, BOSCH, (Please note that ETA Certification is mandatory for using/supplying fasteners for load bearing structural members)
8.	Structural Steel	TATA, SAIL, ESSAR, JSPL, JSW
9.	Pre- stressing Strand (LRPC)	TATA SSL Ltd, USHA MARTIN
10.	*Pot/Elastomeric /Spherical Bearings	Prequalified Manufactures as per RDSO's latest approved list.
11.	HDPE Sheathing	Rex Polyextrusion, Gwalior Poly Pipes Ltd, Dynamic Prestress, JK Prestressing
12.	Formwork Release Agent	FOSROC, MC BAUCHEMIE, CICO, MAPEI, SIKA, CHRYSO
13.	*Prestressing System	Freyssinet, BBR, VSL, Dynamic, Killick Nixon, Tensacciai (India Ltd.), JK Prestressing, Usha Martin, VSIL

S. No.	Details of Materials/ Products	Manufacturer's Name
14.	*Reinforcement Couplers	DEXTRA, , SANFIELD, SPLICETECH COUPLERS
15.	Hollow Sections, Pipes	Surya Pipes, Hi-Tech Pipes, JSW, JSPL, TATA.
16.	Drainage Pipes	Tirupati Plastomatics, Duraline, REX, STIPL
17.	Acrylic Textured Coatings	Spectrum, Surfa Nova, Jotun, Asian Paints, Berger, Hempel, DULUX
18.	Non Shrink Grout	FOSROC, Fairmate, SIKA, CICO, MC-Bauchemie, CHRYSO
19.	Bonding Coat	CICO, FOSROC, BASF, SIKA, MAPEI, MC-BAUCHEMIE, CHRYSO
20.	Polysuphide Sealant	CICO, PIDILITE, FOSROC, SIKA, CHRYSO
21.	*Steel Structural Fasteners	Sundram Fasteners, Nelson, Dextra India, Panchsheel, Pooja Forge (Please note that ETA Certification is mandatory for using/supplying fasteners for load bearing structural members)
22.	*Corrosion Protection Paints	Berger, Jenson and Nicholson, Nerolac, Asian Paints, Akzo Nobel, Jotun
23.	Fire Resistant Paint	Akzo Nobel, PPG, Jotun
24.	Water stopper/ Bar	Greenstreak, Duron, Maruti, Kanta Rubber
25.	*Liquid Polymer membrane waterproofing	SIKA, MAPEI , NINA, CICO, MYK Schomburg, Geo-Constech
26.	Curing Compound	FOSROC, CHRYSO, CICO, MC- BAUCHEMIE, MAPEI, SIKA.
27.	*Polycarbonate Sheets	Gallina Acroplus, Coxwell, Poly U, Fabic, Lexan, (SABIC Innovative Plastics), DANPALON, GE Plastics, VMI Plastics, Power Chem Plast
28.	Fly Ash	Thermal Plants, Ashcrete, Ultra Pozz, Star Pozz, Ashtech
29.	*Pre-Coated Profiled Metal Sheetings	TATA Blue Scope, Multicolor, Essar Steel, Bhushan Steel, Ispat Profile India
30.	Fly Ash Block/ AAC Block	Siporex, Ascolite, J.K. Laxmi, Ashtech
31.	Rock Bolts/Swellex Bolts	Geo Constech, DSI, Atlas Copco, FIREP International, Minova
32.	Soft eye GFRP	Dextra, FIREP International, Minova, Hughes Brothers, Geo Constech
33.	Polymer	WALLGRIP, TRISHUL, Shubham Minerals, Goldy Minerals, GeoPolymer

S. No.	Details of Materials/ Products	Manufacturer's Name
34.	Welding electrodes	Ador welding Ltd.(Advani-Oerlikon),ESAB, D&H Welding Electrodes, Modi Arc
35.	Aluminium Sheets	Hindustan Aluminium, Jindal, Balco
36.	Vitrified Tiles	Asian Tiles, Somany, Johnson, Bell Ceramics, Kajaria, Simpolo
37.	Ceramic Tiles	NITCO, Orient, Regency Ceramics
38.	Wall Putty	JK White, Birla
39.	Flush Doors	Samrat, Kanchan, Prima Swastik, Kutty, Diamond
40.	Adhesives	Pidilite, Araldite, Toyo Ferrous Crete
41.	Plywood	Duroply, Century Plywood, Green Plywood, Kitply
42.	Veneers	Green Plywood, Century Plywood, Kitply
43.	FloatGlass/Toughened Glass/Insulated Glass/Laminated Glass	Saint Gobain, Modiguard, Tata Float, Asahi Glass Ltd.
44.	Heavy Duty Chequered Tiles	NITCO. Hindustan Tiles, Super Tiles & Marbles Pvt.Ltd.
45.	Heavy Duty Vitrified Tiles	Kajaria World
46.	Emulsion Paint	Asian Paints, Berger, Nerolac, Jenson & Nicholson, Dulux, ICI
47.	Synthetic Enamel	Asian Paints, Berger, Nerolac, Jenson & Nicholson, Dulux, ICI
48.	Paver Blocks	As approved by the Engineer
49.	Sanitary & Bath Fittings	Hindware, Parryware, Jaquar, HR & Johnson, Cera, , Somany, Asian Granito
50.	Aluminium doors & windows	Sehgal & Sehgal Industries
51.	Yellow Tactile Tiles	Pelican
52.	SS Railing	The Cavalier, D Line India, DOORMAT, Panchal Enterprises, SS Enterprises
53.	Glass Mosaic Tiles	Mridul Enterprises, Italia, Bissazza, Kenzai, Opio
54.	Granite Slabs & Tiles	As approved by the Engineer.

NOTE: For the categories marked as *, the enclosed undertaking performa should be duly filled and signed by authorized representatives of concerned agencies.

UNDERTAKING

Name of Contract: **Date of start of work:**

Category of work: **Date of completion of work:**

This is to certify that work of …… (Category to be mentioned) at …… (Location) of the contract ..... (Name of contract) has been executed/completed in accordance with the manufacturer's/supplier's specifications and as per the approved method statement.

The work has been jointly inspected by authorised representative of ……(Manufacturer/supplier), …… (Executing agency) &…….. (Contractor) during its execution and all non-conformities observed during inspection have been complied to achieve the best industry standards.

The undersigned take full responsibility of the overall adequacy, accuracy, effectiveness & warranty (upto design life) of the completed work as per the provision of the contract……. (Contract number) and Outline Construction Specifications of the Part 2- Employer's Requirements.

(Stamp and Signature)	**(Stamp and Signature)**	**(Stamp and Signature)**
Manufacturer Representative	**Executing agency Representative**	**Contractor Representative**

6. DFC Letter – Approval of GAD of HORC alignment crossing under DFC bridge 87

डेडीकेटेड फ्रेट कोरीडोर कार्पोरेषन ऑफ इंडिया लि.
भारत सरकार (रेल मंत्रालय) का उपक्रम
डेडीकेटेड फ्रेट कोरीडोर
Dedicated Freight Corridor Corporation of India Ltd.
A Govt. of India (Ministry of Railways) Enterprise

No: DFCC/Noida Unit/DMIC/HRIDC/ 8228

Dated: 03-06-2023

Chief Project Manager/HRIDC
Plot No. 143, 5th Floor, Rail Tel Tower
Sec-44, Gurugram, Haryana-122003

Sub: - Approval of GAD of HORC alignment crossing under DFC bridge 87.

Ref: -

i. Your Letter No. HRIDC/GGN/DFCCIL/2021/1637 dated 10-02-2022.
ii. This office letter no. DFCC/Noida Unit/DMIC/HRIDC/7726 dated 04.03.2023.
iii. Presentation made by HRIDC before director Infra at prithala on 09.05.2023.
iv. your office letter no. HRIDC/GGN/DFCCIL/2021/1914 dated 19.05.2023.

Under the above reference in principal approval for crossing HORC alignment under DFC bridge no. 87 is granted subject to fulfilment of following conditions.

(i) HORC track will be placed clear-off DFC Bridge structure as per SSOD of DFCC/HORC.
(ii) Drawings of DFC Bridge no. 87 are attached herewith for further planning at the end of HRIDC.
(iii) The HORC structural components (viz. Sub-structure, super-structure and foundations) shall be planned/executed at-least 2.0 m clear distance (in plan) from DFC Bridge structural components (viz. sub-structure and foundation).
(iv) HORC Bridge pile/open foundations will be designed duly accounting base pressure below DFC bridge open foundations.
(v) HORC UP-line Bridge foundation is shown adjacent to DFC Bridge foundation. This indicates that there will be overlap of pressure bulb of adjacent foundations. It will be ensured that sufficient bearing capacity is available against the super-imposed base pressure of DFC bridge foundation and HORC bridge foundation.
(vi) Since it is proposed to carry out tunnelling works from Sonipat end, rock/boulders may hit DFC Bridge components while opening of tunnel on DFC Bridge side. HRIDC will submit and obtain DFCCIL approval for the protection arrangement/scheme for DFC works prior to opening of tunnel.
(vii) HRIDC will submit the detailed safety plans for the approval of DFCCIL before start of any execution work near to DFCCIL track.
(viii) HRIDC will submit, analysis of safety, stability and protection measures (temporary and permanent) duly proof checked by IIT/NIT for the DFCC works.
(ix) Sub-structure and foundation of HORC will not infringe with the toe of the buttress wall.
(x) Adequate protection (temporary/permanent) arrangements will be made for DFC Bridge structure, embankment and rock surface during construction of HORC bridge structure and tunnel works.
(xi) Existing drainage works will be re-instated to their original condition. In case, HORC drainage plan is affecting existing drainage scheme, drainage works shall be designed and executed by HRIDC duly accounting DFC drainage requirement, with prior approval of DFCCIL at the cost of HRIDC.
(xii) Duly proof checked (from IIT/NIT) detailed GAD, Design/Drawings of pier/abutment, super-structure and rock slope stability shall be submitted to DFCCIL for his review and approval start of any execution work the vicinity of DFCCIL ROW.
(xiii) HRIDC will be required to submit the construction programmer before the actual start of the work.

03/6/23

सीजीएम कार्यालय, नोएडा/CGM Office, Noida पता/Address- DFCCIL Complex, Sector-145 (Near Sector-146 Metro Station), Noida-201306
फोन नं0/Phone No. 0120-3680888 फैक्स/Fax No ..... ई-मेल/E-mail- noidaunit01@gmail.com
पंजीकृत एवं कॉर्पोरेट कार्यालय: पांचवा तल, सुप्रीम कोर्ट, मेट्रो स्टेशन बिल्डिंग कॉम्पलेक्स, नई दिल्ली – 110001
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(xiv) Whenever necessary/required, HRIDC will seek permission for issuance of **Traffic Work Order** (TOW) from DFCCIL for the activities which may affect train operations and safety of the DFC works.

(xv) HRIDC or its Contractor will interface with DFCCIL Contractor for the planning and execution of HORCL works in DFC ROW.

(xvi) DFCCIL reserves the right of cancellation of approval on violation of any of the condition and may impose any other condition to ensure the safety of DFC bridge structure and DFC train operation.

(xvii)HRIDC will indemnify DFCCIL regarding any damage during construction of HORC line and any damage to DFC works shall be reinstated to its original condition by the HRIDC at his own cost..

HRIDC will indemnify, defend and hold DFCCIL harmless against any and all proceedings, action and third-party claims for any loss, damage, cost and expenses arising out of any action of HRIDC or its Contractor under this work.

03/6/23

R.K.Gupta
CGM/Noida

Copy to:

(i) Director/Infra/DFCCIL New Delhi for kind information please.
(ii) ED/Assets/Management/DFCCIL for kind information please.

7. Geotechnical Investigation Reports

CONTENTS

7.1 Report No: SMC – 2050 - Viaduct Report

GEOTECHNICAL INVESTIGATION REPORT
FOR
VIADUCT

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.

Client:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

Prepared By:

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

GEOTECHNICAL INVESTIGATION REPORT FOR VIADUCT

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.

VIADUCT REPORT

Prepared & Submitted By		
M/s. S. M. Consultants		
Prepared By	Geotechnical Engineer	Shreeeeta
Approved By	Sr. Consultant	Virendrasharma

Client:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

Prepared By:

S.M. CONSULTANTS,
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RASULGARH, BHUBANESWAR-751010,
ODISHA

CONTENTS

Name of Project:	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.

LIST OF TABLES

ANNEXURES

Name of Project:	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.

EXECUTIVE SUMMARY

General Objectives of Investigation: The scope of work was to complete **"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 report presents the results of the Site Investigation and Geotechnical recommendations related to the Project.

Fieldwork and Laboratory Testing: Twelve nos. of borehole at location **Abutment(BH NO -2), Pier(BH NO-3, BH NO-4,BH NO-5,BH NO-6,BH NO-7,BH NO-8,BH NO-9,BH-10,BH-11,BH-11A,BH NO-12)** were drilled. Field-testing of subsoil was conducted and soil samples at various depths were collected during drilling. Geotechnical laboratory tests on collected soil samples were conducted at our laboratory (NABL accredited) at New Delhi. These tests include Grain Size Distributions, Hydrometer Analysis, Atterberg's Limits, Density, Moisture Content, Specific Gravity, Shear Strength Parameters, Void Ratio and Consolidation Test and of soil samples.

Report on Foundation System: A general description of the strata encountered during boring, the soil properties, details of field Test, Laboratory Test and groundwater levels are provided in this report. Recommendations for Foundations based on Geotechnical Engineering parameters related to the proposed structure **(Viaduct)** have been given in this report. The design of Pile Foundations is based on parameters derived from Geotechnical Investigations. The calculation of safe load carrying capacity of pile foundation was carried out as per the relevant clauses of IRC 78 and IS Codes.

1.0.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." Abutment(BH NO -2), Pier(BH NO-3, BH NO-4,BH NO-5,BH NO-6,BH NO-7,BH NO-8,BH NO-9,BH-10,BH-11,BH-11A,BH NO-12).** This work was performed by **M/s. S. M. Consultants, Bhubaneswar** under **Haryana Rail Infrastructure Development Corporation Ltd.**

2.0.PURPOSE AND SCOPE OF SERVICES

The purpose of the current geotechnical investigation was to explore and determine the existing sub-strata conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. at the location and to evaluate shear strength parameters for determination of safe bearing capacity and foundation system of proposed structure **(Viaduct)** using procedures as provided in the relevant IS codes. The goal of our investigation was to identify the key geotechnical issues that could potentially affect the proposed project and to develop geotechnical recommendations for design and construction of foundation of related structures.

Our scope of services included the following tasks:

- Field marking of boring locations.
- Drilling of **twelve** numbers of boreholes up to the required depth below the existing ground level in order to know the sub surface stratification, conducting necessary field tests and collection of sub-strata samples for laboratory testing.
- Testing of soil samples in the laboratory to determine its physical and engineering properties and analyzing all field and laboratory data to evaluate bearing capacity of the sub-strata for given foundation sizes.
- Preparation of this report containing our findings and recommendations including:
  a) Brief description of the proposed project;
  b) Description of the field exploration and laboratory testing programs;
  c) Discussion on the site surface and subsurface conditions.
  d) Preliminary geotechnical parameters for design of foundations for structural support.

3.0. PROJECT DESCRIPTION

Proposed site is located at Sohna, Haryana.

3.1. Location And Topography of Haryana

3.1.1. ***Geography***

Haryana is in north India and has a total area of 44212 square kilometres. Haryana surrounds the country's capital Delhi on three sides (north, west and south). Haryana is a landlocked state in northern India. It is between 27°39' to 30°35' N latitude and between 74°28' and 77°36' E longitude. The total geographical area of the state is 4.42 m ha, which is 1.4% of the geographical area of the country. The altitude of Haryana varies between 700 and 3600 ft (200 metres to 1200 metres) above sea level.

3.1.2. ***Climate***

Haryana is extremely hot in summer at around 45 °C (113 °F) and mild in winter. The hottest months are May and June and the coldest December and January.[83] The climate is arid to semi-arid with average rainfall of 354.5 mm. Around 29% of rainfall is received during the months from July to September, and the remaining rainfall is received during the period from December to February.

3.1.3. ***Rainfall***

Haryana gets highest rainfall (33%) of south west monsoon rainfall in August month while the July month get 32% of the south west monsoon rainfall. June and September receive 14% and 21% of south west 5 monsoon rainfall. Also more than 82% of annual rainfall receives during the southwest monsoon season only. The variability of monsoon or annual rainfall is 31% and 27% respectively.

3.1.4. ***Seismic zone***

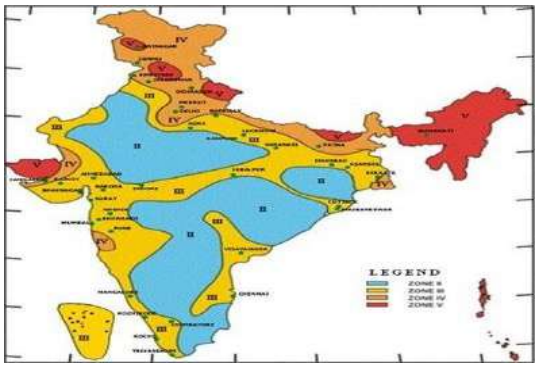

Figure 1. Seismic zone of India

Haryana falls under seismic zones IV. zone IV is considered a high-damage risk zone.

4.0. FIELD INVESTIGATION PROGRAM

Field investigation work was in accordance with IS 1892 -1979.

Field works include:

- Boring in the sub-strata by Rotary Boring Method.
- Collection of disturbed & undisturbed samples from bore holes.
- Conducting SPT in soil as per IS: 2131-1981(Reaffirmed 2016) and collection of SPT samples.

4.1. Present Site Location:

Present site is located at Sohna . Boreholes were conducted for a proposed structure i.e. **(Viaduct).**

4.2. Methodology of Investigation:

By using Rotary Boring, the borehole was progressed up to desired depth. Rotary Boring method of boring is most widely used method of advancing a boreholes. This method along with use of drilling mud to stabilize the side of the borehole is likely to give the least disturbance to soils beneath the base of the borehole and permit taking near to truly undisturbed samples. Diameter of boreholes was 150mm. Where caving of boreholes occurred, casings were used to keep the boreholes stable.

Standard Penetration Tests (SPT) was conducted in the boreholes alternate to UDS. By connecting a split spoon sampler to 'A' rods and driving it by 45cm using a 63.5 kg hammer falling freely from a height of 75cm. The tests were conducted in accordance with IS: 2131-1981(Reaffirmed 2016).

Number of blows required for each 15cm penetration of the split spoon sampler was recorded. First 15cm penetration is ignored. The cumulative no. of blows required to penetrate the rest 30cm of the 45cm sampling interval is reported as the SPT value (N value).

Bore logs showing field data of each borehole has been attached in this report **(ANNEXURE-A).**

4.3. Logging and Sample collection:

During exploration for each borehole log of borings showing details about the exploration were prepared. Bore logs were presented in this report under **Annexure-A.**

Disturbed samples were collected from the split spoon sampler after conducting SPT. The samples were preserved in transparent polythene bags with proper identification mark.

In case of undisturbed samples, tubes were sealed with wax at both the ends. Then samplers were wrapped with moist jute bags to prevent loss of moisture.

4.4. Summary of fieldwork:

The table below shows the numbers of boreholes with max-explored depth and depth of water table encountered.

Table - 1

BH Reference	Chainage Reference in m	Ground Level RL in m.	Max depth of exploration in m.	Ground water table below E.G.L in m.
A-(BH NO-02)	21305	191.135	32.0	1.5
PIER- (BH NO-03)	21805	191.220	32.0	2.5
PIER- (BH NO-04)	22265	191.013	32.0	2.0
PIER- (BH NO-05)	22160	192.226	32.0	3.0
PIER- (BH NO-06)	22660	194.594	32.0	Not Found
PIER- (BH NO-07)	23160	196.146	32.0	Not Found
PIER- (BH NO-08)	23660	200.069	20.0	Not Found
PIER- (BH NO-09)	22705	191.897	40.0	1.90
PIER- (BH NO-10)	23205	193.009	40.0	2.40
PIER- (BH NO-11)	23705	193.717	40.0	1.80
PIER- (BH NO-11A)	24205	196.637	40.0	6.50
PIER- (BH NO-12)	24700	203.485	20.0	Not Found

Note: - This Report is for Alternative Alignment 2A.For BH No. 05, 06, 07 & 08 chainages are as per the old alignment-2.

5.0. LABORATORY TESTING

Laboratory methods in accordance with relevant standard codes of practices are adopted to ascertain the different essential characteristics of sub-soil using field samples obtained in during field investigations. The tests as under have been conducted to ascertain the parameters indicated in the test. The finding of these test are required for use in relevant engineering designs.

The table below shows the laboratory tests with concerned IS codes followed.

Table – 2

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)

The result sheets of the tests are presented in the subsequent pages.

6.0. DISCUSSION ON THE ENGINEERING PROPERTIES OF THE SUB-STRATA AT THE PROJECT SITE

Abutment (BH NO- 02, CH-21305 m)

1. From N.G.L to 1.5 m depth, a non-plastic, non-expansive Silty sand stratum exists from which one DS was collected at 0.5 m depth.
2. From 1.50 m to 32.0 m (max. explored) depth, medium-plastic, stiff to hard consistency silt & clay with low compressibility stratum exist from which six UDS samples were collected at 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 11,15,22,28,48,54 & 66 at 1.50 m,4.5 m,9.0 m,15.0 m,21.0 m,27.0 m & 32.0 m depth respectively.

Pier - (BH NO- 03, CH-21805 m)

1. From N.G.L to 1.5 m depth, a non-plastic, Silty sand stratum exists from which one DS was collected at 0.5 m depth.
2. From 1.50 m to 9.0 m depth, medium-plastic, stiff to very stiff consistency silt & clay with low compressibility stratum exist from which two UDS sample were collected at 3.0 m & 6.0 m depth. The field SPT N values were found to be 12 & 17 at 1.50 m & 4.5 m depth respectively.
3. From 9.0 m to 12.0 m depth, a non-plastic, medium compacted Silty sand stratum exists. The field SPT N value was found to be 24 at 9.0 m depth respectively.
4. From 12.0 m to 21.0 m depth, medium-plastic, hard consistency silt & clay with low compressibility stratum exist from which two UDS sample were collected at 12.0 m & 18.0 m depth. The field SPT N value was found to be 32 at 15.0 m depth respectively.
5. From 21.0 m to 24.0 m depth, a non-plastic, very dense compacted clayey silts with none to low plasticity stratum exists. The field SPT N value was found to be 59 at 21.0 m depth respectively.
6. From 24.0 m to 32.0 m (max. explored) depth, non-plastic, very dense compacted Silty sand stratum exist. The field SPT N values were found to be 68 & 77 at 27.0 m & 32.0 m depth respectively.

Pier - (BH NO- 04, CH-21580 m)

1. From N.G.L to 3.0 m depth, a 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 16 at 1.50 m depth respectively.
2. From 3.0 m to 12.0 m depth, non-plastic, medium to dense compacted Silty sand stratum exist from which two UDS sample were collected at 3.0 m & 6.0 m depth. The field SPT N values were found to be 18 & 36 at 4.50 m & 9.0 m depth respectively.
3. From 12.0 m to 21.0 m depth, a medium-plastic, hard consistency Silt & clay with low compressibility stratum exists from which two UDS were collected at 12.0 m & 18.0 m depth. The field SPT N value was found to be 52 at 15.0 m depth respectively.
4. From 21.0 m to 32.0 m (max. explored) depth, non-plastic, very dense compacted Silty sand stratum exist. The field SPT N values were found to be 65,76 & 85 at 21.0 m, 27.0 m & 32.0 m depth respectively.

Pier - (BH NO- 05, CH-22160 m)

1. From N.G.L to 3.0 m depth, a 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 15 at 1.50 m depth respectively.
2. From 3.0 m to 4.50 m depth, medium-plastic, Clayey sand stratum exist from which one UDS sample was collected at 3.0 m depth.
3. From 4.50 m to 6.0 m depth, non-plastic, clayey silts with none to low plasticity stratum exist. The field SPT N value was found to be 23 at 4.50 m.
4. From 6.0 m to 18.0 m depth, a medium-plastic, medium to dense compacted clayey sand stratum exists from which two UDS were collected at 6.0 m & 12.0 m depth. The field SPT N value were found to be 28 & 50 at 9.0 m & 15.0 m depth respectively.
5. 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 value were found to be 61 & 70 at 21.0 m & 27.0 m depth respectively.

6. From 30.0 m to 32.0 m (max. explored) depth, medium-plastic, very dense compacted clayey sand stratum exist from which one UDS sample was collected at 30.0 m depth. The field SPT N values was found to be 73 at 32.0 m depth respectively.

Pier - (BH NO- 06, CH-22660 m)

1. From N.G.L to 6.0 m depth, a 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 15 & 25 at 1.50 m & 4.5 m depth.
2. From 6.0 m to 15.0 m depth, non-plastic, dense compacted Silty sand stratum exist from which two UDS sample were collected at 6.0 m & 12.0 m depth. The Field SPT N value was found to be 39 at 9.0 m Depth,
3. From 15.0 m to 24.0 m depth, non-plastic, dense to very dense clayey silts with none to low plasticity stratum exist from which one UDS was collected at 18.0 m depth. The field SPT N value were found to be 47 & 60 at 15.0 m & 21.0 m depth
4. From 24.0 m to 32.0 m (max. explored) depth, non-plastic, very dense compacted Silty sand 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 71 & 83 at 27.0 m & 32.0 m depth respectively.

Pier - (BH NO- 07, CH-23160 m)

1. From N.G.L to 1.50 m depth, a non-plastic, Silty sand stratum exists from which one DS was collected at 0.5 m depth.
2. From 1.50 m to 3.0 m depth, a non-plastic, medium compacted poorly graded silty sand stratum exists. The field SPT N value was found to be 18 at 1.50 m depth
3. From 3.0 m to 4.50 m depth, a non-plastic, Silty sand stratum exists from which one UDS was collected at 3.0 m depth.
4. From 4.50 m to 6.0 m depth, a non-plastic, dense compacted poorly graded sand stratum exists. The field SPT N value was found to be 36 at 4.50 m depth
5. From 6.0 m to 9.0 m depth, a non-plastic, Silty sand stratum exists from which one UDS was collected at 6.0 m depth.

6. From 9.0 m to 18.0 m depth, medium-plastic, hard consistency Silt & clay with low compressibility stratum exist. The Field SPT N values were found to be 50 & 54 at 9.0 m & 15.0 m Depth.
7. From 18.0 m to 21.0 m depth, a non-plastic, poorly graded Silty sand stratum exists from which one UDS was collected at 18.0 m depth.
8. From 21.0 m to 27.0 m depth, medium-plastic, hard consistency Silt & clay with low compressibility stratum exist from which one UDS sample was collected at 24.0 m depth. The Field SPT N value was found to be 68 at 21.0 m Depth.
9. From 27.0 m to 32.0 m (max. explored) depth, non-plastic, very dense compacted Silty sand stratum exist from which one UDS sample was collected at 30.0 m depth. The field SPT N values were found to be 79 & 88 at 27.0 m & 32.0 m depth respectively.

Pier - (BH NO- 08, CH-23660 m)

1. From N.G.L m to 15.0 m depth, non-plastic, dense to very dense compacted clayey silts with none to low plasticity stratum exist from which one DS & three UDS sample 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 50, 51 & 59 at 1.50 m, 4.50 m & 9.0 m Depth.
2. From 15.0 m to 20.0 m (max. explored) depth, medium-plastic, medium to dense compacted clayey sand stratum exist from which one UDS sample was collected at 18.0 m depth. The field SPT N values were found to be 33 & 25 at 15.0 m & 20.0 m depth respectively.

Pier - (BH NO- 09, CH-22705 m)

1. From N.G.L to 3.0 m depth, a non-plastic, loose 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 5 at 1.50 m depth
2. From 3.0 m to 4.50 m depth, a low-plastic, stiff consistency, inorganic silty clayey soil stratum exists. The field SPT N value was found to be 13 at 3.0 m depth
3. From 4.50 m to 6.0 m depth, a non-plastic, Clayey silts with none to low plasticity stratum exists from which one UDS was collected at 4.50 m depth.
4. From 6.0 m to 9.0 m depth, a non-plastic, medium compacted silty sand stratum exists. The field SPT N value was found to be 19 at 6.0 m depth

5. From 9.0 m to 15.0 m depth, medium-plastic, very stiff consistency Silt & clay with low compressibility stratum exist from which one UDS was collected at 9.0 m depth. The Field SPT N value was found to be 17 at 12.0 m Depth.
6. From 15.0 m to 27.0 m depth, a non-plastic, medium compacted Clayey silts with none to low plasticity stratum exists from which two UDS were collected at 15.0 m & 21.0 m depth. The Field SPT N values were found to be 25 & 29 at 18.0 m & 24.0 m Depth.
7. From 27.0 m to 40.0 m (max. explored) depth, non-plastic, very dense compacted Silty sand stratum exist from which one UDS sample was collected at 27.0 m depth. The field SPT N values were found to be 61,77 & greater than 50 at 30.0 m,33.0 m,36.0 m,39.0 m & 40.0 m depth respectively.

Pier - (BH NO- 10, CH-23205 m)

1. From N.G.L to 12.0 m depth, a non-plastic, loose to medium compacted Silty sand stratum exists from which one DS was collected at 0.5 m depth and three UDS were collected at 1.50 m,4.5 m,9.0 m depth. The field SPT N values were found to be 5 & 11 at 3.0 m & 6.0 m depth
2. From 12.0 m to 15.0 m depth, a low-plastic, stiff consistency, inorganic silty clayey soil stratum exists. The field SPT N value was found to be 13 at 12.0 m depth
3. From 15.0 m to 18.0 m depth, a medium-plastic, silt and clay with low compressibility stratum exists from which one UDS was collected at 15.0 m depth.
4. From 18.0 m to 40.0 m (max. explored) depth, non-plastic, medium to very dense compacted Silty sand stratum exist from which two UDS sample were collected at 21.0 m & 27.0 m depth. The field SPT N values were found to be 17,30,64,77,84 & greater than 50 at 18.0 m,24.0 m,30.0 m,33.0 m,36.0 m,39.0 m & 40.0 m depth respectively.

Pier - (BH NO- 11, CH-23705 m)

1. From N.G.L to 9.0 m depth, a non-plastic, loose to medium compacted Silty sand stratum exists from which one DS was collected at 0.5 m depth and two UDS were collected at 1.50 m & 4.5 m depth. The field SPT N values were found to be 9 & 18 at 3.0 m & 6.0 m depth
2. From 9.0 m to 15.0 m depth, a medium-plastic, very stiff consistency silt and clay with low compressibility stratum exists from which one UDS was collected at 9.0 m depth. The field SPT N value was found to be 26 at 12.0 m depth.

3. From 15.0 m to 40.0 m (max. explored) depth, non-plastic, dense to very dense compacted Silty sand stratum exist from which three UDS sample were collected at 15.0 m,21.0 m & 27.0 m depth. The field SPT N values were found to be 32,37,85 & greater than 50 at 18.0 m,24.0 m,30.0 m,33.0 m,36.0 m,39.0 m & 40.0 m depth respectively.

Pier - (BH NO- 11A, CH-24205 m)

1. From N.G.L to 6.0 m depth, a non-plastic, loose compacted Silty sand stratum exists from which one DS was collected at 0.5 m depth and two UDS were collected at 1.50 m & 4.5 m depth. The field SPT N values were found to be 5 at 3.0 m depth.
2. From 6.0 m to 15.0 m depth, a medium-plastic, stiff consistency silt and clay with low compressibility stratum exists from which one UDS was collected at 9.0 m depth. The field SPT N values were found to be 10 & 12 at 6.0 m & 12.0 m depth.
3. From 15.0 m to 18.0 m depth, a non-plastic, Clayey silts with none to low plasticity stratum exists from which one UDS was collected at 15.0 m depth.
4. From 18.0 m to 36.0 m depth, non-plastic, very dense compacted Silty sand stratum exist. The field SPT N values were found to be 56,67,74 & greater than 50 at 18.0 m,21.0 m,24.0 m,27.0 m,30.0 m & 33.0 m depth respectively.
5. From 36.0 m to 40.0 m (max. explored) depth, very dense compacted Pebble pieces' stratum encountered. The field SPT N values were found to be greater than 50 at 36.0 m,39.0 m & 40.0 m depth respectively.

Pier - (BH NO- 12, CH-24700 m)

1. From N.G.L to 4.5 m depth, a non-plastic, medium to very dense compacted clayey silts with none to low plasticity stratum exists. The field SPT N values were found to be 17,24 & greater than 50 at 1.50 m,3.0 m & 4.50 m depth.
2. From 4.50 m to 6.0 m depth, a Boulder stratum encountered.
3. From 6.0 m to 20.0 m (max. explored) depth, rock stratum encountered. The field SPT N values were found to be greater than 50 at 36.0 m,39.0 m & 40.0 m depth respectively. Core Recovery varies from 16.66 % to 36.66 % and R.Q.D varies from zero to 24.95 %.

7. ABSTRACTOF BEARING/LOAD CARRYING CAPACITY

Table-3

7.1 Load Carrying Capacity of Bored Cast-In-Situ Pile

Location	Dia of pile in (m)	Length of Pile in (m)	Safe Load Carrying Capacity in (Ton)	Recommended safe load carrying capacity in (Ton)	Safe Horizontal Load Carrying Capacity in (Ton)	Recommended Safe Horizontal Load Carrying Capacity in (Ton)
Abutment (BH-2)	1.20	23	265	260	52	50
		25	292	285	52	50
Pier (BH-3)	1.20	20	251	245	52	50
		23	307	300	52	50
Pier (BH-4)	1.20	20	228	220	31	30
		23	280	275	31	30
		25	314	310	31	30
Pier (BH-5)	1.20	25	257	250	30	30
		28	284	280	30	30
Pier (BH-6)	1.20	20	271	270	34	30
		23	324	320	34	30
Pier (BH-7)	1.20	20	262	255	36	35
		23	289	280	36	35
Pier (BH-8)	1.20	18	202	195	36	35
Pier (BH-9)	1.20	25	232	230	23	20
		28	302	300	23	20
Pier (BH-10)	1.20	34	353	350	5	5
		36	385	380	5	5
		38	418	400	5	5
Pier (BH-11)	1.20	23	340	320	24	20
		25	376	370	24	20
		27	427	400	24	20

Location	Dia of pile in (m)	Length of Pile in (m)	Safe Load Carrying Capacity in (Ton)	Recommended safe load carrying capacity in (Ton)	Safe Horizontal Load Carrying Capacity in (Ton)	Recommended Safe Horizontal Load Carrying Capacity in (Ton)
Pier (BH-11A)	1.20	23	291	290	52	50
		25	323	320	52	50
		27	356	350	52	50

Table-4

7.2 Abstract of Safe Load Carrying Capacity of Socketed Pile

Location	Dia of pile in (m)	Length of Pile above Rock (m)	Length of Socket in to rock in m	Safe Load Carrying Capacity in (Ton)	Recommended safe load carrying capacity in (Ton)	Safe Horizontal Load Carrying Capacity in (Ton)	Recommended Safe Horizontal Load Carrying Capacity in (Ton)
Pier (BH-12)	1.2	9.7	0.3	473	450	36	36

7.3 Abstract of Safe Bearing Pressure of Soil

Table-5

Location	Depth in m.	Net Safe Bearing Capacity in T/m^2	Settlement in mm	Safe Bearing Pressure in T/m^2	Safe Bearing Pressure in T/m^2
				25 mm settlement	50 mm settlement
Abutment (BH-02)	2.0	9	102	2	4
	3.0	10	96	3	5
	4.0	11	91	3	6
Pier (BH-03)	2.0	12	109	3	6
	3.0	13	100	3	7
	4.0	14	91	4	8
Pier (BH-04)	2.0	13	42	8	13
	3.0	15	47	8	15
	4.0	16	52	8	15
Pier (BH-05)	2.0	10	27	9	10
	3.0	12	30	10	12
	4.0	14	29	12	14
Pier (BH-06)	2.0	9	19	9	9
	3.0	11	18	11	11
	4.0	13	18	13	13
Pier (BH-07)	2.0	13	38	9	13
	3.0	17	39	11	17
	4.0	22	51	11	22

Location	Depth in m.	Net Safe Bearing Capacity in T/m^2	Settlement in mm	Safe Bearing Pressure in T/m^2	Safe Bearing Pressure in T/m^2
				25 mm settlement	50 mm settlement
Pier (BH-08)	2.0	11	10	11	11
	3.0	12	11	12	12
	4.0	14	14	14	14
Pier (BH-09)	3.0	13	70	5	9
	4.0	14	79	4	9
Pier (BH-11)	2.0	11	63	4	9
	3.0	14	84	4	8
	4.0	18	107	4	8
Pier (BH-11A)	2.0	12	312	1	2
	3.0	14	354	1	2
	4.0	16	395	1	2
Pier (BH-12)	2.0	79	120	16	33
	3.0	230	261	22	44
	4.0	281	305	23	46

Note*

1. **The actual load carrying capacity of piles depends upon many factors such as the quality of construction of piles, disturbance to sub-soil during construction etc. The influence of these factors is not amenable to theoretical computation. It is therefore, a usual practice to confirm theoretical estimated pile capacity by conducting pile load test on prototype piles-in-situ.**
2. **It is therefore, recommended that few initial load tests be conducted on piles at the site as per Indian standard (IS: 2911, Part IV, 2013) by subjecting the pile to a load level of 2.5 times of the safe load carrying capacity of the pile. It is also advisable to conduct few routine load tests on piles as per (IS: 2911, Part IV, 2013).**
3. **The allowable bearing pressure determined from various B.I.S Codes have been reduced due to likely variation and uncertainties in properties of sub soil determined based on available limited test result.**
4. **Foundation suitable for design may be considered for BH-12.**
5. **SBP has calculated considering the squire footing with size of L=10.0 m& B=8.0 m.**

8.0 Liquefaction Potential

The assessment for liquefaction of soil has been made as per Annexure D. It was revealed that the subsoil from BH-02 to BH-08 & BH-12, is not prone to liquefaction. Further subsoil in BH-9, BH-10 in different stretch of depth is prone to liquefaction hence pile lengths have been increased suitably to account for loss in frictional component of pile capacity.

ANNEXURE -A
BORE LOGS

Name of Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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
Ground surface level : [RL(+) 191.135m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : 1.50 m below the E.G.L

Abutment(BH NO:02)
Location:Rewasan toll Naka
CH NO: 21305m
Date of boring started:05.02.2021
Date of boring completed:06.02.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		191.135		0.0									
01	1.5	190.635		0.5	Silty Sand	---	DS	---	---	---	---	---	DS was collected
02		189.635		1.5		---	SPT	03	04	07	11	0.45	
03	13.5	188.135		3.0	Silt and Clay with Low Compressibility	---	UDS	---	---	---	---	---	UDS was collected
04		186.635		4.5		---	SPT	06	07	08	15	0.45	
05		185.135		6.0		---	UDS	---	---	---	---	---	UDS was collected
06		182.135		9.0		---	SPT	07	10	12	22	0.45	
07		179.135		12.0		---	UDS	---	---	---	---	---	UDS was collected
08		176.135		15.0		---	SPT	11	13	15	28	0.45	

Name of Project:	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.

Cont... Abutment(BH NO:02)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		176.135		15.0									
09	17.0	173.135		18.0	Silt and Clay with Low Compressibility	---	UDS	---	---	---	---	---	UDS was collected
10		170.135		21.0		---	SPT	10	22	26	48	0.45	
11		167.135		24.0		---	UDS	---	---	---	---	---	UDS was collected
12		164.135		27.0		---	SPT	19	25	29	54	0.45	
13		161.135		30.0		---	UDS	---	---	---	---	---	UDS was collected
14		159.135		32.0		---	SPT	23	32	34	66	0.45	

Name of Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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
Ground surface level : [RL(+) 191.220m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : 2.5 m below the E.G.L

Pier(BH NO:03)
Location:Rewasan toll Naka
CH NO: 21805m
Date of boring started:07.02.2021
Date of boring completed:08.02.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		191.220		0.0									
01	1.5	190.720		0.5	Silty Sand	---	DS	---	---	---	---	---	DS was collected
02		189.720		1.5		---	SPT	03	05	07	12	0.45	
03	7.5	188.220		3.0	Silt and Clay with Low Compressibility	---	UDS	---	---	---	---	---	UDS was collected
04		186.720		4.5		---	SPT	05	07	10	17	0.45	
05		185.220		6.0		---	UDS	---	---	---	---	---	UDS was collected
06		182.220		9.0		---	SPT	07	10	14	24	0.45	
07	3.0	179.220		12.0	Silty Sand	---	UDS	---	---	---	---	---	UDS was collected
08	3.0	176.220		15.0	Silt and Clay with Low Compressibility	---	SPT	09	13	19	32	0.45	

Name of Project:	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.

Cont...Pier(BH NO:03)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		176.220		15.0									
09	6.0	173.220		18.0	Silt and Clay with Low Compressibility	---	UDS	---	---	---	---	---	UDS was collected
10		170.220		21.0		---	SPT	21	28	31	59	0.45	
11	3.0	167.220		24.0	Clayey silts with none to low plasticity	---	DS	---	---	---	---	---	
12	8.0	164.220		27.0	Silty Sand	---	SPT	28	31	37	68	0.45	
13		161.220		30.0		---	DS	---	---	---	---	---	
14		159.220		32.0		---	SPT	31	36	41	77	0.45	

Name of Project:	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 Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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 Sohana-Maneser section of HORC project
Ground surface level : [RL(+) 191.013m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : 2.0 m below the E.G.L

Pier(BH NO:04)
Location:Kherli-Kankar Village
CH NO: 2226.5m
Date of boring started:09.02.2021
Date of boring completed:10.02.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		191.013		0.0									
01		190.513		0.5		---	DS	---	---	---	---	---	DS was collected
02	3.0	189.513		1.5	Clayey Silts with none to Low Plasticity	---	SPT	04	05	11	16	0.45	
03		188.013		3.0		---	UDS	---	---	---	---	---	UDS was collected
04		186.513		4.5		---	SPT	06	08	10	18	0.45	
05		185.013		6.0		---	UDS	---	---	---	---	---	UDS was collected
06	9.0	182.013		9.0	Silty Sand	---	SPT	10	14	22	36	0.45	
07		179.013		12.0		---	UDS	---	---	---	---	---	UDS was collected
08	3.0	176.013		15.0	Silt and Clay with Low Compressibility	---	SPT	22	24	28	52	0.45	

Name of Project:	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.

Cont...Pier(BH NO:04)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		176.013		15.0									
09	6.0	173.013		18.0	Silt and Clay with Low Compressibility	---	UDS	---	---	---	---	---	UDS was collected
10		170.013		21.0		---	SPT	29	32	33	65	0.45	
11	11.0	167.013		24.0	Silty Sand	---	DS	---	---	---	---	---	
12		164.013		27.0		---	SPT	32	37	39	76	0.45	
13		161.013		30.0		---	DS	---	---	---	---	---	
14		159.013		32.0		---	SPT	30	39	46	85	0.45	

Name of Project:	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 Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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
Ground surface level : [RL(+) 192.226m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : 3.0 m below the E.G.L

Pier(BH NO:05)
Location:Kherli-Kankar Village
CH NO: 22160m
Date of boring started:10.02.2021
Date of boring completed:11.02.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		192.226		0.0									
01		191.726		0.5		---	DS	---	---	---	---	---	DS was collected
02	3.0	190.726		1.5	Clayey Silts with none to Low Plasticity	---	SPT	04	06	09	15	0.45	
03		189.226		3.0		---	UDS	---	---	---	---	---	UDS was collected
04	1.5	187.726		4.5	Clayey Sand	---	SPT	07	08	15	23	0.45	
05	1.5	186.226		6.0	Clayey Silts with none to Low Plasticity	---	UDS	---	---	---	---	---	UDS was collected
06	9.0	183.226		9.0	Clayey Sand	---	SPT	10	12	16	28	0.45	
07		180.226		12.0		---	UDS	---	---	---	---	---	UDS was collected
08		177.226		15.0		---	SPT	25	29	31	50	0.45	

Name of Project:	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.

Cont...Pier(BH NO:05)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		177.226		15.0									
	3.0				Clayey Sand								
09		174.226		18.0		---	UDS	---	---	---	---	---	UDS was collected
10		171.226		21.0		---	SPT	28	30	31	61	0.45	
11	12.0	168.226		24.0	Silt and Clay with Low Compressibility	---	UDS	---	---	---	---	---	UDS was collected
12		165.226		27.0		---	SPT	25	33	37	70	0.45	
13		162.226		30.0		---	UDS	---	---	---	---	---	UDS was collected
	2.0				Clayey Sand								
14		160.226		32.0		---	SPT	28	34	39	73	0.45	

Name of Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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
Ground surface level : [RL(+) 194.594m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : Not Found

Pier(BH NO:06)
Location:Kherli-Kankar Village
CH NO: 22660m
Date of boring started:11.02.2021
Date of boring completed:13.02.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		194.594		0.0									
01		194.094		0.5		---	DS	---	---	---	---	---	DS was collected
02		193.094		1.5		---	SPT	05	07	08	15	0.45	
03	6.0	191.594		3.0	Clayey Silts with none to Low Plasticity	---	UDS	---	---	---	---	---	UDS was collected
04		190.094		4.5		---	SPT	09	11	14	25	0.45	
05		188.594		6.0		---	UDS	---	---	---	---	---	UDS was collected
06		185.594		9.0		---	SPT	15	18	21	39	0.45	
07	9.0	182.594		12.0	Silty Sand	---	UDS	---	---	---	---	---	UDS was collected
08		179.594		15.0		---	SPT	20	22	25	47	0.45	

Cont...Pier(BH NO:06)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		179.594		15.0									
09	9.0	176.594		18.0	Clayey Silts with none to Low Plasticity	---	UDS	---	---	---	---	---	UDS was collected
10		173.594		21.0		---	SPT	26	29	31	60	0.45	
11		170.594		24.0		---	UDS	---	---	---	---	---	UDS was collected
12	8.0	167.594		27.0	Silty Sand	---	SPT	31	33	38	71	0.45	
13		164.594		30.0		---	UDS	---	---	---	---	---	UDS was collected
14		162.594		32.0		---	SPT	38	40	43	83	0.45	

Name of Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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 Sohana-Manesar section of HORC project
Ground surface level : [RL(+) 196.146m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : Not Found

Pier(BH NO:07)
Location:Khor-Basai Village
CH NO: 23160m
Date of boring started: 14.02.2021
Date of boring completed: 15.02.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		196.146		0.0									
01	1.5	195.646		0.5	Silty Sand	---	DS	---	---	---	---	---	DS was collected
02		194.646		1.5		---	SPT	05	07	11	18	0.45	
03	1.5	193.146		3.0	Poorly graded Silty Sand	---	UDS	---	---	---	---	---	UDS was collected
04	1.5	191.646		4.5	Silty Sand	---	SPT	11	16	20	36	0.45	
05	1.5	190.146		6.0	Poorly graded Sand	---	UDS	---	---	---	---	---	UDS was collected
06	3.0	187.146		9.0	Silty Sand	---	SPT	21	23	27	50	0.45	
07	6.0	184.146		12.0	Silt and Clay with Low Compressibility	---	DS	---	---	---	---	---	
08		181.146		15.0		---	SPT	22	25	29	54	0.45	

Name of Project:	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.

Cont...Pier(BH NO:07)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		181.146		15.0									
09	3.0	178.146		18.0	Silt and Clay with Low Compressibility	---	UDS	---	---	---	---	---	UDS was collected
10	3.0	175.146		21.0	Poorly graded Silty Sand	---	SPT	30	33	35	68	0.45	
11	6.0	172.146		24.0	Silt and Clay with Low Compressibility	---	UDS	---	---	---	---	---	UDS was collected
12		169.146		27.0		---	SPT	36	39	40	79	0.45	
13	5.0	166.146		30.0	Silty Sand	---	UDS	---	---	---	---	---	UDS was collected
14		161.146		32.0		---	SPT	41	43	45	88	0.45	

Name of Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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 Sohana-Manesar section of HORC project
Ground surface level : [RL(+) 200.069m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Indination : Vertical
Ground water table : Not Found

Pier(BH NO:08)
Location:Khori-Basai Village
CH NO: 23660m
Date of boring started:18.02.2021
Date of boring completed:20.02.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		200.069		0.0									
01		199.569		0.5		---	DS	---	---	---	---	---	DS was collected
02		198.569		1.5		---	SPT	08	26	24	50	0.45	
03		197.069		3.0		---	UDS	---	---	---	---	---	UDS was collected
04		195.569		4.5		---	SPT	15	24	27	51	0.45	
05		194.069		6.0		---	UDS	---	---	---	---	---	UDS was collected
06	15.0	191.069		9.0	Clayey silts with none to Low Plasticity	---	SPT	12	24	35	59	0.45	
07		188.069		12.0		---	UDS	---	---	---	---	---	UDS was collected
08		185.069		15.0		---	SPT	09	14	19	33	0.45	

Name of Project:	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.

Cont...Pier(BH NO:08)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		185.069		15.0									
09	5.0	182.069		18.0	Clayey Sand	---	UDS	---	---	---	---	---	UDS was collected
10		180.069		20.0		---	SPT	11	12	13	25	0.45	

Name of Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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 Sohana-Manesar section of HORC project
Ground surface level : [RL(+) 191.897m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : 1.90 m below the E.G.L

Pier(BH NO:09)
Location:Dhirdhaunka
CH NO: 22705m
Date of boring started:27.11.2021
Date of boring completed:29.11.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		191.897		0.0									
01		191.397		0.5		---	DS	---	---	---	---	---	DS was collected
02	3.0	190.397		1.5	Clayey silts with None to Low Plasticity	---	SPT	02	02	03	05	0.45	
03		188.897		3.0		---	SPT	04	06	07	13	0.45	
04	1.5	187.397		4.5	Inorganic Silty Clayey Soil	---	UDS	---	---	---	---	---	UDS was collected
05	1.5	185.897		6.0	Clayey silts with None to Low Plasticity	---	SPT	07	08	11	19	0.45	
06	3.0	182.897		9.0	Silty Sand	---	UDS	---	---	---	---	---	UDS was collected
07	6.0	179.897		12.0	Silt and Clay with Low Compressibility	---	SPT	05	07	10	17	0.45	
08		176.897		15.0		---	UDS	---	---	---	---	---	UDS was collected
09	3.0	173.897		18.0	Clayey silts with None to Low Plasticity	---	SPT	08	11	14	25	0.45	

Name of Project:	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.

Cont...Pier(BH NO:09)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		173.897		18.0									
10		170.897		21.0		---	UDS	---	---	---	---	---	UDS was collected
11	9.0	167.897		24.0	Clayey silts with None to Low Plasticity	---	SPT	09	13	16	29	0.45	
12		164.897		27.0		---	UDS	---	---	---	---	---	UDS was collected
13		161.897		30.0		---	SPT	20	29	32	61	0.45	
14		158.897		33.0		---	SPT	23	36	41	77	0.45	
15	13.0	155.897		36.0	Silty Sand	---	SPT	25	40	>50	>50	0.35	
16		152.897		39.0		---	SPT	27	43	>50	>50	0.31	
17		151.897		40.0		---	SPT	36	>50	>50	>50	0.18	

Name of Project:	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 Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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 Sohana-Manesar section of HORC project
Ground surface level : [RL(+) 193.009m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : 2.4 m below the E.G.L

Pier(BH NO:10)
Location:Dhirdhaunka
CH NO: 23205m
Date of boring started:30.11.2021
Date of boring completed:02.12.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		193.009		0.0									
01		192.509		0.5		---	DS	---	---	---	---	---	DS was collected
02		191.509		1.5		---	UDS	---	---	---	---	---	UDS was collected
03		190.009		3.0		---	SPT	02	02	03	05	0.45	
04		188.509		4.5		---	UDS	---	---	---	---	---	UDS was collected
05	12.0	187.009		6.0	Silty Sand	---	SPT	03	04	07	11	0.45	
06		184.009		9.0		---	UDS	---	---	---	---	---	UDS was collected
07		181.009		12.0		---	SPT	04	06	07	13	0.45	
08	6.0	178.009		15.0	Inorganic Silty Clayey Soil	---	UDS	---	---	---	---	---	UDS was collected
09		175.009		18.0	Silt and Clay with Low Compressibility	---	SPT	05	07	10	17	0.45	

Name of Project:	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.

Cont...Pier(BH NO:10)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		175.009		18.0									
10		172.009		21.0		---	UDS	---	---	---	---	---	UDS was collected
11		169.009		24.0		---	SPT	08	13	17	30	0.45	
12	15.0	166.009		27.0	Silty Sand	---	UDS	---	---	---	---	---	UDS was collected
13		163.009		30.0		---	SPT	11	28	36	64	0.45	
14		160.009		33.0		---	SPT	16	32	45	77	0.45	
15	3.0	157.009		36.0	Clayey silt with Nonelo Low Plasticity	---	SPT	18	36	48	84	0.45	
16	4.0	154.009		39.0	Silty Sand	---	SPT	26	45	>50	>50	0.32	
17		153.009		40.0		---	SPT	30	49	>50	>50	0.30	

Name of Project:	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 Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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 Sohana-Manesar section of HORC project
Ground surface level : [RL(+) 193.717m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : 1.80 m below the E.G.L

Pier(BH NO:11)
Location: Maraula
CH NO: 23705m
Date of boring started:03.12.2021
Date of boring completed:04.12.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt. 193.717	Graphical representation of soil strata	Depth from ground level in m. 0.0	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
01		193.217		0.5		---	DS	---	---	---	---	---	DS was collected
02		192.217		1.5		---	UDS	---	---	---	---	---	UDS was collected
03		190.717		3.0		---	SPT	03	04	05	09	0.45	
04		189.217		4.5	Silty Sand	---	UDS	---	---	---	---	---	UDS was collected
05	9.0	187.717		6.0		---	SPT	06	08	10	18	0.45	
06		184.717		9.0		---	UDS	---	---	---	---	---	UDS was collected
07	6.0	181.717		12.0	Silt and Clay with Low Compressibility	---	SPT	08	11	15	26	0.45	
08		178.717		15.0		---	UDS	---	---	---	---	---	UDS was collected
09	3.0	175.717		18.0	Silty Sand	---	SPT	11	14	18	32	0.45	

Name of Project:	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.

Cont...Pier(BH NO:11)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt. 175.717	Graphical representation of soil strata	Depth from ground level in m. 18.0	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 = N	Penetration of soil strata in m.	Remarks
10		172.717		21.0		---	UDS	---	---	---	---	---	UDS was collected
11		169.717		24.0		---	SPT	13	16	21	37	0.45	
12		166.717		27.0		---	UDS	---	---	---	---	---	UDS was collected
13	22.0	163.717		30.0	Silty Sand	---	SPT	25	36	49	85	0.45	
14		160.717		33.0		---	SPT	>50	---	---	>50	0.10	DS was collected
15		157.717		36.0		---	SPT	>50	---	---	>50	0.08	DS was collected
16		154.717		39.0		---	SPT	>50	---	---	>50	0.08	DS was collected
17		153.717		40.0		---	SPT	>50	---	---	>50	0.06	DS was collected

Name of Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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 Sohana-Manesar section of HORC project
Ground surface level : [RL(+) 196.637m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground water table : 6.50 m below the E.G.L

Pier(BH NO:11-A)
Location:Maraula
CH NO: 24205m
Date of boring started:05.12.2021
Date of boring completed:06.12.2021

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		196.637		0.0									
01		196.137		0.5		---	DS	---	---	---	---	---	DS was collected
02		195.137		1.5		---	UDS	---	---	---	---	---	UDS was collected
03	6.0	193.637		3.0	Silty Sand	---	SPT	02	02	03	05	0.45	
04		192.137		4.5		---	UDS	---	---	---	---	---	UDS was collected
05		190.637		6.0		---	SPT	03	04	06	10	0.45	
06		187.637		9.0		---	UDS	---	---	---	---	---	UDS was collected
07	9.0	184.637		12.0	Silt and Clay with Low Compressibility	---	SPT	04	05	07	12	0.45	
08		181.637		15.0		---	UDS	---	---	---	---	---	UDS was collected
09	3.0	178.637		18.0	Clayey silt with Noncrete Low Plasticity	---	SPT	18	26	30	56	0.45	

Name of Project:	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.

Cont...Pier(BH NO:11-A)

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		178.637		18.0									
10		175.637		21.0		---	SPT	21	31	36	67	0.45	
11		172.637		24.0		---	SPT	23	34	40	74	0.45	
12	18.0	169.637		27.0	Silty Sand	---	SPT	>50	---	---	>50	0.07	DS was collected
13		166.637		30.0		---	SPT	>50	---	---	>50	0.07	DS was collected
14		163.637		33.0		---	SPT	>50	---	---	>50	0.06	DS was collected
15		160.637		36.0		---	SPT	>50	---	---	>50	0.06	DS was collected
16	4.0	157.637		39.0	Pebbles	---	SPT	>50	---	---	>50	0.05	DS was collected
17		156.637		40.0		---	SPT	>50	---	---	>50	0.04	DS was collected

Name of Project:	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 Consultants : M/s S.M.Consultants , Bhubaneswar.
Name of the client : Haryana Rail Infrastructure Development Corporation Ltd.
Name of Work : 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 Sohana-Manesar section of HORC project
Ground surface level : [RL(+) 203.485m]
Type of boring : Rotary Boring
Diameter of boring : 150mm
Inclination : Vertical
Ground watertable : Not Found

Pier(BH NO:12)
Location:Maraula
CH NO: 24700m
Date of boring started:27.02.2022
Date of boring completed:03.03.2022

Sl. No.	Thickness of soil strata in mt.	R.L. in mt.	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Colour of boring water	Type of sampling	No. of blows for 1st 15 cm penetration(1)	No. of blows for 2nd 15 cm penetration(2)	No. of blows for 3rd 15 cm penetration(3)	S.P.T. value = 2+3 =N	Penetration of soil strata in m.	Remarks
		203.485		0.0									
02		201.985		1.5		BROWN	SPT	04	08	11	17	0.45	
03	6.0	200.485		3.0	Clayey silts with none to Low Plasticity	BROWN	SPT	06	08	16	24	0.45	
04		198.985		4.5		BROWN	SPT	10	24	>50	>50	0.33	
05		197.485		6.0		BROWN	BOULDER	---	---	---	---	---	Core Recovery=16.66 % R.Q.D=NIL
06	1.5	195.985		7.5	Boulder	BROWN	ROCK	---	---	---	---	---	Core Recovery=18.66 % R.Q.D=NIL
07		194.485		9.0		BROWN	ROCK	---	---	---	---	---	Core Recovery=20.66 % R.Q.D=NIL
08		192.985		10.5		BROWN	ROCK	---	---	---	---	---	Core Recovery=22.66 % R.Q.D=7 %
09		191.485		12.0		BROWN	ROCK	---	---	---	---	---	Core Recovery=36 % R.Q.D=16.66 %
10	12.5	189.985		13.5	Rock	BROWN	ROCK	---	---	---	---	---	Core Recovery=22.66 % R.Q.D=7.33 %
11		188.485		15.0		BROWN	ROCK	---	---	---	---	---	Core Recovery=26.66 % R.Q.D=14.46 %
12		186.985		16.5		BROWN	ROCK	---	---	---	---	---	Core Recovery=36.66 % R.Q.D=22.46 %
13		185.485		18.0		BROWN	ROCK	---	---	---	---	---	Core Recovery=24.66 % R.Q.D=8.67
14		184.485		20.0		BROWN	ROCK	---	---	---	---	---	Core Recovery=35 % R.Q.D=24.95 %

ANNEXURE -B
LABORATORY TEST RESULT

ABUTMENT (BH-02, CH-21305 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
1	**At 0.5 m depth**	DS	---	0	0	3.28	48.51	48.21	0.00	21	---	NP	---	---	---	---	---	---	2.63	---	---	SM
2	**At 1.5 m depth**	SPT	11	0.13	0.92	1.82	16.06	64.57	16.50	31	18	13	---	---	---	---	---	---	2.71	---	---	CL
3	**At 3.0 m depth**	UDS	---	0	0.65	2.31	15.64	64.80	16.60	32	19	13	11.28	1.762	1.583	0.31	10	UU	2.71	0.71	0.132	CL
4	**At 4.5 m depth**	SPT	15	0	0.82	1.98	18.21	63.29	15.70	30	18	12	---	---	---	---	---	---	2.70	---	---	CL
5	**At 6.0 m depth**	UDS	---	0.32	1.08	1.26	16.24	64.50	16.60	31	17	14	12.64	1.792	1.591	0.29	11	UU	2.71	0.70	0.129	CL
6	**At 9.0 m depth**	SPT	22	8.88	1.55	1.11	23.71	49.65	15.10	29	17	12	---	---	---	---	---	---	2.70	---	---	CL
7	**At 12.0 m depth**	UDS	---	0	0	0	40.22	45.58	14.20	28	18	10	13.56	1.816	1.599	0.28	10	UU	2.70	0.69	0.126	CL
8	**At 15.0 m depth**	SPT	28	0.62	0.24	1.24	29.52	52.88	15.50	30	17	13	---	---	---	---	---	---	2.70	---	---	CL

Name of Project:	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.

Contd… ABUTMENT (BH-02, CH-21305 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
9	**At 18.0 m depth**	UDS	---	0	0	1.45	27.43	55.32	15.80	32	18	14	14.28	1.845	1.614	0.30	9	UU	2.71	0.68	0.125	CL
10	**At 21.0 m depth**	SPT	48	23.64	2.87	6.92	3.82	48.05	14.70	30	17	13	---	---	---	---	---	---	2.70	---	---	CL
11	**At 24.0 m depth**	UDS	---	14.62	3.85	8.24	3.62	54.57	15.10	31	18	13	15.47	1.887	1.634	0.28	15	UU	2.71	0.66	0.119	CL
12	**At 27.00 m depth**	SPT	54	17.11	2.86	6.31	5.24	53.48	15.00	30	18	12	---	---	---	---	---	---	2.70	---	---	CL
13	**At 30.00 m depth**	UDS	---	17.64	3.24	5.84	3.26	54.22	15.80	31	19	12	16.38	1.926	1.655	0.29	16	UU	2.71	0.64	0.117	CL
14	**At 32.00 m depth**	SPT	66	19.56	6.45	6.38	2.53	50.48	14.60	30	17	13	---	---	---	---	---	---	2.70	---	---	CL

Name of Project:	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.

PIER (BH-03, CH-21805 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
1	**At 0.5 m depth**	DS	---	0	0	0	73.31	26.69	0.00	21	---	NP	---	---	---	---	---	---	2.63	---	---	SM
2	**At 1.5 m depth**	SPT	12	0	0	6.26	7.24	69.20	17.30	32	20	12	---	---	---	---	---	---	2.71	---	---	CL
3	**At 3.0 m depth**	UDS	---	15.74	8.53	6.18	8.45	46.60	14.50	30	20	10	11.87	1.762	1.575	0.30	13	UU	2.70	0.71	0.129	CL
4	**At 4.5 m depth**	SPT	17	0	0	0	39.15	46.65	14.20	29	19	10	---	---	---	---	---	---	2.69	---	---	CL
5	**At 6.0 m depth**	UDS	---	13.78	5.45	9.03	8.43	48.21	15.10	30	18	12	12.32	1.804	1.606	0.31	12	UU	2.70	0.68	0.124	CL
6	**At 9.0 m depth**	SPT	24	0.14	0	0.14	60.77	38.95	0.00	21	---	NP	---	---	---	---	---	---	2.62	---	---	SM
7	**At 12.0 m depth**	UDS	---	15.33	7.25	11.48	13.99	38.75	13.20	28	16	12	13.54	1.826	1.608	0.29	14	UU	2.69	0.67	0.120	CL
8	**At 15.0 m depth**	SPT	32	6.59	1.2	3.59	15.31	57.11	16.20	32	19	13	---	---	---	---	---	---	2.72	---	---	CL

Name of Project:	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.

Contd… PIER (BH-03, CH-21805 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
9	**At 18.0 m depth**	UDS	---	15.58	3.53	2.43	21.20	43.06	14.20	30	18	12	14.18	1.871	1.639	0.28	15	UU	2.69	0.64	0.118	CL
10	**At 21.0 m depth**	SPT	59	0.45	0.16	3.54	33.68	54.67	7.50	27	---	NP	---	---	---	---	---	---	2.67	---	---	ML
11	**At 24.0 m depth**	DS	---	0.11	0	0.36	66.48	33.05	0.00	21	---	NP	---	---	---	---	---	---	2.64	---	---	SM
12	**At 27.00 m depth**	SPT	68	0	0	1.62	71.26	27.12	0.00	19	---	NP	---	---	---	---	---	---	2.63	---	---	SM
13	**At 30.00 m depth**	DS	---	0	0	0.84	68.64	30.52	0.00	20	---	NP	---	---	---	---	---	---	2.64	---	---	SM
14	**At 32.00 m depth**	SPT	77	0	0	1.08	64.37	34.55	0.00	21	---	NP	---	---	---	---	---	---	2.65	---	---	SM

Name of Project:	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.

PIER (BH-04, CH-22265 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
1	**At 0.5 m depth**	DS	---	15.58	3.53	2.43	21.20	51.96	5.30	26	---	NP	---	---	---	---	---	---	2.66	---	---	ML
2	**At 1.5 m depth**	SPT	16	0.45	0.16	3.54	33.68	54.97	7.20	27	---	NP	---	---	---	---	---	---	2.67	---	---	ML
3	**At 3.0 m depth**	UDS	---	0.11	0	0.36	66.48	33.05	0.00	19	---	NP	11.54	1.768	1.585	0.03	26	DS	2.65	0.67	---	SM
4	**At 4.5 m depth**	SPT	18	0	0	1.62	71.26	27.12	0.00	18	---	NP	---	---	---	---	---	---	2.63	---	---	SM
5	**At 6.0 m depth**	UDS	---	0	0	0.84	68.64	30.52	0.00	20	---	NP	11.96	1.795	1.603	0.05	24	DS	2.64	0.65	---	SM
6	**At 9.0 m depth**	SPT	36	0	0	1.08	64.37	34.55	0.00	20	---	NP	---	---	---	---	---	---	2.64	---	---	SM
7	**At 12.0 m depth**	UDS	---	15.58	3.53	2.43	21.20	44.06	13.20	31	18	13	12.21	1.844	1.643	0.28	14	UU	2.70	0.64	0.111	CL
8	**At 15.0 m depth**	SPT	52	0.45	0.16	3.54	33.68	48.07	14.10	32	18	13	---	---	---	---	---	---	2.71	---	---	CL

Name of Project:	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.

Contd… PIER (BH-04, CH-22265 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
9	**At 18.0 m depth**	UDS	---	6.57	1.22	2.22	7.92	64.67	17.40	33	20	13	13.58	1.893	1.667	0.31	11	UU	2.72	0.63	0.109	CL
10	**At 21.0 m depth**	SPT	65	0.21	0.13	2.31	58.34	39.01	0.00	20	---	NP	---	---	---	---	---	---	2.63	---	---	SM
11	**At 24.0 m depth**	DS	---	0.36	0	0.48	60.34	38.82	0.00	20	---	NP	---	---	---	---	---	---	2.63	---	---	SM
12	**At 27.00 m depth**	SPT	76	0	0	0.21	58.62	41.17	0.00	21	---	NP	---	---	---	---	---	---	2.64	---	---	SM
13	**At 30.00 m depth**	DS	---	0	0	0.17	62.56	37.27	0.00	20	---	NP	---	---	---	---	---	---	2.63	---	---	SM
14	**At 32.00 m depth**	SPT	85	0	0	0.08	63.69	36.23	0.00	20	---	NP	---	---	---	---	---	---	2.64	---	---	SM

Name of Project:	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.

PIER (BH-05, CH-22160 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
1	**At 0.5 m depth**	DS	---	0	0	8.62	21.56	62.22	7.60	27	---	NP	---	---	---	---	---	---	2.67	---	---	ML
2	**At 1.5 m depth**	SPT	15	0	0	5.36	25.83	62.01	6.80	25	---	NP	---	---	---	---	---	---	2.66	---	---	ML
3	**At 3.0 m depth**	UDS	---	7.54	1.86	2.89	41.63	34.88	11.20	28	19	9	11.82	1.763	1.577	0.10	19	DS	2.68	0.70	0.118	SC
4	**At 4.5 m depth**	SPT	23	0	0	5.23	41.23	48.34	5.20	25	---	NP	---	---	---	---	---	---	2.66	---	---	ML
5	**At 6.0 m depth**	UDS	---	24.25	17.67	15.73	9.46	22.69	10.20	26	18	8	12.45	1.784	1.586	0.08	21	DS	2.65	0.67	0.116	SC
6	**At 9.0 m depth**	SPT	28	4.67	3.84	11.26	33.89	34.64	11.70	29	19	10	---	---	---	---	---	---	2.67	---	---	SC
7	**At 12.0 m depth**	UDS	---	8.62	1.06	1.79	41.23	35.00	12.30	29	18	11	12.94	1.826	1.617	0.10	20	DS	2.67	0.65	0.110	SC
8	**At 15.0 m depth**	SPT	50	7.23	1.34	2.13	40.82	35.98	12.50	27	17	10	---	---	---	---	---	---	2.66	---	---	SC

Name of Project:	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.

Contd… PIER (BH-05, CH-22160 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
9	**At 18.0 m depth**	UDS	---	0	0.64	2.34	41.12	41.30	14.60	31	18	13	13.65	1.875	1.650	0.30	10	UU	2.69	0.63	0.115	CL
10	**At 21.0 m depth**	SPT	61	0	0.84	3.26	44.62	37.08	14.20	30	19	11	---	---	---	---	---	---	2.68	---	---	CL
11	**At 24.0 m depth**	UDS	---	0	0.51	2.29	23.88	56.52	16.80	33	20	13	14.85	1.926	1.677	0.32	8	UU	2.71	0.62	0.109	CL
12	**At 27.00 m depth**	SPT	70	0	0	2.47	26.84	55.09	15.60	32	19	13	---	---	---	---	---	---	2.70	---	---	CL
13	**At 30.00 m depth**	UDS	---	6.62	0.53	1.53	44.52	35.00	11.80	27	19	8	15.34	1.934	1.677	0.11	18	DS	2.67	0.59	0.105	SC
14	**At 32.00 m depth**	SPT	73	7.63	0.82	1.69	43.23	35.23	11.40	27	18	9	---	---	---	---	---	---	2.66	---	---	SC

Name of Project:	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.

PIER (BH-06, CH-22660 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
1	**At 0.5 m depth**	DS	---	0	0	2.56	39.89	51.15	6.40	25	---	NP	---	---	---	---	---	---	2.66	---	---	ML
2	**At 1.5 m depth**	SPT	15	0	0	2.89	35.62	54.19	7.30	26	---	NP	---	---	---	---	---	---	2.67	---	---	ML
3	**At 3.0 m depth**	UDS	---	0	0	1.56	39.65	52.29	6.50	25	---	NP	11.54	1.758	1.576	0.12	17	DS	2.66	0.69	0.111	ML
4	**At 4.5 m depth**	SPT	25	0	0.45	2.36	38.62	52.17	6.40	25	---	NP	---	---	---	---	---	---	2.66	---	---	ML
5	**At 6.0 m depth**	UDS	---	1.87	9.02	22.25	30.46	36.40	0.00	20	---	NP	12.62	1.794	1.593	0.03	26	DS	2.64	0.66	---	SM
6	**At 9.0 m depth**	SPT	39	1.23	7.56	20.38	31.64	39.19	0.00	21	---	NP	---	---	---	---	---	---	2.64	---	---	SM
7	**At 12.0 m depth**	UDS	---	1.84	1.39	3.93	48.41	44.43	0.00	21	---	NP	13.24	1.816	1.604	0.04	24	DS	2.65	0.65	---	SM
8	**At 15.0 m depth**	SPT	47	0	0.45	3.45	34.26	54.44	7.40	26	---	NP	---	---	---	---	---	---	2.67	---	---	ML

Name of Project:	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.

Contd… PIER (BH-06, CH-22660 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
9	**At 18.0 m depth**	UDS	---	0	0.28	2.87	36.24	53.51	7.10	26	---	NP	14.45	1.863	1.628	0.13	18	DS	2.66	0.63	0.108	ML
10	**At 21.0 m depth**	SPT	60	0	1.23	2.63	39.87	50.17	6.10	24	---	NP	---	---	---	---	---	---	2.66	---	---	ML
11	**At 24.0 m depth**	UDS	---	2.63	1.85	5.36	48.69	41.47	0.00	21	---	NP	15.28	1.895	1.644	0.04	26	DS	2.65	0.61	---	SM
12	**At 27.00 m depth**	SPT	71	2.15	1.63	4.82	47.32	44.08	0.00	21	---	NP	---	---	---	---	---	---	2.65	---	---	SM
13	**At 30.00 m depth**	UDS	---	4.15	2.88	6.3	51.13	35.54	0.00	20	---	NP	16.21	1.943	1.672	0.03	28	DS	2.64	0.58	---	SM
14	**At 32.00 m depth**	SPT	83	2.46	1.85	4.36	53.47	37.86	0.00	20	---	NP	---	---	---	---	---	---	2.64	---	---	SM

Name of Project:	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.

PIER (BH-07, CH-23160 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
1	**At 0.5 m depth**	DS	---	0	0	0.24	50.16	49.60	0.00	21	---	NP	---	---	---	---	---	---	2.64	---	---	SM
2	**At 1.5 m depth**	SPT	18	0	0	0	89.62	10.38	0.00	18	---	NP	---	---	---	---	---	---	2.62	---	---	SP-SM
3	**At 3.0 m depth**	UDS	---	0	0.02	1.09	74.84	24.05	0.00	19	---	NP	12.32	1.772	1.578	0.02	26	DS	2.63	0.67	---	SM
4	**At 4.5 m depth**	SPT	36	0	0	0.34	98.85	0.81	0.00	18	---	NP	---	---	---	---	---	---	2.62	---	---	SP
5	**At 6.0 m depth**	UDS	---	0	0	0.63	70.26	29.11	0.00	19	---	NP	13.26	1.794	1.584	0.04	25	DS	2.63	0.66	---	SM
6	**At 9.0 m depth**	SPT	50	17.10	6.16	4.70	16.62	40.22	15.20	32	18	14	---	---	---	---	---	---	2.70	---	---	CL
7	**At 12.0 m depth**	DS	---	2.65	5.82	6.21	19.64	49.28	16.40	33	18	13	---	---	---	---	---	---	2.71	---	---	CL
8	**At 15.0 m depth**	SPT	54	6.91	6.62	6.55	21.99	42.13	15.80	31	17	14	---	---	---	---	---	---	2.70	---	---	CL

Name of Project:	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.

Contd… PIER (BH-07, CH-23160 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
9	**At 18.0 m depth**	UDS	---	0	0	0.62	92.44	6.94	0.00	18	---	NP	15.36	1.894	1.642	0.06	25	DS	2.62	0.60	---	SP-SM
10	**At 21.0 m depth**	SPT	68	2.54	0.33	1.24	41.11	40.18	14.60	30	18	12	---	---	---	---	---	---	2.70	---	---	CL
11	**At 24.0 m depth**	UDS	---	2.76	1.95	0.28	6.91	70.90	17.20	34	20	14	15.45	1.973	1.709	0.32	10	UU	2.72	0.59	0.108	CL
12	**At 27.00 m depth**	SPT	79	1.32	0.34	19.36	32.64	46.34	0.00	20	---	NP	---	---	---	---	---	---	2.65	---	---	SM
13	**At 30.00 m depth**	UDS	---	2.55	3.04	29.05	18.69	46.67	0.00	21	---	NP	16.24	1.992	1.714	0.04	27	DS	2.64	0.54	---	SM
14	**At 32.00 m depth**	SPT	88	1.46	0.55	1.25	48.29	48.45	0.00	21	---	NP	---	---	---	---	---	---	2.65	---	---	SM

Name of Project:	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.

PIER (BH-08, CH-23660 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
1	**At 0.5 m depth**	DS	---	0	0	3.65	42.23	46.92	7.20	26	---	NP	---	---	---	---	---	---	2.67	---	---	ML
2	**At 1.5 m depth**	SPT	50	0	0	1.86	45.32	46.62	6.20	25	---	NP	---	---	---	---	---	---	2.66	---	---	ML
3	**At 3.0 m depth**	UDS	---	0	0	3.18	44.21	46.51	6.10	25	---	NP	10.63	1.758	1.589	0.12	19	DS	2.65	0.67	0.102	ML
4	**At 4.5 m depth**	SPT	51	0	0	2.14	38.56	51.10	8.20	27	---	NP	---	---	---	---	---	---	2.68	---	---	ML
5	**At 6.0 m depth**	UDS	---	0	0	4.54	41.62	46.94	6.90	26	---	NP	12.15	1.812	1.616	0.13	17	DS	2.66	0.65	0.105	ML
6	**At 9.0 m depth**	SPT	59	0	0	1.47	43.56	47.57	7.40	26	---	NP	---	---	---	---	---	---	2.66	---	---	ML
7	**At 12.0 m depth**	UDS	---	0	0	2.38	35.12	54.40	8.10	27	---	NP	13.56	1.863	1.641	0.15	17	DS	2.68	0.63	0.110	ML
8	**At 15.0 m depth**	SPT	33	0	0.23	1.89	48.56	37.02	12.30	28	19	9	---	---	---	---	---	---	2.66	---	---	SC

Name of Project:	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.

Contd… PIER(BH-08, CH-23660 m)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis				Hydrometer Analysis		Atterberg's Limit			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 test Triaxial test (UU) Direct shear test (DS)	Specific gravity	Void ratio	Consolidation test (Compression Index, Cc)	Group of soil
				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 %										
9	**At 18.0 m depth**	UDS	---	0	0.45	3.41	51.28	33.66	11.20	27	18	9	14.28	1.895	1.658	0.09	19	DS	2.66	0.60	0.106	SC
10	**At 20.0 m depth**	SPT	25	0	0.63	2.69	54.62	31.06	11.00	26	19	7	---	---	---	---	---	---	2.65	---	---	SC

Name of Project:	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.

PIER(BH-09, CH-22705)

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

Sl. No.	Sample Collected at	Type of soil collected	S. P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
1	**At 0.5 m depth**	DS	---	0	0.16	0.18	46.38	43.92	9.36	25	---	NP	---	---	---	---	---	---	2.66	---	---	ML
2	**At 1.5 m depth**	SPT	5	0.57	0.25	1.22	39.73	46.99	11.24	26	---	NP	---	---	---	---	---	---	2.67	---	---	ML
3	**At 3.0 m depth**	SPT	13	4.37	4.36	4.53	9.49	60.56	16.69	26	20	6	---	---	---	---	---	---	2.69	---	---	ML-CL
4	**At 4.5 m depth**	UDS	---	0	0	0.73	40.7	46.93	11.64	25	---	NP	11.54	1.755	1.573	0.15	18	UU	2.66	0.69	0.116	ML
5	**At 6.0 m depth**	SPT	19	0	0	9.64	43.56	46.80	0.00	20	---	NP	---	---	---	---	---	---	2.66	---	---	SM
6	**At 9.0 m depth**	UDS	---	10.7	6.7	5.93	8.46	47.65	20.56	30	18	12	12.87	1.832	1.623	0.25	12	UU	2.72	0.68	0.123	CL
7	**At 12.0 m depth**	SPT	17	0.3	0.28	0.98	4.42	69.17	24.85	32	19	13	---	---	---	---	---	---	2.72	---	---	CL
8	**At 15.0 m depth**	UDS	---	0	0.56	2.14	16.07	70.68	10.55	27	---	NP	14.46	1.878	1.641	0.18	14	UU	2.72	0.66	0.114	ML

Name of Project:	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.

Contd… PIER(BH-09,CH-22705)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
9	**At 18.0 m depth**	SPT	25	0.18	0.19	1.32	28.34	59.11	10.86	25	---	NP	---	---	---	---	---	---	2.67	---	---	ML
10	**At 21.0 m depth**	UDS	---	0.36	2.59	9.7	36.26	41.40	9.69	24	---	NP	15.96	1.923	1.658	0.15	14	UU	2.72	0.64	0.106	ML
11	**At 24.0 m depth**	SPT	29	10.1	3.74	4.15	8.43	62.52	11.06	26	---	NP	---	---	---	---	---	---	2.72	---	---	ML
12	**At 27.00 m depth**	UDS	---	12.58	2.36	1.24	42.91	40.91	0.00	19	---	NP	16.12	1.929	1.661	0.03	27	DS	2.64	0.59	---	SM
13	**At 30.00 m depth**	SPT	61	28.48	2.95	2.17	20.06	46.34	0.00	20	---	NP	---	---	---	---	---	---	2.66	---	---	SM
14	**At 33.00 m depth**	SPT	77	8.79	0.06	2.54	40.04	48.57	0.00	21	---	NP	---	---	---	---	---	---	2.66	---	---	SM
15	**At 36.00 m depth**	SPT	>50	12.85	0.04	2.87	42.2	42.04	0.00	20	---	NP	---	---	---	---	---	---	2.65	---	---	SM
16	**At 39.00 m depth**	SPT	>50	8.05	0.43	3.72	53.93	33.87	0.00	19	---	NP	---	---	---	---	---	---	2.63	---	---	SM
17	**At 40.00 m depth**	SPT	>50	10.46	2.03	2.98	39.52	45.01	0.00	20	---	NP	---	---	---	---	---	---	2.65	---	---	SM

Name of Project:	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.

PIER (BH-10, CH-23205)

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

Sl. No.	Sample Collected at	Type of soil collected	S. P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
1	**At 0.5 m depth**	DS	---	0	0	0.82	68.39	30.79	0.00	18	---	NP	---	---	---	---	---	---	2.65	---	---	SM
2	**At 1.5 m depth**	UDS	---	0	0	0.77	56.52	42.71	0.00	21	---	NP	11.26	1.759	1.581	0.02	25	DS	2.66	0.68	---	SM
3	**At 3.0 m depth**	SPT	5	10.5	3.3	3.87	44.19	38.14	0.00	20	---	NP	---	---	---	---	---	---	2.65	---	---	SM
4	**At 4.5 m depth**	UDS	---	0.21	0	0.68	62.17	36.94	0.00	19	---	NP	11.76	1.789	1.601	0.03	26	DS	2.65	0.66	---	SM
5	**At 6.0 m depth**	SPT	11	0	1.01	0.54	62.16	36.29	0.00	19	---	NP	---	---	---	---	---	---	2.65	---	---	SM
6	**At 9.0 m depth**	UDS	---	0	0	0.8	63.86	35.34	0.00	19	---	NP	12.86	1.813	1.606	0.01	25	DS	2.64	0.64	---	SM
7	**At 12.0 m depth**	SPT	13	2.68	1.01	1.01	5.83	72.58	16.89	27	21	6	---	---	---	---	---	---	2.69	---	---	ML-CL
8	**At 15.0 m depth**	UDS	---	2.05	1.03	1.58	7.14	63.99	24.21	32	19	13	13.26	1.881	1.661	0.27	11	UU	2.7	0.63	0.114	CL

Name of Project:	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.

Contd… PIER (BH-10,CH-23205)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
9	**At 18.0 m depth**	SPT	17	2.04	0.16	1	54.52	42.28	0.00	21	---	NP	---	---	---	---	---	---	2.65	---	---	SM
10	**At 21.0 m depth**	UDS	---	0	0.23	3.35	68.23	28.19	0.00	18	---	NP	15.63	1.896	1.640	0.03	25	DS	2.64	0.61	---	SM
11	**At 24.0 m depth**	SPT	30	0	0	5.13	58.88	35.99	0.00	19	---	NP	---	---	---	---	---	---	2.65	---	---	SM
12	**At 27.00 m depth**	UDS	---	0	0.28	5.38	59.25	35.09	0.00	19	---	NP	17.26	1.943	1.657	0.04	24	DS	2.65	0.60	---	SM
13	**At 30.00 m depth**	SPT	64	0	0	3.72	58.83	37.45	0.00	20	---	NP	---	---	---	---	---	---	2.66	---	---	SM
14	**At 33.00 m depth**	SPT	77	4.36	2	2.65	24.74	55.39	10.86	27	---	NP	---	---	---	---	---	---	2.68	---	---	ML
15	**At 36.00 m depth**	SPT	84	7.24	0	7.67	51.71	33.38	0.00	19	---	NP	---	---	---	---	---	---	2.65	---	---	SM
16	**At 39.00 m depth**	SPT	>50	5.84	0	2.21	56.72	35.23	0.00	20	---	NP	---	---	---	---	---	---	2.65	---	---	SM
17	**At 40.00 m depth**	SPT	>50	5.28	0	1.74	47.84	45.14	0.00	21	---	NP	---	---	---	---	---	---	2.66	---	---	SM

Name of Project:	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.

PIER (BH-11,CH-23705)

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

Sl. No.	Sample Collected at	Type of soil collected	S. P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
1	**At 0.5 m depth**	DS	---	0	0	0	55.05	44.95	0.00	21	---	NP	---	---	---	---	---	---	2.65	---	---	SM
2	**At 1.5 m depth**	UDS	---	0	0	0.51	50.28	49.21	0.00	22	---	NP	10.56	1.754	1.586	0.04	23	DS	2.66	0.68	---	SM
3	**At 3.0 m depth**	SPT	9	0	0	4.56	53.61	41.83	0.00	20	---	NP	---	---	---	---	---	---	2.65	---	---	SM
4	**At 4.5 m depth**	UDS	---	1.15	0	0.51	48.76	49.58	0.00	22	---	NP	12.56	1.796	1.596	0.04	25	DS	2.66	0.67	---	SM
5	**At 6.0 m depth**	SPT	18	9.85	2.57	1.6	70.34	15.64	0.00	19	---	NP	---	---	---	---	---	---	2.63	---	---	SM
6	**At 9.0 m depth**	UDS	---	5.19	2.12	1.44	9.61	55.77	25.87	32	19	13	14.26	1.863	1.630	0.26	13	UU	2.71	0.66	0.117	CL
7	**At 12.0 m depth**	SPT	26	11.46	2.67	1.85	9.55	51.02	23.45	30	18	12	---	---	---	---	---	---	2.70	---	---	CL
8	**At 15.0 m depth**	UDS	---	5.16	3.12	0.5	61.29	29.93	0.00	19	---	NP	15.78	1.886	1.629	0.02	27	DS	2.64	0.62	---	SM

Name of Project:	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.

Contd… PIER (BH-11, CH-23705)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
9	**At 18.0 m depth**	SPT	32	7.09	3.55	1.1	52.97	35.29	0.00	20	---	NP	---	---	---	---	---	---	2.64	---	---	SM
10	**At 21.0 m depth**	UDS	---	3.49	3.42	1.25	56.54	35.30	0.00	20	---	NP	16.93	1.918	1.640	0.02	26	DS	2.64	0.61	---	SM
11	**At 24.0 m depth**	SPT	37	10.4	5.24	2.52	40.13	41.71	0.00	21	---	NP	---	---	---	---	---	---	2.65	---	---	SM
12	**At 27.00 m depth**	UDS	---	7.77	3.46	1.81	51.02	35.94	0.00	20	---	NP	17.64	1.956	1.663	0.03	27	DS	2.65	0.59	---	SM
13	**At 30.00 m depth**	SPT	85	11.85	5.5	38.58	29.07	15.00	0.00	18	---	NP	---	---	---	---	---	---	2.63	---	---	SM
14	**At 33.00 m depth**	SPT	>50	16.43	9.27	30.06	27.07	17.17	0.00	19	---	NP	---	---	---	---	---	---	2.63	---	---	SM
15	**At 36.00 m depth**	SPT	>50	12.91	6.82	33.11	30.9	16.26	0.00	19	---	NP	---	---	---	---	---	---	2.63	---	---	SM
16	**At 39.00 m depth**	SPT	>50	9.55	5.13	37.91	31.44	15.97	0.00	18	---	NP	---	---	---	---	---	---	2.64	---	---	SM
17	**At 40.00 m depth**	SPT	>50	15.13	13.01	46.89	11.59	13.38	0.00	18	---	NP	---	---	---	---	---	---	2.63	---	---	SM

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PIER (BH-11A,CH-24205)

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

Sl. No.	Sample Collected at	Type of soil collected	S. P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
1	**At 0.5 m depth**	DS	---	0	0	0	69.72	30.28	0.00	19	---	NP	---	---	---	---	---	---	2.65	---	---	SM
2	**At 1.5 m depth**	UDS	---	0	0	0.94	60.7	38.36	0.00	20	---	NP	11.45	1.776	1.594	0.04	25	DS	2.66	0.67	---	SM
3	**At 3.0 m depth**	SPT	5	2.13	0.9	2.36	70.19	24.42	0.00	19	---	NP	---	---	---	---	---	---	2.64	---	---	SM
4	**At 4.5 m depth**	UDS	---	0	0	0.53	85.64	13.83	0.00	18	---	NP	12.63	1.802	1.600	0.02	26	DS	2.64	0.65	---	SM
5	**At 6.0 m depth**	SPT	10	8.54	1.99	3.21	9.87	52.63	23.76	33	20	13	---	---	---	---	---	---	2.72	---	---	CL
6	**At 9.0 m depth**	UDS	---	14.78	2.2	2.32	9.39	49.91	21.40	31	19	12	13.47	1.876	1.653	0.25	14	UU	2.71	0.64	0.111	CL
7	**At 12.0 m depth**	SPT	12	2.03	0.78	3.35	18.84	51.54	23.46	32	19	13	---	---	---	---	---	---	2.72	---	---	CL
8	**At 15.0 m depth**	UDS	---	18.5	6.49	9.25	13.48	42.66	9.62	25	---	NP	14.26	1.903	1.665	0.16	19	UU	2.70	0.62	0.108	ML

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Contd… PIER (BH-11A,CH-24205)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
9	**At 18.0 m depth**	SPT	56	16.94	2.05	2.3	48.93	29.78	0.00	21	---	NP	---	---	---	---	---	---	2.65	---	---	SM
10	**At 21.0 m depth**	SPT	67	18.69	3.42	2.86	52.65	22.38	0.00	20	---	NP	---	---	---	---	---	---	2.64	---	---	SM
11	**At 24.0 m depth**	SPT	74	21.42	5.82	3.12	48.39	21.25	0.00	19	---	NP	---	---	---	---	---	---	2.64	---	---	SM
12	**At 27.00 m depth**	SPT	>50	20.48	2.96	1.66	51.47	23.43	0.00	21	---	NP	---	---	---	---	---	---	2.63	---	---	SM
13	**At 30.00 m depth**	SPT	>50	22.65	3.85	2.46	49.53	21.51	0.00	20	---	NP	---	---	---	---	---	---	2.64	---	---	SM
14	**At 33.00 m depth**	SPT	>50	26.19	2.48	3.21	50.69	17.43	0.00	19	---	NP	---	---	---	---	---	---	2.63	---	---	SM
15	**At 36.00 m depth**	SPT	>50	Pebble Pieces Were Collected																		
16	**At 39.00 m depth**	SPT	>50	Pebble Pieces Were Collected																		
17	**At 40.00 m depth**	SPT	>50	Pebble Pieces Were Collected																		

Name of Project:	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.

PIER (BH-12,CH-24700)

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

Sl. No.	Sample Collected at	Type of soil collected	S. P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %											
1	**At 0.5 m to 1.5 m depth**	SPT	17	4.21	0.86	0.47	42.56	45.66	6.24	20	---	NP	---	---	---	---	---	---	2.67	---	**---**	ML
2	**At 1.5 m to 3.0 m depth**	SPT	24	0	1.38	0.52	47.36	46.58	4.16	19	---	NP	---	---	---	---	---	---	2.66	---	**---**	ML
3	**At 3.0 m to 4.5 m depth**	SPT	>50	3.64	0.27	0.21	45.52	46.24	4.12	20	---	NP	---	---	---	---	---	---	2.67	---	**---**	ML
4	**At 4.5 m to 6.0 m depth**	BOULDER	---	CORE RECOVERY=16.66% & R.Q.D=NIL																		
5	**At 6.0 m to 7.5 m depth**	ROCK	---	CORE RECOVERY=18.66% & R.Q.D=NIL																		
6	**At 7.5 m to 9.0 m depth**	ROCK	---	CORE RECOVERY=20.66% & R.Q.D=NIL																		
7	**At 9.0 m to 10.5 m depth**	ROCK	---	CORE RECOVERY=22.66% & R.Q.D=7%																		
8	**At 10.5 m to 12.0 m depth**	ROCK	---	CORE RECOVERY=36% & R.Q.D=16.66%																		

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Contd… PIER (BH-12,CH-24700)

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

Sl. No.	Sample Collected at	Type of soil collected	S.P.T N Value	Grain size analysis						Atterberg's Limit			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
				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 %										
9	**At 12.0 m to 13.5 m depth**	ROCK	---	CORE RECOVERY=22.66% & R.Q.D=7.33%																		
10	**At 13.5 m to 15.0 m depth**	ROCK	---	CORE RECOVERY=26.66% & R.Q.D=14.46%																		
11	**At 15.0 m to 16.5 m depth**	ROCK	---	CORE RECOVERY=36.66% & R.Q.D=22.46%																		
12	**At 16.5 m to 18.0 m depth**	ROCK	---	CORE RECOVERY=24.66% & R.Q.D=8.67%																		
13	**At 18.0 m to 20.0 m depth**	ROCK	---	CORE RECOVERY=35% & R.Q.D=24.95%																		

Name of Project:	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.

BH NO.	Depth	Sample Number	Weight Density	Specific Gravity	Water Absorption	Tensile Strength Test	UCS Test	Modulas of Elasticity	Poisson's Ratio	Point load index	Triaxial		Hardness Test	Abrasiveness Test
			(kN/m³)		(%)	(Mpa)	(Mpa)	(Mpa)		(Mpa)	c (Mpa)	(φ°)		
BH NO-12	7.50	BH12/0322/R/01	---	---	---	---	37.79	40.3	0.15	---	---	---	---	---
		BH12/0322/R/02	---	---	---	---	---	---	---	11.49	---	---	---	---
	9.00	BH12/0322/R/03	---	---	---	---	---	---	---	---	---	---	---	---
		BH12/0322/R/04	25.4	2.58	0.34	---	---	---	---	---	---	---	---	---
		BH12/0322/R/05	---	---	---	---	---	---	---	14.81	---	---	---	---
		BH12/0322/R/06	---	---	---	14.93	---	---	---	---	---	---	---	---
	10.50	BH12/0322/R/07	---	---	---	---	---	---	---	---	---	---	33.8	2.7
		BH12/0322/R/08	---	---	---	---	33.91	44	0.11	---	---	---	---	---
		BH12/0322/R/09	25.74	2.61	0.49	---	---	---	---	---	---	---	---	---
	12.00	BH12/0322/R/10	---	---	---	---	40.18	41	0.13	---	---	---	---	---
		BH12/0322/R/11	---	---	---	---	---	---	---	---	---	---	---	2.86
		BH12/0322/R/12	---	---	---	---	---	---	---	13.67	---	---	---	---
		BH12/0322/R/13	25.57	2.59	0.46	---	---	---	---	---	---	---	---	---
	13.50	BH12/0322/R/14	---	---	---	---	---	---	---	---	---	---	---	---
		BH12/0322/R/15	---	---	---	---	---	---	---	---	---	---	---	---
		BH12/0322/R/16	---	---	---	---	34.78	38.6	0.13	---	---	---	---	---
		BH12/0322/R/17	---	---	---	---	---	---	---	---	---	---	35.2	2.9
	15.00	BH12/0322/R/18	25.06	2.55	0.37	---	---	---	---	---	---	---	---	---
		BH12/0322/R/19	---	---	---	13.78	---	---	---	---	---	---	---	---
		BH12/0322/R/20	---	---	---	---	37.22	40.7	0.14	---	---	---	---	---
	16.50	BH12/0322/R/21	---	---	---	16.33	---	---	---	---	---	---	---	---
		BH12/0322/R/22	---	---	---	---	---	---	---	---	---	---	31.2	3.11
		BH12/0322/R/23	---	---	---	---	38.63	42.3	0.15	---	---	---	---	---
		BH12/0322/R/24	---	---	---	---	---	---	---	---	---	---	---	---
		BH12/0322/R/25	25.43	2.58	0.38	---	---	---	---	---	---	---	---	---
	18.00	BH12/0322/R/26	---	---	---	---	---	---	---	---	---	---	---	---
		BH12/0322/R/27	---	---	---	---	42.3	39	0.17		---	---	---	---
		BH12/0322/R/28	---	---	---	---	---	---	---	---	---	---	---	---
		BH12/0322/R/29	---	---	---	---	---	---	---	---	---	---	---	---
	20.00	BH12/0322/R/30	---	---	---	---	---	---	---	---	---	---	27.3	2.66
		BH12/0322/R/31	---	---	---	---	37.12	48.1	0.16	---	---	---	---	---
		BH12/0322/R/32	24.98	2.54	0.46	14.41	---	---	---	---	15.77	63.37	---	---
		BH12/0322/R/33	---	---	---	---	---	---	---	---			---	---
		BH12/0322/R/34	---	---	---	---	---	---	---	---			---	---

Name of Project:	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.

ANNEXURE -C
CALCULATION OF LOAD CARRYING CAPACITY OF PILE

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Abutment (BH NO-02)

Dia = 1.2 m

Length = 23.00 m **From Bottom of the Pile Cap**

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

- A_p = cross sectional area of pile tip, in m^2
- N_c = bearing capacity factor, may be taken as " 9 "
- c_p = average cohesion at pile tip, in kN/m^2
- α_i = adhesion factor for the ith layer depending on the consistency of soil
- c_i = average cohesion for the ith layer, in kN/m^2
- A_p = cross sectional area of pile tip, in m^2
- D = diameter of the pile shaft, in m
- γ = effective unit weight of the soil at pile tip, in kN/m^2
- P_D = effective overburden pressure at pile tip, in kN/m^2
- $\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
- N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
- K_i = coefficient of Earth pressure applicable for the ith layer.
- P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2
- δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
- A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -02

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
6.000		2	4.00	4.00	15	1.762	0.31	10	X
12.000	**2.000**	3	6.00	10.00	22	1.792	0.29	11	X
18.000		4	6.00	16.00	28	1.816	0.28	10	X
22.000		5	4.00	20.00	48	1.845	0.30	9	X
25.000		6	3.00	23.00	---	1.887	0.28	15	X

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
4.00		4.00	1.000	4.000	4.000	2.00
10.00		6.00	1.000	6.000	10.000	7.00
16.00		6.00	1.000	6.000	16.000	13.00
20.00		4.00	1.000	4.000	18.000	17.00
23.00		3.00	1.000	3.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	X	4.00	15.08	1.0	46.8	7.977			
Zone III	X	6.00	22.62	1.0	65.6	46.166	**527.233**	**2.500**	**210.893**
Zone IV	X	6.00	22.62	1.0	63.3	77.774			
Zone V	X	4.00	15.08	1.0	45.2	60.904			
Zone VI	X	3.00	11.31	1.0	31.7	81.822			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	2.80
B.Capacity	=	**28.50**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap ($0.5D\gamma N_\gamma + P_d N_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	15.00
N_q	=	10.00
N_γ	=	2.65
B.Capacity	=	**205.37**

ϕ		Nγ
15		2.65
20		5.39

Hence, B. Capacity = 233.87

Q_{safe} = **93.550** t

Total Q_{safe} = 210.9 + 93.55

= **304.44** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***39.02*** ***t***
3. Net bearing capacity of pile = ***265.42*** ***t***

say ***265.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **265 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760	cm^4	
5.	Embeded Length of Pile (L_e)	=	23.00	m	> 4T
					12.79237763 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.90 kg/cm^3

T = 319.81 cm
= 3.198 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.199
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.199
= **7.04** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 51869.05 kg
= **52** t

Hence, the horizontal Load carrying capacity of the pile is taken as **52 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.
In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 527.23 T

W_p = 39.024 T

so Q_{tu} = 390.512 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

130.17 T

SAY 130.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Abutment (BH NO-02)

Dia = 1.2 m

Length = 25.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -02

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
6.000		2	4.00	4.00	15	1.762	0.31	10	X
12.000	**2.000**	3	6.00	10.00	22	1.792	0.29	11	X
18.000		4	6.00	16.00	28	1.816	0.28	10	X
22.000		5	4.00	20.00	48	1.845	0.30	9	X
27.000		6	5.00	25.00	---	1.887	0.28	15	X

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t/m^3	t/m^2	t/m^2	t/m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
4.00		4.00	1.000	4.000	4.000	2.00
10.00		6.00	1.000	6.000	10.000	7.00
16.00		6.00	1.000	6.000	16.000	13.00
20.00		4.00	1.000	4.000	18.000	17.00
25.00		5.00	1.000	5.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	$Q_u = X + Y$ t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**602.891**	**2.500**	**241.156**
Zone II	X	4.00	15.08	1.0	46.8	7.977			
Zone III	X	6.00	22.62	1.0	65.6	46.166			
Zone IV	X	6.00	22.62	1.0	63.3	77.774			
Zone V	X	4.00	15.08	1.0	45.2	60.904			
Zone VI	X	5.00	18.85	1.0	52.8	136.370			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	2.80
B.Capacity	=	**28.50**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$Ap (0.5D\gamma N_\gamma + P_d N_q)$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	15.00
N_q	=	10.00
N_γ	=	2.65
B.Capacity	=	**205.37**

ϕ		Nγ
15		2.65
20		5.39

Hence, B. Capacity = 233.87

Q_{safe} = **93.550** t

Total Q_{safe} = 241.16 + 93.55

= **334.71** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***42.41*** ***t***
3. Net bearing capacity of pile = ***292.29*** ***t***

say ***292.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **292 ton in the design**

Name of Project:	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.

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760	cm^4	
5.	Embeded Length of Pile (L_e)	=	25.00	m	> 4T
					12.79237763 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.90 kg/cm^3

T = 319.81 cm
= 3.198 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.199
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.199
= **7.04** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\ (L_1 + L_f)^3}{3\ E\ I}$$

Fixed Head Piles

$$Y = \frac{Q\ (L_1 + L_f)^3}{12\ E\ I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\ EI\ Y}{(L_1 + L_f)^3}$

= 51869.05 kg
= **52** t

Hence, the horizontal Load carrying capacity of the pile is taken as **52 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5-1)$ gm

Frictional resistance = 602.89 T

W_p = 42.417 T

so Q_{tu} = 444.344 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

148.11 T

SAY 148.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering Pier(BH NO-03)

Dia = 1.2 m

Length = 20.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$$Q_u = R_u + R_f$$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N q)$$

$$= X' + Y' \quad \text{where;} \quad X' = A_p N_c c_p \quad \textit{For Cohesive Soil}$$

$$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q) \quad \textit{For Granular Soil}$$

The Ultimate Side Resistance of Pile due to friction is as follows:

$$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$$

$$= X + Y \quad \text{where;} \quad X = \Sigma^n_{i=1} \alpha_i c_i A_{si} \quad \textit{For Cohesive Soil}$$

$$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si} \quad \textit{For Granular Soil}$$

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the "i^{th}" layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -03

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
9.000		2	7.00	7.00	17	1.783	0.30	12	X
12.000	**2.000**	3	3.00	10.00	24	---	0.05	25	Y
18.000		4	6.00	16.00	32	1.826	0.29	14	X
21.000		5	3.00	19.00	---	1.871	0.28	15	X
22.000		6	1.00	20.00	59	---	0.11	18	Y

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Name of Project:	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.

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
7.00		7.00	1.000	7.000	7.000	3.50
10.00		3.00	1.000	3.000	10.000	8.50
16.00		6.00	1.000	6.000	16.000	13.00
19.00		3.00	1.000	3.000	18.000	17.00
20.00		1.00	1.000	1.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	X	7.00	26.39	1.0	79.2	29.448			
Zone III	Y	3.00	11.31	0.0	0.0	67.241	**493.452**	**2.500**	**197.381**
Zone IV	X	6.00	22.62	1.0	65.6	109.973			
Zone V	X	3.00	11.31	1.0	31.7	77.276			
Zone VI	Y	1.00	3.77	0.0	0.0	33.073			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil
$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	1.10
B.Capacity	=	**11.20**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap ($0.5D\gamma N_\gamma + P_d N_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	18.00
N_q	=	10.00
N_γ	=	4.29
B.Capacity	=	**206.49**

ϕ		Nγ
15		2.65
20		5.39

Hence, B. Capacity = 217.69

Q_{safe} = **87.074** t

Total Q_{safe} = 197.39 + 87.08
= **284.46** t

1. Density of concrete = ***2.50*** ***t/m*** ^{3}
2. Salfe weight of pile (Buoyant) = ***33.93*** ***t***
3. Net bearing capacity of pile = ***250.53*** ***t***

say ***251.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **251 ton in the design**

Name of Project:	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.

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	20.00	m	> 4T
					12.79237763 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.90 kg/cm^3

T = 319.81 cm
= 3.198 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.199
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.199
= **7.04** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 51869.05 kg
= **52** t

Hence, the horizontal Load carrying capacity of the pile is taken as **52 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 493.45 T

W_p = 33.934 T

so Q_{tu} = 362.902 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

120.97 T

SAY 121.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering Pier(BH NO-03)

Dia = 1.2 m

Length = 23.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D Nq)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -03

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
9.000		2	7.00	7.00	17	1.783	0.30	12	X
12.000	**2.000**	3	3.00	10.00	24	---	0.05	25	Y
18.000		4	6.00	16.00	32	1.826	0.29	14	X
21.000		5	3.00	19.00	---	1.871	0.28	15	X
25.000		6	4.00	23.00	59	---	0.04	25	Y

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
7.00		7.00	1.000	7.000	7.000	3.50
10.00		3.00	1.000	3.000	10.000	8.50
16.00		6.00	1.000	6.000	16.000	13.00
19.00		3.00	1.000	3.000	18.000	17.00
23.00		4.00	1.000	4.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**650.237**	**2.500**	**260.095**
Zone II	X	7.00	26.39	1.0	79.2	29.448			
Zone III	Y	3.00	11.31	0.0	0.0	67.241			
Zone IV	X	6.00	22.62	1.0	65.6	109.973			
Zone V	X	3.00	11.31	1.0	31.7	77.276			
Zone VI	Y	4.00	15.08	0.0	0.0	189.857			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$\mathbf{A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)}$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$\mathbf{A_p N_c C_p}$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.40
B.Capacity	=	**4.07**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap (0.5DγN$_\gamma$+P$_d$N$_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	25.00
N_q	=	10.00
N_γ	=	10.88
B.Capacity	=	**210.96**

ϕ		Nγ
25		10.88
30		22.40

Hence, B. Capacity = 215.03

Q_{safe} = **86.012** t

Total Q_{safe} = 260.1 + 86.02

= **346.11** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***39.02*** ***t***
3. Net bearing capacity of pile = ***307.09*** ***t***

say ***307.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **307 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	Π d^4 / 64		
		=	0.10179	m^4	
		=	10178760	cm^4	
5.	Embeded Length of Pile (L_e)	=	23.00	m	> 4T
					12.79237763 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.90 kg/cm^3

T = 319.81 cm
= 3.198 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.199
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.199
= **7.04** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{3 E I}$$

Fixed Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{12 E I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12 EI Y}{(L_1 + L_f)^3}$

= 51869.05 kg
= **52** t

Hence, the horizontal Load carrying capacity of the pile is taken as **52 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 650.24 T

W_p = 39.024 T

so Q_{tu} = 472.515 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

157.50 T

SAY 158.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-04)

Dia = 1.2 m

Length = 20.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$$Q_u = R_u + R_f$$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D Nq)$$

$$= X' + Y' \quad \text{where;} \quad X' = A_p N_c c_p \quad \textit{For Cohesive Soil}$$

$$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q) \quad \textit{For Granular Soil}$$

The Ultimate Side Resistance of Pile due to friction is as follows:

$$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$$

$$= X + Y \quad \text{where;} \quad X = \Sigma^n_{i=1} \alpha_i c_i A_{si} \quad \textit{For Cohesive Soil}$$

$$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si} \quad \textit{For Granular Soil}$$

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -04

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
6.000		2	4.00	4.00	17	1.768	0.03	26	Y
12.000	**2.000**	3	6.00	10.00	36	1.795	0.05	24	Y
18.000		4	6.00	16.00	52	1.844	0.28	14	X
21.000		5	3.00	19.00	---	1.893	0.31	11	X
22.000		6	1.00	20.00	65	---	0.04	25	Y

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
4.00		4.00	1.000	4.000	4.000	2.00
10.00		6.00	1.000	6.000	10.000	7.00
16.00		6.00	1.000	6.000	16.000	13.00
19.00		3.00	1.000	3.000	18.000	17.00
20.00		1.00	1.000	1.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	4.00	15.08	0.0	0.0	22.065			
Zone III	Y	6.00	22.62	0.0	0.0	105.744	**439.695**	**2.500**	**175.878**
Zone IV	X	6.00	22.62	1.0	63.3	109.973			
Zone V	X	3.00	11.31	1.0	35.1	56.059			
Zone VI	Y	1.00	3.77	0.0	0.0	47.464			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil
$\mathbf{A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)}$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$\mathbf{A_p N_c C_p}$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.40
B.Capacity	=	**4.07**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$\mathbf{Ap (0.5D\gamma N_\gamma + P_d N_q)}$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	25.00
N_q	=	10.00
N_γ	=	10.88
B.Capacity	=	**210.96**

ϕ		$N\gamma$
25		10.88
30		22.40

Hence, B. Capacity = 215.03

Q_{safe} = **86.012** t

Total Q_{safe} = 175.88 + 86.02
= **261.89** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***33.93*** ***t***
3. Net bearing capacity of pile = ***227.96*** ***t***

say ***228.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **228 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	20.00	m	> 4T
					15.19998131 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.38 kg/cm^3

T = 380.00 cm
= 3.800 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.8
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.8
= **8.36** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 30919.53 kg
= **31** t

Hence, the horizontal Load carrying capacity of the pile is taken as **31 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 439.70 T

W_p = 33.934 T

so Q_{tu} = 327.064 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

109.02 T

SAY 109.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-04)

Dia = 1.2 m

Length = 23.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D Nq)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the "i^{th}" layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -04

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
6.000		2	4.00	4.00	17	1.768	0.03	26	Y
12.000	**2.000**	3	6.00	10.00	36	1.795	0.05	24	Y
18.000		4	6.00	16.00	52	1.844	0.28	14	X
21.000		5	3.00	19.00	---	1.893	0.31	11	X
25.000		6	4.00	23.00	65	---	0.04	25	Y

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
4.00		4.00	1.000	4.000	4.000	2.00
10.00		6.00	1.000	6.000	10.000	7.00
16.00		6.00	1.000	6.000	16.000	13.00
19.00		3.00	1.000	3.000	18.000	17.00
23.00		4.00	1.000	4.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	4.00	15.08	0.0	0.0	22.065			
Zone III	Y	6.00	22.62	0.0	0.0	105.744	**582.088**	**2.500**	**232.835**
Zone IV	X	6.00	22.62	1.0	63.3	109.973			
Zone V	X	3.00	11.31	1.0	35.1	56.059			
Zone VI	Y	4.00	15.08	0.0	0.0	189.857			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil
$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.40
B.Capacity	=	**4.07**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap (0.5DγN$_\gamma$+P$_d$N$_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	25.00
N_q	=	10.00
N_γ	=	10.88
B.Capacity	=	**210.96**

ϕ		Nγ
25		10.88
30		22.40

Hence, B. Capacity = 215.03

Q_{safe} = **86.012** t

Total Q_{safe} = 232.84 + 86.02
= **318.85** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***39.02*** ***t***
3. Net bearing capacity of pile = ***279.83*** ***t***

say ***280.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **280 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	23.00	m	> 4T
					15.19998131 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.38 kg/cm^3

T = 380.00 cm
= 3.800 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.8
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.8
= **8.36** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 30919.53 kg
= **31** t

Hence, the horizontal Load carrying capacity of the pile is taken as **31 ton for the design**

Name of Project:	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.

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.
In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5-1)$ gm

Frictional resistance = 582.09 T

W_p = 39.024 T

so Q_{tu} = 427.082 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

142.36 T

SAY 142.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-04)

Dia = 1.2 m

Length = 25.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$$Q_u = R_u + R_f$$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$$

$$= X' + Y' \quad \text{where;} \quad X' = A_p N_c c_p \quad \textit{For Cohesive Soil}$$

$$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q) \quad \textit{For Granular Soil}$$

The Ultimate Side Resistance of Pile due to friction is as follows:

$$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$$

$$= X + Y \quad \text{where;} \quad X = \Sigma^n_{i=1} \alpha_i c_i A_{si} \quad \textit{For Cohesive Soil}$$

$$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si} \quad \textit{For Granular Soil}$$

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -04

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
6.000		2	4.00	4.00	17	1.768	0.03	26	Y
12.000	**2.000**	3	6.00	10.00	36	1.795	0.05	24	Y
18.000		4	6.00	16.00	52	1.844	0.28	14	X
21.000		5	3.00	19.00	---	1.893	0.31	11	X
27.000		6	6.00	25.00	65	---	0.04	25	Y

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
4.00		4.00	1.000	4.000	4.000	2.00
10.00		6.00	1.000	6.000	10.000	7.00
16.00		6.00	1.000	6.000	16.000	13.00
19.00		3.00	1.000	3.000	18.000	17.00
25.00		6.00	1.000	6.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	4.00	15.08	0.0	0.0	22.065			
Zone III	Y	6.00	22.62	0.0	0.0	105.744	**677.017**	**2.500**	**270.807**
Zone IV	X	6.00	22.62	1.0	63.3	109.973			
Zone V	X	3.00	11.31	1.0	35.1	56.059			
Zone VI	Y	6.00	22.62	0.0	0.0	284.786			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil
$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.40
B.Capacity	=	**4.07**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap (0.5DγN$_γ$+P$_d$N$_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	25.00
N_q	=	10.00
N_γ	=	10.88
B.Capacity	=	**210.96**

ϕ		Nγ
25		10.88
30		22.40

Hence, B. Capacity = 215.03

Q_{safe} = **86.012** t

Total Q_{safe} = 270.81 + 86.02
= **356.82** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***42.41*** ***t***
3. Net bearing capacity of pile = ***314.41*** ***t***

say ***314.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **314 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	25.00	m	> 4T
					15.19998131 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.38 kg/cm^3

T = 380.00 cm
= 3.800 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.8
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.8
= **8.36** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 30919.53 kg
= **31** t

Hence, the horizontal Load carrying capacity of the pile is taken as **31 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 677.02 T

W_p = 42.417 T

so Q_{tu} = 493.761 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

164.59 T

SAY 165.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering Pier (BH NO-05)

Dia = 1.2 m

Length = 25.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D Nq)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the "i^{th}" layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -05

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	15	---	0.11	17	Y
9.000	**2.000**	3	6.00	7.00	23	1.773	0.09	20	Y
15.000		4	6.00	13.00	28	1.826	0.10	20	Y
18.000		5	3.00	16.00	50	---	0.10	20	Y
24.000		6	6.00	22.00	61	1.875	0.30	10	X
27.000		7	3.00	25.00	---	1.926	0.32	8	X

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
7.00		6.00	1.000	6.000	7.000	4.00
13.00		6.00	1.000	6.000	13.000	10.00
16.00		3.00	1.000	3.000	16.000	14.50
22.00		6.00	1.000	6.000	18.000	17.00
25.00		3.00	1.000	3.000	18.000	18.00

No. of Zones Considered *7*

Q $_{safe}$ due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**511.956**	**2.500**	**204.782**
Zone II	Y	1.00	3.77	0.0	0.0	0.864			
Zone III	Y	6.00	22.62	0.0	0.0	49.397			
Zone IV	Y	6.00	22.62	0.0	0.0	123.492			
Zone V	Y	3.00	11.31	0.0	0.0	89.532			
Zone VI	X	6.00	22.62	1.0	67.9	101.705			
Zone VII	X	3.00	11.31	1.0	36.2	42.916			

Q $_{safe}$ due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	3.20
B.Capacity	=	**32.57**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap ($0.5D\gamma N_\gamma + P_d N_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	8.00
N_q	=	10.00
N_γ	=	0.91
B.Capacity	=	**204.19**

ϕ		Nγ
5		0.45
10		1.22

Hence, B. Capacity = 236.77

Q_{safe} = **94.706** t

Total Q_{safe} = 204.79 + 94.71

= **299.49** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***42.41*** ***t***
3. Net bearing capacity of pile = ***257.08*** ***t***

say ***257.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **257 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	25.00	m	> 4T
					15.36523734 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.36 kg/cm^3

T = 384.13 cm
= 3.841 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.842
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.842
= **8.45** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\ (L_1 + L_f)^3}{3\ E\ I}$$

Fixed Head Piles

$$Y = \frac{Q\ (L_1 + L_f)^3}{12\ E\ I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\ EI\ Y}{(L_1 + L_f)^3}$

= 29932.59 kg
= **30** t

Hence, the horizontal Load carrying capacity of the pile is taken as **30 ton for the design**

Name of Project:	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.

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 511.96 T

W_p = 42.417 T

so Q_{tu} = 383.721 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

127.91 T

SAY 128.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering Pier (BH NO-05)

Dia = 1.2 m

Length = 28.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$$Q_u = R_u + R_f$$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D Nq)$$

$$= X' + Y' \quad \text{where;} \quad X' = A_p N_c c_p \quad \textit{For Cohesive Soil}$$

$$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q) \quad \textit{For Granular Soil}$$

The Ultimate Side Resistance of Pile due to friction is as follows:

$$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$$

$$= X + Y \quad \text{where;} \quad X = \Sigma^n_{i=1} \alpha_i c_i A_{si} \quad \textit{For Cohesive Soil}$$

$$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si} \quad \textit{For Granular Soil}$$

Where;

- A_p = cross sectional area of pile tip, in m^2
- N_c = bearing capacity factor, may be taken as " 9 "
- c_p = average cohesion at pile tip, in kN/m^2
- α_i = adhesion factor for the ith layer depending on the consistency of soil
- c_i = average cohesion for the ith layer, in kN/m^2
- A_p = cross sectional area of pile tip, in m^2
- D = diameter of the pile shaft, in m
- γ = effective unit weight of the soil at pile tip, in kN/m^2
- P_D = effective overburden pressure at pile tip, in kN/m^2
- $\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
- N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
- K_i = coefficient of Earth pressure applicable for the ith layer.
- P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2
- δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
- A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -05

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	15	---	0.11	17	Y
9.000	**2.000**	3	6.00	7.00	23	1.773	0.09	20	Y
15.000		4	6.00	13.00	28	1.826	0.10	20	Y
18.000		5	3.00	16.00	50	---	0.10	20	Y
24.000		6	6.00	22.00	61	1.875	0.30	10	X
30.000		7	6.00	28.00	70	1.926	0.32	8	X

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Name of Project:	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.

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00		0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
7.00		6.00	1.000	6.000	7.000	4.00
13.00	2.000	6.00	1.000	6.000	13.000	10.00
16.00		3.00	1.000	3.000	16.000	14.50
22.00		6.00	1.000	6.000	18.000	17.00
28.00		6.00	1.000	6.000	18.000	18.00

No. of Zones Considered *7*

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	1.00	3.77	0.0	0.0	0.864			
Zone III	Y	6.00	22.62	0.0	0.0	49.397			
Zone IV	Y	6.00	22.62	0.0	0.0	123.492	**591.062**	**2.500**	**236.425**
Zone V	Y	3.00	11.31	0.0	0.0	89.532			
Zone VI	X	6.00	22.62	1.0	67.9	101.705			
Zone VII	X	6.00	22.62	1.0	72.4	85.832			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	3.20
B.Capacity	=	**32.57**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap ($0.5 D \gamma N_\gamma + P_d N_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	8.00
N_q	=	10.00
N_γ	=	0.91
B.Capacity	=	**204.19**

ϕ		Nγ
5		0.45
10		1.22

Hence, B. Capacity = 236.77

Q_{safe} = **94.706** t

Total Q_{safe} = 236.43 + 94.71

= **331.13** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***47.50*** ***t***
3. Net bearing capacity of pile = ***283.63*** ***t***

say ***284.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **284 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	28.00	m	> 4T
					15.36523734 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.36 kg/cm^3

T = 384.13 cm
= 3.841 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.842
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.842
= **8.45** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 29932.59 kg
= **30** t

Hence, the horizontal Load carrying capacity of the pile is taken as **30 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 591.06 T

W_p = 47.507 T

so Q_{tu} = 441.548 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

147.18 T

SAY 147.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-06)

Dia = 1.2 m

Length = 20.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D Nq)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

- A_p = cross sectional area of pile tip, in m^2
- N_c = bearing capacity factor, may be taken as " 9 "
- c_p = average cohesion at pile tip, in kN/m^2
- α_i = adhesion factor for the ith layer depending on the consistency of soil
- c_i = average cohesion for the ith layer, in kN/m^2
- A_p = cross sectional area of pile tip, in m^2
- D = diameter of the pile shaft, in m
- γ = effective unit weight of the soil at pile tip, in kN/m^2
- P_D = effective overburden pressure at pile tip, in kN/m^2
- $\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
- N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
- K_i = coefficient of Earth pressure applicable for the ith layer.
- P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2
- δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
- A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -06

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
6.000		2	4.00	4.00	20	1.758	0.12	17	Y
12.000	**2.000**	3	6.00	10.00	39	1.794	0.03	26	Y
15.000		4	3.00	13.00	---	1.816	0.04	24	Y
18.000		5	3.00	16.00	47	---	0.13	18	Y
22.000		6	4.00	20.00	60	1.863	0.13	18	Y

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Bulk Density γ_b	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
4.00		4.00	1.758	7.032	7.032	3.52
10.00		6.00	1.794	10.764	17.796	12.41
13.00		3.00	1.816	5.448	18.000	17.90
16.00		3.00	1.816	5.448	18.000	18.00
20.00		4.00	1.863	7.452	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**596.442**	**2.500**	**238.577**
Zone II	Y	4.00	15.08	0.0	0.0	24.315			
Zone III	Y	6.00	22.62	0.0	0.0	205.432			
Zone IV	Y	3.00	11.31	0.0	0.0	135.186			
Zone V	Y	3.00	11.31	0.0	0.0	99.218			
Zone VI	Y	4.00	15.08	0.0	0.0	132.291			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$\mathbf{A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)}$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$\mathbf{A_p N_c C_p}$		
Ap	=	1.131
Nc	=	9.000
Cp	=	1.30
B.Capacity	=	**13.23**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap (0.5DγNγ+PdNq)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.86
ϕ	=	18.00
N_q	=	10.00
N_γ	=	4.29
B.Capacity	=	**209.00**

ϕ		$N\gamma$
15		2.65
20		5.39

Hence, B. Capacity = 222.24

Q_{safe} = **88.894** t

Total Q_{safe} = 238.58 + 88.9

= **327.47** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile = ***56.55*** ***t***
3. Net bearing capacity of pile = ***270.92*** ***t***

say ***271.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **271 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	20.00	m	> 4T
					14.69458314 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.45 kg/cm^3

T = 367.36 cm
= 3.674 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.674
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.674
= **8.08** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{3 E I}$$

Fixed Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{12 E I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12 EI Y}{(L_1 + L_f)^3}$

= 34220.81 kg
= **34** t

Hence, the horizontal Load carrying capacity of the pile is taken as **34 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5-1)$ gm

Frictional resistance = 596.44 T

W_p = 33.934 T

so Q_{tu} = 431.561 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

143.85 T

SAY 144.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-06)

Dia = 1.2 m

Length = 23.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -06

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
6.000		2	4.00	4.00	20	1.758	0.12	17	Y
12.000	**2.000**	3	6.00	10.00	39	1.794	0.03	26	Y
15.000		4	3.00	13.00	---	1.816	0.04	24	Y
18.000		5	3.00	16.00	47	---	0.13	18	Y
25.000		6	7.00	23.00	60	1.879	0.08	22	Y

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Name of Project:	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.

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Bulk Density γ_b	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
4.00		4.00	1.758	7.032	7.032	3.52
10.00		6.00	1.794	10.764	17.796	12.41
13.00		3.00	1.816	5.448	18.000	17.90
16.00		3.00	1.816	5.448	18.000	18.00
23.00		7.00	1.879	13.153	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	$Q_u = X + Y$ t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**752.025**	**2.500**	**300.810**
Zone II	Y	4.00	15.08	0.0	0.0	24.315			
Zone III	Y	6.00	22.62	0.0	0.0	205.432			
Zone IV	Y	3.00	11.31	0.0	0.0	135.186			
Zone V	Y	3.00	11.31	0.0	0.0	99.218			
Zone VI	Y	7.00	26.39	0.0	0.0	287.874			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil

$$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.80
B.Capacity	=	**8.14**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$A_p (0.5 D \gamma N_\gamma P_d N_q)$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.88
ϕ	=	22.00
N_q	=	10.00
N_γ	=	7.59
B.Capacity	=	**213.25**

ϕ		Nγ
20		5.39
25		10.88

Hence, B. Capacity = 221.39

Q_{safe} = **88.556** t

Total Q_{safe} = 300.81 + 88.56
= **389.37** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile = ***65.03*** ***t***
3. Net bearing capacity of pile = ***324.34*** ***t***
say ***324.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **324 ton in the design**

Name of Project:	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.

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	23.00	m	> 4T
					14.69458314 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.45 kg/cm^3

T = 367.36 cm
= 3.674 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.674
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.674
= **8.08** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 34220.81 kg
= **34** t

Hence, the horizontal Load carrying capacity of the pile is taken as **34 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5-1)$ gm

Frictional resistance =	752.02	T
W_p =	39.024	T
so Q_{tu} =	540.373	T

safe Up Lift capacity with a factor of safety of 3 = Q_{tu}/3

	180.12	**T**
	SAY 180.00	**T**

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-07)

Dia = 1.2 m

Length = 20.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$$Q_u = R_u + R_f$$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D Nq)$$

$$= X' + Y' \quad \text{where;} \quad X' = A_p N_c c_p \quad \textit{For Cohesive Soil}$$

$$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q) \quad \textit{For Granular Soil}$$

The Ultimate Side Resistance of Pile due to friction is as follows:

$$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$$

$$= X + Y \quad \text{where;} \quad X = \Sigma^n_{i=1} \alpha_i c_i A_{si} \quad \textit{For Cohesive Soil}$$

$$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si} \quad \textit{For Granular Soil}$$

Where;

- A_p = cross sectional area of pile tip, in m^2
- N_c = bearing capacity factor, may be taken as " 9 "
- c_p = average cohesion at pile tip, in kN/m^2
- α_i = adhesion factor for the ith layer depending on the consistency of soil
- c_i = average cohesion for the ith layer, in kN/m^2
- A_p = cross sectional area of pile tip, in m^2
- D = diameter of the pile shaft, in m
- γ = effective unit weight of the soil at pile tip, in kN/m^2
- P_D = effective overburden pressure at pile tip, in kN/m^2
- $\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
- N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
- K_i = coefficient of Earth pressure applicable for the ith layer.
- P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2
- δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
- A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -07

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
9.000		2	7.00	7.00	27	1.783	0.03	25	Y
15.000	**2.000**	3	6.00	13.00	50	1.872	0.28	12	X
18.000		4	3.00	16.00	54	---	0.28	12	X
21.000		5	3.00	19.00	---	1.894	0.06	25	Y
22.000		6	1.00	20.00	68	1.933	0.32	10	X

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Bulk Density γ_b	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
7.00		7.00	1.783	12.481	12.481	6.24
13.00		6.00	1.872	11.232	18.000	15.24
16.00		3.00	1.872	5.616	18.000	18.00
19.00		3.00	1.894	5.682	18.000	18.00
20.00		1.00	1.933	1.933	18.000	18.00

No. of Zones Considered ***5***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	7.00	26.39	0.0	0.0	115.189			
Zone III	X	6.00	22.62	1.0	63.3	109.913	**557.410**	**2.500**	**222.964**
Zone IV	X	3.00	11.31	1.0	31.7	64.907			
Zone V	Y	3.00	11.31	0.0	0.0	142.393			
Zone V1	X	1.00	3.77	1.0	12.1	17.948			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil
$\mathbf{A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)}$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$\mathbf{A_p N_c C_p}$		
Ap	=	1.131
Nc	=	9.000
Cp	=	3.20
B.Capacity	=	**32.57**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap (0.5DγN$_\gamma$+P$_d$N$_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.93
ϕ	=	10.00
N_q	=	10.00
N_γ	=	1.22
B.Capacity	=	**205.18**

ϕ		$N\gamma$
10		1.22
15		2.65

Hence, B. Capacity = 237.75

Q_{safe} = **95.099** t

Total Q_{safe} = 222.97 + 95.1
= **318.06** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile = ***56.55*** ***t***
3. Net bearing capacity of pile = ***261.51*** ***t***
say ***262.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **262 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	20.00	m	> 4T
					14.38817702 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.50 kg/cm^3

T = 359.70 cm
= 3.597 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.598
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.598
= **7.91** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{3 E I}$$

Fixed Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{12 E I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12 EI Y}{(L_1 + L_f)^3}$

= 36453.97 kg
= **36** t

Hence, the horizontal Load carrying capacity of the pile is taken as **36 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 557.41 T

W_p = 33.934 T

so Q_{tu} = 405.540 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

135.18 T

SAY 135.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-07)

Dia = 1.2 m

Length = 23.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -07

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
9.000		2	7.00	7.00	27	1.783	0.03	25	Y
15.000	**2.000**	3	6.00	13.00	50	1.872	0.28	12	X
18.000		4	3.00	16.00	54	---	0.28	12	X
21.000		5	3.00	19.00	---	1.894	0.06	25	Y
25.000		6	4.00	23.00	68	1.933	0.32	10	X

Note*

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed and as available elsewhere in the literature.

Name of Project:	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.

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Bulk Density γ_b	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
7.00		7.00	1.783	12.481	12.481	6.24
13.00		6.00	1.872	11.232	18.000	15.24
16.00		3.00	1.872	5.616	18.000	18.00
19.00		3.00	1.894	5.682	18.000	18.00
23.00		4.00	1.933	7.732	18.000	18.00

No. of Zones Considered ***5***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**647.443**	**2.500**	**258.977**
Zone II	Y	7.00	26.39	0.0	0.0	115.189			
Zone III	X	6.00	22.62	1.0	63.3	109.913			
Zone IV	X	3.00	11.31	1.0	31.7	64.907			
Zone V	Y	3.00	11.31	0.0	0.0	142.393			
Zone V1	X	4.00	15.08	1.0	48.3	71.792			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	3.20
B.Capacity	=	**32.57**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap ($0.5D\gamma N_\gamma + P_d N_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.93
ϕ	=	10.00
N_q	=	10.00
N_γ	=	1.22
B.Capacity	=	**205.18**

ϕ		Nγ
10		1.22
15		2.65

Hence, B. Capacity = 237.75

Q_{safe} = **95.099** t

Total Q_{safe} = 258.98 + 95.1

= **354.08** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile = ***65.03*** ***t***
3. Net bearing capacity of pile = ***289.05*** ***t***

say ***289.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **289 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	23.00	m	> 4T
					14.38817702 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.50 kg/cm^3

T = 359.70 cm
= 3.597 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.598
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.598
= **7.91** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 36453.97 kg
= **36** t

Hence, the horizontal Load carrying capacity of the pile is taken as **36 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 647.44 T

W_p = 39.024 T

so Q_{tu} = 470.653 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

156.88 T

SAY 157.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-08)

Dia = 1.2 m

Length = 18.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -08

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
9.000	**2.000**	2	7.00	7.00	50	1.785	0.12	18	Y
15.000		3	6.00	13.00	59	1.863	0.15	17	Y
20.000		5	5.00	18.00	33	1.895	0.09	19	Y

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Bulk Density γ_b	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
7.00		7.00	1.785	12.495	12.495	6.25
13.00		6.00	1.863	11.178	18.000	15.25
18.00		5.00	1.895	9.475	18.000	18.00

No. of Zones Considered ***4***

Q_{safe} due friction

Zone	Component (X or Y)	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**413.760**	**2.500**	**165.504**
Zone II	Y	7.00	26.39	0.0	0.0	80.353			
Zone III	Y	6.00	22.62	0.0	0.0	158.165			
Zone IV	Y	5.00	18.85	0.0	0.0	175.241			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$\mathbf{A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)}$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$\mathbf{A_p N_c C_p}$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.90
B.Capacity	=	**9.16**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$\mathbf{Ap\ (0.5D\gamma N_\gamma P_d N_q)}$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.90
ϕ	=	19.00
N_q	=	10.00
N_γ	=	4.84
B.Capacity	=	**209.80**

ϕ		Nγ
15		2.65
20		5.39

Hence, B. Capacity = 218.96

Q_{safe} = **87.585** t

Total Q_{safe} = 165.51 + 87.59

= **253.09** t

1. Density of concrete = ***2.50*** ***t/m*** ^{3}
2. Salfe weight of pile = ***50.89*** ***t***
3. Net bearing capacity of pile = ***202.20*** ***t***

say ***202.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **202 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	18.00	m	> 4T
					14.38817702 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.50 kg/cm^3

T = 359.70 cm
= 3.597 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.598
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.598
= **7.91** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 36453.97 kg
= **36** t

Hence, the horizontal Load carrying capacity of the pile is taken as **36 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5-1)$ gm

Frictional resistance = 413.76 T

W_p = 30.540 T

so Q_{tu} = 306.380 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

102.13 T

SAY 102.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-09)

Dia = 1.2 m

Length = 25.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the "i^{th}" layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -09

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	---	---	0.15	18	Y
4.500	**2.000**	3	1.50	2.50	13	---	0.19	12	X
9.000		4	4.50	7.00	19	1.755	0.15	18	Y
15.000		5	6.00	13.00	17	1.832	0.25	12	X
21.000		6	6.00	19.00	25	1.878	0.18	14	Y
27.000		7	6.00	25.00	29	1.923	0.15	14	Y

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00		0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
2.50		1.50	1.000	1.500	2.500	1.75
7.00	2.000	4.50	1.000	4.500	7.000	4.75
13.00		6.00	1.000	6.000	13.000	10.00
19.00		6.00	1.000	6.000	18.000	15.50
25.00		6.00	1.000	6.000	18.000	18.00

No. of Zones Considered ***7***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	1.00	3.77	0.0	0.0	0.919			
Zone III	X	1.50	5.65	1.0	10.7	3.155			
Zone IV	Y	4.50	16.96	0.0	0.0	39.274	**466.150**	**2.500**	**186.460**
Zone V	X	6.00	22.62	1.0	56.6	72.119			
Zone VI	Y	6.00	22.62	0.0	0.0	131.122			
Zone VII	Y	6.00	22.62	0.0	0.0	152.271			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	1.50
B.Capacity	=	**15.27**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$Ap (0.5D\gamma N_\gamma + P_d N_q)$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	14.00
N_q	=	10.00
N_γ	=	2.36
B.Capacity	=	**205.18**

ϕ		Nγ
10		1.22
15		2.65

Hence, B. Capacity = 220.45

Q_{safe} = **88.179** t

Total Q_{safe} = 186.46 + 88.18

= **274.64** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***42.41*** ***t***
3. Net bearing capacity of pile = ***232.23*** ***t***

say ***232.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **232 ton in the design**

Name of Project:	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.

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	25.00	m	> 4T
					16.8056071 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.23 kg/cm^3

T = 420.14 cm
= 4.201 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 4.202
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 4.202
= **9.24** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\ (L_1 + L_f)^3}{3\ E\ I}$$

Fixed Head Piles

$$Y = \frac{Q\ (L_1 + L_f)^3}{12\ E\ I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\ EI\ Y}{(L_1 + L_f)^3}$

= 22877.02 kg
= **23** t

Hence, the horizontal Load carrying capacity of the pile is taken as **23 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5-1)$ gm

Frictional resistance = 466.15 T

W_p = 42.417 T

so Q_{tu} = 353.184 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

117.73 T

SAY 118.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-09)

Dia = 1.2 m

Length = 28.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$$Q_u = R_u + R_f$$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$$

$$= X' + Y' \quad \text{where;} \quad X' = A_p N_c c_p \quad \textit{For Cohesive Soil}$$

$$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q) \quad \textit{For Granular Soil}$$

The Ultimate Side Resistance of Pile due to friction is as follows:

$$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$$

$$= X + Y \quad \text{where;} \quad X = \Sigma^n_{i=1} \alpha_i c_i A_{si} \quad \textit{For Cohesive Soil}$$

$$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si} \quad \textit{For Granular Soil}$$

Where;

- A_p = cross sectional area of pile tip, in m^2
- N_c = bearing capacity factor, may be taken as " 9 "
- c_p = average cohesion at pile tip, in kN/m^2
- α_i = adhesion factor for the ith layer depending on the consistency of soil
- c_i = average cohesion for the ith layer, in kN/m^2
- A_p = cross sectional area of pile tip, in m^2
- D = diameter of the pile shaft, in m
- γ = effective unit weight of the soil at pile tip, in kN/m^2
- P_D = effective overburden pressure at pile tip, in kN/m^2
- $\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
- N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
- K_i = coefficient of Earth pressure applicable for the ith layer.
- P_{Di} = effective overburden pressure for the "i^{th}" layer, in kN/m^2
- δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
- A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -09

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	---	---	0.15	18	Y
4.500		3	1.50	2.50	13	---	0.19	12	X
9.000	**2.000**	4	4.50	7.00	19	1.755	0.15	18	Y
15.000		5	6.00	13.00	17	1.832	0.25	12	X
21.000		6	6.00	19.00	25	1.878	0.18	14	Y
27.000		7	6.00	25.00	29	1.923	0.15	14	Y
30.000		8	3.00	28.00	---	1.929	0.03	27	Y

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
2.50		1.50	1.000	1.500	2.500	1.75
7.00		4.50	1.000	4.500	7.000	4.75
13.00		6.00	1.000	6.000	13.000	10.00
19.00		6.00	1.000	6.000	18.000	15.50
25.00		6.00	1.000	6.000	18.000	18.00
28.00		3.00	1.000	3.000	18.000	18.00

No. of Zones Considered ***8***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**655.670**	**2.500**	**262.268**
Zone II	Y	1.00	3.77	0.0	0.0	0.919			
Zone III	X	1.50	5.65	1.0	10.7	3.155			
Zone IV	Y	4.50	16.96	0.0	0.0	39.274			
Zone V	X	6.00	22.62	1.0	56.6	72.119			
Zone VI	Y	6.00	22.62	0.0	0.0	131.122			
Zone VII	Y	6.00	22.62	1.0	33.9	152.271			
Zone VIII	Y	3.00	11.31	0.0	0.0	155.590			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.30
B.Capacity	=	**3.05**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$A_p (0.5 D \gamma N_\gamma, P_d N_q)$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	27.00
N_q	=	10.00
N_γ	=	15.49
B.Capacity	=	**214.09**

ϕ		Nγ
25		10.88
30		22.40

Hence, B. Capacity = 217.14

Q_{safe} = **86.855** t

Total Q_{safe} = 262.27 + 86.86

= **349.12** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***47.50*** ***t***
3. Net bearing capacity of pile = ***301.62*** ***t***

say ***302.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **302 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	28.00	m	> 4T
					16.8056071 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.23 kg/cm^3

T = 420.14 cm
= 4.201 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 4.202
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 4.202
= **9.24** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 22877.02 kg
= **23** t

Hence, the horizontal Load carrying capacity of the pile is taken as **23 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5-1)$ gm

Frictional resistance = 655.67 T

W_p = 47.507 T

so Q_{tu} = 484.620 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

161.54 T

SAY 162.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-10)

Dia = 1.2 m

Length = 34.00 m **From Bottom of the Pile Cap**

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

- A_p = cross sectional area of pile tip, in m^2
- N_c = bearing capacity factor, may be taken as " 9 "
- c_p = average cohesion at pile tip, in kN/m^2
- α_i = adhesion factor for the ith layer depending on the consistency of soil
- c_i = average cohesion for the ith layer, in kN/m^2
- A_p = cross sectional area of pile tip, in m^2
- D = diameter of the pile shaft, in m
- γ = effective unit weight of the soil at pile tip, in kN/m^2
- P_D = effective overburden pressure at pile tip, in kN/m^2
- $\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
- N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
- K_i = coefficient of Earth pressure applicable for the ith layer.
- P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2
- δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
- A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -10

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
12.000		2	10.00	10.00	8	1.801	0.02	25	Y
18.000	2.000	3	6.00	16.00	13	1.881	0.27	11	X
27.000		4	9.00	25.00	23	1.896	0.03	25	Y
33.000		5	6.00	31.00	64	1.943	0.04	24	Y
36.000		6	3.00	34.00	77	1.943	0.04	24	Y

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
10.00		10.00	1.000	10.000	10.000	5.00
16.00		6.00	1.000	6.000	16.000	13.00
25.00		9.00	1.000	9.000	18.000	17.00
31.00		6.00	1.000	6.000	18.000	18.00
34.00		3.00	1.000	3.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**811.316**	**2.500**	**324.526**
Zone II	Y	10.00	37.70	0.0	0.0	0.000			
Zone III	X	6.00	22.62	1.0	0.0	0.000			
Zone IV	Y	9.00	33.93	0.0	0.0	403.447			
Zone V	Y	6.00	22.62	0.0	0.0	271.913			
Zone VI	Y	3.00	11.31	0.0	0.0	135.956			

Due to liquefaction upto 18.0 m, Ultimate load capacity due to friction up to a depth of 18.0 m has not been considered.

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil
$\mathbf{A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)}$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$\mathbf{A_p N_c C_p}$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.40
B.Capacity	=	**4.07**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$\mathbf{Ap (0.5D\gamma N_\gamma P_d N_q)}$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	24.00
N_q	=	10.00
N_γ	=	9.78
B.Capacity	=	**210.21**

ϕ		Nγ
20		5.39
25		10.88

Hence, B. Capacity = 214.28

Q_{safe} = **85.714** t

Total Q_{safe} = 324.53 + 85.72
= **410.24** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***57.68*** ***t***
3. Net bearing capacity of pile = ***352.56*** ***t***

say ***353.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **353 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	34.00	m	> 4T
					27.39010985 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.02 kg/cm^3

T = 684.75 cm
= 6.848 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 6.848
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 6.848
= **15.06** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 5284.22 kg
= **5** t

Hence, the horizontal Load carrying capacity of the pile is taken as **5 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 811.32 T

W_p = 57.687 T

so Q_{tu} = 598.564 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

199.52 T

SAY 200.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-10)

Dia = 1.2 m

Length = 36.00 m **From Bottom of the Pile Cap**

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -10

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
12.000		2	10.00	10.00	8	1.801	0.02	25	Y
18.000	**2.000**	3	6.00	16.00	13	1.881	0.27	11	X
27.000		4	9.00	25.00	23	1.896	0.03	25	Y
33.000		5	6.00	31.00	64	1.943	0.04	24	Y
38.000		6	5.00	36.00	77	1.943	0.04	24	Y

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
10.00		10.00	1.000	10.000	10.000	5.00
16.00		6.00	1.000	6.000	16.000	13.00
25.00		9.00	1.000	9.000	18.000	17.00
31.00		6.00	1.000	6.000	18.000	18.00
36.00		5.00	1.000	5.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	$Q_u = X + Y$ t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	10.00	37.70	0.0	0.0	0.000			
Zone III	X	6.00	22.62	1.0	0.0	0.000	**901.953**	**2.500**	**360.781**
Zone IV	Y	9.00	33.93	0.0	0.0	403.447			
Zone V	Y	6.00	22.62	0.0	0.0	271.913			
Zone VI	Y	5.00	18.85	0.0	0.0	226.594			

Due to liquefaction upto 18.0 m, Ultimate load capacity due to friction up to a depth of 18.0 m has not been considered.

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$\mathbf{A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)}$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$\mathbf{A_p N_c C_p}$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.40
B.Capacity	=	**4.07**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$\mathbf{Ap (0.5D\gamma N_\gamma + P_d N_q)}$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	24.00
N_q	=	10.00
N_γ	=	9.78
B.Capacity	=	**210.21**

ϕ		$N\gamma$
20		5.39
25		10.88

Hence, B. Capacity = 214.28

Q_{safe} = **85.714** t

Total Q_{safe} = 360.79 + 85.72

= **446.50** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***61.07*** ***t***
3. Net bearing capacity of pile = ***385.42*** ***t***

say ***385.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **385 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	36.00	m	> 4T
					27.39010985 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.02 kg/cm^3

T = 684.75 cm
= 6.848 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 6.848
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 6.848
= **15.06** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 5284.22 kg
= **5** t

Hence, the horizontal Load carrying capacity of the pile is taken as **5 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 901.95 T

W_p = 61.080 T

so Q_{tu} = 662.383 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

220.79 T

SAY 221.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-10)

Dia = 1.2 m

Length = 38.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -10

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
12.000		2	10.00	10.00	8	1.801	0.02	25	Y
18.000	**2.000**	3	6.00	16.00	13	1.881	0.27	11	X
27.000		4	9.00	25.00	23	1.896	0.03	25	Y
33.000		5	6.00	31.00	64	1.943	0.04	24	Y
40.000		6	7.00	38.00	77	1.943	0.04	24	Y

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t/m^3	t/m^2	t/m^2	t/m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
10.00		10.00	1.000	10.000	10.000	5.00
16.00		6.00	1.000	6.000	16.000	13.00
25.00		9.00	1.000	9.000	18.000	17.00
31.00		6.00	1.000	6.000	18.000	18.00
38.00		7.00	1.000	7.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	$Q_u = X + Y$ t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	10.00	37.70	0.0	0.0	0.000			
Zone III	X	6.00	22.62	1.0	0.0	0.000	**992.591**	**2.500**	**397.036**
Zone IV	Y	9.00	33.93	0.0	0.0	403.447			
Zone V	Y	6.00	22.62	0.0	0.0	271.913			
Zone VI	Y	7.00	26.39	0.0	0.0	317.231			

Due to liquefaction upto 18.0 m, Ultimate load capacity due to friction up to a depth of 18.0 m has not been considered.

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil

$$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.40
B.Capacity	=	**4.07**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$Ap (0.5D\gamma N_\gamma, P_d N_q)$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	24.00
N_q	=	10.00
N_γ	=	9.78
B.Capacity	=	**210.21**

ϕ		Nγ
20		5.39
25		10.88

Hence, B. Capacity = 214.28

Q_{safe} = **85.714** t

Total Q_{safe} = 397.04 + 85.72
= **482.75** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***64.47*** ***t***
3. Net bearing capacity of pile = ***418.28*** ***t***

say ***418.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **418 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	38.00	m	> 4T
					27.39010985 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.02 kg/cm^3

T = 684.75 cm
= 6.848 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 6.848
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 6.848
= **15.06** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 5284.22 kg
= **5** t

Hence, the horizontal Load carrying capacity of the pile is taken as **5 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 992.59 T

W_p = 64.474 T

so Q_{tu} = 726.201 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

242.07 T

SAY 242.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-11)

Dia = 1.2 m

Length = 23.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p	=	cross sectional area of pile tip, in m^2
N_c	=	bearing capacity factor, may be taken as " 9 "
c_p	=	average cohesion at pile tip, in kN/m^2
α_i	=	adhesion factor for the ith layer depending on the consistency of soil
c_i	=	average cohesion for the ith layer, in kN/m^2
A_p	=	cross sectional area of pile tip, in m^2
D	=	diameter of the pile shaft, in m
γ	=	effective unit weight of the soil at pile tip, in kN/m^2
P_D	=	effective overburden pressure at pile tip, in kN/m^2
$\Sigma^n_{i=1}$	=	summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
N_γ & N_q	=	bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
K_i	=	coefficient of Earth pressure applicable for the ith layer.
P_{Di}	=	effective overburden pressure for the " i^{th} " layer, in kN/m^2
δ	=	angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
A_{si}	=	surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -11

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	---	1.754	0.04	23	Y
9.000	**2.000**	3	6.00	7.00	14	1.796	0.04	25	Y
15.000		4	6.00	13.00	26	1.863	0.26	13	X
20.000		5	5.00	18.00	32	1.886	0.02	27	Y
25.000		6	5.00	23.00	37	1.918	0.02	26	Y

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
7.00		6.00	1.000	6.000	7.000	4.00
13.00		6.00	1.000	6.000	13.000	10.00
18.00		5.00	1.000	5.000	18.000	15.50
23.00		5.00	1.000	5.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y K P_{Di} tanδ A_{si}	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**671.954**	**2.500**	**268.782**
Zone II	Y	1.00	3.77	0.0	0.0	0.000			
Zone III	Y	6.00	22.62	0.0	0.0	63.286			
Zone IV	X	6.00	22.62	1.0	58.8	78.332			
Zone V	Y	5.00	18.85	0.0	0.0	223.301			
Zone VI	Y	5.00	18.85	0.0	0.0	248.226			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil
$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.20
B.Capacity	=	**2.04**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap ($0.5D\gamma N_\gamma + P_d N_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	26.00
N_q	=	13.00
N_γ	=	13.18
B.Capacity	=	**273.59**

ϕ		Nγ
25		10.88
30		22.40

Hence, B. Capacity = 275.63

Q_{safe} = **110.252** t

Total Q_{safe} = 268.79 + 110.26
= **379.03** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***39.02*** ***t***
3. Net bearing capacity of pile = ***340.01*** ***t***

say ***340.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **340 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	23.00	m	> 4T
					16.52767527 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.25 kg/cm^3

T = 413.19 cm
= 4.132 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 4.132
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 4.132
= **9.09** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 24050.65 kg
= **24** t

Hence, the horizontal Load carrying capacity of the pile is taken as **24 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5-1)$ gm

Frictional resistance = 671.95 T

W_p = 39.024 T

so Q_{tu} = 486.993 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

162.33 T

SAY 162.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-11)

Dia = 1.2 m

Length = 25.00 m **From Bottom of the Pile Cap**

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -11

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	---	1.754	0.04	23	Y
9.000	**2.000**	3	6.00	7.00	14	1.796	0.04	25	Y
15.000		4	6.00	13.00	26	1.863	0.26	13	X
20.000		5	5.00	18.00	32	1.886	0.02	27	Y
27.000		6	7.00	25.00	37	1.918	0.02	26	Y

Design Parameters

Pile Diameter = 1.200 m
K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
7.00		6.00	1.000	6.000	7.000	4.00
13.00		6.00	1.000	6.000	13.000	10.00
18.00		5.00	1.000	5.000	18.000	15.50
25.00		7.00	1.000	7.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	1.00	3.77	0.0	0.0	0.000			
Zone III	Y	6.00	22.62	0.0	0.0	63.286			
Zone IV	X	6.00	22.62	1.0	58.8	78.332	**771.244**	**2.500**	**308.498**
Zone V	Y	5.00	18.85	0.0	0.0	223.301			
Zone VI	Y	7.00	26.39	0.0	0.0	347.516			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil
$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.20
B.Capacity	=	**2.04**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap (0.5DγNγ+PdNq)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	26.00
N_q	=	13.00
N_γ	=	13.18
B.Capacity	=	**273.59**

ϕ		Nγ
25		10.88
30		22.40

Hence, B. Capacity = 275.63

Q_{safe} = **110.252** t

Total Q_{safe} = 308.5 + 110.26
= **418.75** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***42.41*** ***t***
3. Net bearing capacity of pile = ***376.34*** ***t***

say ***376.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **376 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	25.00	m	> 4T
					16.52767527 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.25 kg/cm^3

T = 413.19 cm
= 4.132 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 4.132
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 4.132
= **9.09** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{3 E I}$$

Fixed Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{12 E I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12 EI Y}{(L_1 + L_f)^3}$

= 24050.65 kg
= **24** t

Hence, the horizontal Load carrying capacity of the pile is taken as **24 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 771.24 T

W_p = 42.417 T

so Q_{tu} = 556.580 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

185.53 T

SAY 186.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-11)

Dia = 1.2 m

Length = 27.00 m **From Bottom of the Pile Cap**

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -11

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	---	1.754	0.04	23	Y
9.000	**2.000**	3	6.00	7.00	14	1.796	0.04	25	Y
15.000		4	6.00	13.00	26	1.863	0.26	13	X
21.000		5	6.00	19.00	32	1.886	0.02	27	Y
29.000		6	8.00	27.00	37	1.937	0.03	27	Y

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t/m^3	t/m^2	t/m^2	t/m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
7.00		6.00	1.000	6.000	7.000	4.00
13.00		6.00	1.000	6.000	13.000	10.00
19.00		6.00	1.000	6.000	18.000	15.50
27.00		8.00	1.000	8.000	18.000	18.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	$Q_u = X + Y$ t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	1.00	3.77	0.0	0.0	0.000			
Zone III	Y	6.00	22.62	0.0	0.0	63.286			
Zone IV	X	6.00	22.62	1.0	58.8	78.332	**883.295**	**2.500**	**353.318**
Zone V	Y	6.00	22.62	0.0	0.0	267.961			
Zone VI	Y	8.00	30.16	0.0	0.0	414.907			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level
For c-ϕ Soil

$$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.30
B.Capacity	=	**3.05**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$Ap (0.5D\gamma N_\gamma, P_d N_q)$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	27.00
N_q	=	14.00
N_γ	=	15.49
B.Capacity	=	**295.52**

ϕ		Nγ
25		10.88
30		22.40

Hence, B. Capacity = 298.57

Q_{safe} = **119.428** t

Total Q_{safe} = 353.32 + 119.43

= **472.75** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***45.80*** ***t***
3. Net bearing capacity of pile = ***426.94*** ***t***

say ***427.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **427 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	27.00	m	> 4T
					16.52767527 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.25 kg/cm^3

T = 413.19 cm
= 4.132 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 4.132
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 4.132
= **9.09** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\ (L_1 + L_f)^3}{3\ E\ I}$$

Fixed Head Piles

$$Y = \frac{Q\ (L_1 + L_f)^3}{12\ E\ I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\ EI\ Y}{(L_1 + L_f)^3}$

= 24050.65 kg
= **24** t

Hence, the horizontal Load carrying capacity of the pile is taken as **24 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 883.30 T

W_p = 45.810 T

so Q_{tu} = 634.674 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

211.56 T

SAY 212.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-11A)

Dia = 1.2 m

Length = 23.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p = cross sectional area of pile tip, in m^2

N_c = bearing capacity factor, may be taken as " 9 "

c_p = average cohesion at pile tip, in kN/m^2

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for the ith layer, in kN/m^2

A_p = cross sectional area of pile tip, in m^2

D = diameter of the pile shaft, in m

γ = effective unit weight of the soil at pile tip, in kN/m^2

P_D = effective overburden pressure at pile tip, in kN/m^2

$\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.

K_i = coefficient of Earth pressure applicable for the ith layer.

P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2

δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).

A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -11A

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	---	1.776	0.04	25	Y
6.000	**2.000**	3	3.00	4.00	5	1.802	0.02	26	Y
15.000		4	9.00	13.00	11	1.876	0.25	14	X
18.000		5	3.00	16.00	56	1.903	0.16	19	Y
25.000		6	7.00	23.00	66	---	0.02	25	Y

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed based on our experience and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
4.00		3.00	1.000	3.000	4.000	2.50
13.00		9.00	1.000	9.000	13.000	8.50
16.00		3.00	1.000	3.000	16.000	14.50
23.00		7.00	1.000	7.000	18.000	17.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	1.00	3.77	0.0	0.0	0.000			
Zone III	Y	3.00	11.31	0.0	0.0	20.685			
Zone IV	X	9.00	33.93	1.0	84.8	107.859	**611.856**	**2.500**	**244.742**
Zone V	Y	3.00	11.31	0.0	0.0	84.700			
Zone VI	Y	7.00	26.39	0.0	0.0	313.792			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.20
B.Capacity	=	**2.04**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$Ap (0.5D\gamma N_\gamma + P_d N_q)$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	25.00
N_q	=	10.00
N_γ	=	10.88
B.Capacity	=	**210.96**

ϕ		$N\gamma$
25		10.88
30		22.40

Hence, B. Capacity = 212.99

Q_{safe} = **85.198** t

Total Q_{safe} = 244.75 + 85.2

= **329.94** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***39.02*** ***t***
3. Net bearing capacity of pile = ***290.92*** ***t***

say ***291.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **291 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	23.00	m	> 4T
					12.79237763 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.90 kg/cm^3

T = 319.81 cm
= 3.198 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.199
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.199
= **7.04** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 51869.05 kg
= **52** t

Hence, the horizontal Load carrying capacity of the pile is taken as **52 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 611.86 T

W_p = 39.024 T

so Q_{tu} = 446.928 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

148.98 T

SAY 149.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-11A)

Dia = 1.2 m

Length = 25.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

- A_p = cross sectional area of pile tip, in m^2
- N_c = bearing capacity factor, may be taken as " 9 "
- c_p = average cohesion at pile tip, in kN/m^2
- α_i = adhesion factor for the ith layer depending on the consistency of soil
- c_i = average cohesion for the ith layer, in kN/m^2
- A_p = cross sectional area of pile tip, in m^2
- D = diameter of the pile shaft, in m
- γ = effective unit weight of the soil at pile tip, in kN/m^2
- P_D = effective overburden pressure at pile tip, in kN/m^2
- $\Sigma^n_{i=1}$ = summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
- N_γ & N_q = bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
- K_i = coefficient of Earth pressure applicable for the ith layer.
- P_{Di} = effective overburden pressure for the " i^{th} " layer, in kN/m^2
- δ = angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
- A_{si} = surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -11A

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t / m^3	kg / cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	---	1.776	0.04	25	Y
6.000	2.000	3	3.00	4.00	5	1.802	0.02	26	Y
15.000		4	9.00	13.00	11	1.876	0.25	14	X
18.000		5	3.00	16.00	56	1.903	0.16	19	Y
27.000		6	9.00	25.00	66	---	0.02	25	Y

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed based on our experience and as available elsewhere in the literature.

Name of Project:	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.

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
4.00		3.00	1.000	3.000	4.000	2.50
13.00		9.00	1.000	9.000	13.000	8.50
16.00		3.00	1.000	3.000	16.000	14.50
25.00		9.00	1.000	9.000	18.000	17.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000	**701.511**	**2.500**	**280.604**
Zone II	Y	1.00	3.77	0.0	0.0	0.000			
Zone III	Y	3.00	11.31	0.0	0.0	20.685			
Zone IV	X	9.00	33.93	1.0	84.8	107.859			
Zone V	Y	3.00	11.31	0.0	0.0	84.700			
Zone VI	Y	9.00	33.93	0.0	0.0	403.447			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$\mathbf{A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)}$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$\mathbf{A_p N_c C_p}$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.20
B.Capacity	=	**2.04**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
$\mathbf{Ap (0.5D\gamma N_\gamma + P_d N_q)}$		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	25.00
N_q	=	10.00
N_γ	=	10.88
B.Capacity	=	**210.96**

ϕ		Nγ
25		10.88
30		22.40

Hence, B. Capacity = 212.99

Q_{safe} = **85.198** t

Total Q_{safe} = 280.61 + 85.2

= **365.80** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***42.41*** ***t***
3. Net bearing capacity of pile = ***323.39*** ***t***

say ***323.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **323 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	25.00	m	> 4T
					12.79237763 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.90 kg/cm^3

T = 319.81 cm
= 3.198 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.199
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.199
= **7.04** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 51869.05 kg
= **52** t

Hence, the horizontal Load carrying capacity of the pile is taken as **52 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 701.51 T

W_p = 42.417 T

so Q_{tu} = 510.091 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

170.03 T

SAY 170.00 T

CALCULATION OF LOAD CARRYING CAPACITY OF PILE

Calculation of load carrying capacity of bored cast in-situ pile considering

Pier (BH NO-11A)

Dia = 1.2 m

Length = 27.00 m From Bottom of the Pile Cap

Vertical Load Carrying Capacity

As per IRC:78-2014 (Appendix-5) & IS : 2911 Part I / Sec 2 - 2010 (Appendix B)

Axial Capacity of Piles in Soil - Static Formula

Ultimate Load Carrying Capacity (Qu) of a Pile is given by :

$Q_u = R_u + R_f$

Where, R_u = Ultimate Base Resistance

R_f = Ultimate Shaft Resistance

The Ultimate Base Resistance of Pile is as follows:

$R_u = A_p N_c c_p + Ap (0.5 D\gamma N_\gamma + P_D N_q)$

$= X' + Y'$ where; $X' = A_p N_c c_p$ *For Cohesive Soil*

$Y' = A_p (0.5 D\gamma N_\gamma + P_D N_q)$ *For Granular Soil*

The Ultimate Side Resistance of Pile due to friction is as follows:

$R_f = \Sigma^n_{i=1} \alpha_i c_i A_{si} + \Sigma K P_{Di} \tan \delta_i A_{si}$

$= X + Y$ where; $X = \Sigma^n_{i=1} \alpha_i c_i A_{si}$ *For Cohesive Soil*

$Y = \Sigma^n_{i=1} K_i P_{Di} \tan \delta_i A_{si}$ *For Granular Soil*

Where;

A_p	=	cross sectional area of pile tip, in m^2
N_c	=	bearing capacity factor, may be taken as " 9 "
c_p	=	average cohesion at pile tip, in kN/m^2
α_i	=	adhesion factor for the ith layer depending on the consistency of soil
c_i	=	average cohesion for the ith layer, in kN/m^2
A_p	=	cross sectional area of pile tip, in m^2
D	=	diameter of the pile shaft, in m
γ	=	effective unit weight of the soil at pile tip, in kN/m^2
P_D	=	effective overburden pressure at pile tip, in kN/m^2
$\Sigma^n_{i=1}$	=	summation for layers 1 to n in which pile is installed and which contribute to positive skin friction.
N_γ & N_q	=	bearing capacity factors depending upon the angle of internal friction "ϕ" at pile tip.
K_i	=	coefficient of Earth pressure applicable for the ith layer.
P_{Di}	=	effective overburden pressure for the " i^{th} " layer, in kN/m^2
δ	=	angle of wall friction between pile and soil, in degrees (may be taken equal to ϕ).
A_{si}	=	surface area of pile shaft in the ith layer, in m^2

Presented below is in tabular form the various soil parameters as encountered through the Bore hole

Bore hole Location -11A

Levels		Layer	Thickness of the strata	Depth from Bed	Average SPT N value	Bulk Density γ_b	c	ϕ	Compnent (X or Y)
0.000			(m)	(m)		t/m^3	kg/cm^2	(degrees)	
2.000		1	0.00	0.00	---	---	0.00	0	
3.000		2	1.00	1.00	---	1.776	0.04	25	Y
6.000	**2.000**	3	3.00	4.00	5	1.802	0.02	26	Y
15.000		4	9.00	13.00	11	1.876	0.25	14	X
18.000		5	3.00	16.00	56	1.903	0.16	19	Y
29.000		6	11.00	27.00	---	---	0.02	25	Y

The values of c and ϕ, strength parameters, where ever not evaluated by testing have been assumed based on our experience and as available elsewhere in the literature.

Design Parameters

Pile Diameter = 1.200 m

K = 1.50

Calculated below is the Avg. Overburden pressure at different layers.

Depth from Bed	Scour Level from Bed	Depth of Strata	Submerged Density γ_{sub}	Overburden Pressure of thickness of the strata	Cumulative Overburden Pressure	Avg. Overburden Pressure of ith layer (thickness of the strata)
(m)	(m)	(m)	t / m^3	t / m^2	t / m^2	t / m^2
0.00	2.000	0.00	0.000	0.000	0.000	0.00
1.00		1.00	1.000	1.000	1.000	0.50
4.00		3.00	1.000	3.000	4.000	2.50
13.00		9.00	1.000	9.000	13.000	8.50
16.00		3.00	1.000	3.000	16.000	14.50
27.00		11.00	1.000	11.000	18.000	17.00

No. of Zones Considered ***6***

Q_{safe} due friction

Zone	Component (X or	Depth (m)	A_{si} (m^2)	α	X $\alpha C' A_s$	Y $K P_{Di} \tan\delta A_{si}$	Q_u = X + Y t	Factor of Safety	Q_{safe} t
Zone I	0	0.00	0.00	0.0	0.0	0.000			
Zone II	Y	1.00	3.77	0.0	0.0	0.000			
Zone III	Y	3.00	11.31	0.0	0.0	20.685			
Zone IV	X	9.00	33.93	1.0	84.8	107.859	**791.166**	**2.500**	**316.466**
Zone V	Y	3.00	11.31	0.0	0.0	84.700			
Zone VI	Y	11.00	41.47	0.0	0.0	493.102			

Q_{safe} due to end bearing

End Bearing Capacity of pile at founding level

For c-ϕ Soil

$A_p N_c C_p + A_p (0.5 D \gamma N_\gamma + P_d N_q)$

Where

End Bearing Capacity of pile at founding level		
For Cohesive Soil		
$A_p N_c C_p$		
Ap	=	1.131
Nc	=	9.000
Cp	=	0.20
B.Capacity	=	**2.04**

and

End Bearing Capacity of pile at founding level		
For Granular Soil		
Ap ($0.5D\gamma N_\gamma$,$P_d N_q$)		
Ap	=	1.131
D	=	1.200
Pd	=	18.00
γ	=	1.00
ϕ	=	25.00
N_q	=	10.00
N_γ	=	10.88
B.Capacity	=	**210.96**

ϕ		$N\gamma$
25		10.88
30		22.40

Hence, B. Capacity = 212.99

Q_{safe} = **85.198** t

Total Q_{safe} = 316.47 + 85.2

= **401.66** t

1. Density of concrete = ***2.50*** ***t/m^3***
2. Salfe weight of pile (Buoyant) = ***45.80*** ***t***
3. Net bearing capacity of pile = ***355.86*** ***t***

say ***356.00*** ***t***

Hence, the vertical Load carrying capacity of the pile is taken as **356 ton in the design**

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assume)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	$\Pi\ d^4 / 64$		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	27.00	m	> 4T
					12.79237763 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.90 kg/cm^3

T = 319.81 cm
= 3.198 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.199
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20 for pile in sand

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.199
= **7.04** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{3\,E\,I}$$

Fixed Head Piles

$$Y = \frac{Q\,(L_1 + L_f)^3}{12\,E\,I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12\,EI\,Y}{(L_1 + L_f)^3}$

= 51869.05 kg
= **52** t

Hence, the horizontal Load carrying capacity of the pile is taken as **52 ton for the design**

ESTIMATION OF UP-LIFT CAPACITY

In the worst case of submergance the first part of the expression representing end bearing resistance is neglected, and in its place submerged weight of the pile is taken to add towards the ultimate capacity of pile.

In the instant case therefore the ultimate uplift capacity of pile (Q_{tu}) shall be given by

Q_{tu} = (2/3) rd of frictional resistance + W_p

where W_p = Submerged weight of pile = $(3.141/4)\times D^2\times L\times(2.5\text{-}1)$ gm

Frictional resistance = 791.17 T

W_p = 45.810 T

so Q_{tu} = 573.254 T

safe Up Lift capacity with a factor of safety of 3 = $Q_{tu}/3$

191.08 T

SAY 191.00 T

PILE LOAD CALCULATION BY FORMULA
(As per Method-1 of IRC: 78 - 2014)
Pier (BH No- 12)
Length of pile=12.00 m and Dia. = 1.2 m

Pile Dia (D)=		**1200** mm
Ksp = Empirical Co-efficient (0.3 to 1.2)		**0.3**
qc = Ave. Compressive strength of rock core =		**36.00** N/mm^2
		As per IRC-78 Appendix-5 (709.3.1)
d = Dia of socket =		1200.00 mm
l = length of socket as per IRC:78-2014		300.00 mm
d_f = Depth factor = 1 + 0.4 (length of socket / dia of socket) =		1.1
Ab = Cross-sectional area of pile at base =	$0.785 \times D^2$ =	1130400.00 mm^2
As = Surface area of socket =	$3.142 \times d \times l$ =	1131120.00 mm^2
C_{us} = Ultimate shear along the socket of normal rock = $0.225 X (q_c)^{0.5}$		**1.35** N/mm^2
Re = Ultimate end bearing = Ksp.qc.df.Ab =		13429152
Raf = Ultimate side socket shear = As.Cus =		1527012

Qa = Ultimate load carrying capacity of pile = Re + R_{af} = Ksp.q_c.d_f.A_b + A_s.q_s = 14956164 Newton

Considering factor of safety as per Clause 709.3.2 of IRC:78-2014

Safe load carrying capacity of pile = Qs = Re/3 + Raf/6= Ksp.qc.df.Ab/3 + As.qs/6

Qs = 4730886 Newton

= 473.09 Ton

SAY = 473 Ton

Horizontal Load Carrying Capacity

As per IS : 2911 Part I / Sec 2 - 1979 (Appendix C)

1.	Pile Diameter	=	1.200	m	
2.	Concrete design mix strength	=	35	Mpa	(Assumed)
3.	Modulus of elasticity of Concrete (E_c)	=	5000 x sqrt (35)		
		=	295804.0	kg / cm^2	
4.	Moment of Inertia (I)	=	Π d^4 / 64		
		=	0.10179	m^4	
		=	10178760.2	cm^4	
5.	Embeded Length of Pile (L_e)	=	19.955	m	> 4T
					14.39 m

The depth of fixity is determined from the codal provisions and the graph given there.

From Table we get n_h = 0.50 kg/cm^3 (Assumed)

T = 359.70 cm
= 3.597 m

Free Length of pile (L_1) = Pile cap bottom Level - Scour Level

L_1 = **0.000** m

Hence; L_1 / T = 0 / 3.598
= 0.00

Therefore from the graph we read the corresponding value of " **L_f / T** ".

L_f / T = 2.20

Hence;

Equivalent Cantilever Length L_f = 2.2 x 3.598
= **7.91** m

The pile head deflection is calculated by " **Y** "

Free Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{3 E I}$$

Fixed Head Piles

$$Y = \frac{Q (L_1 + L_f)^3}{12 E I}$$

In our case the piles are considered to be Fixed Head piles

Considering an allowable deflection of 0.5 cm (say) at Scour Level

Lateral Load at Pile top; $Q = \frac{12 EI Y}{(L_1 + L_f)^3}$

= 36453.97 kg
= **36** t

Hence, the horizontal Load carrying capacity of the pile is taken as **36 ton for the design**

ESTIMATION OF UPLIFT LOAD CARRYING CAPACITY

Frictional Resistance

d = Dia of socket =		1200.00	mm	
l = length of pile from bottom of the pile cap		10.00	m	
l = length of socket as per IRC:78-2014		300.00	mm	As per IRC-78 clause 709.3.6.2
As = Surface area of socket =	3.142 x d x l =	1131120.00	mm^2	
qc = Ave. Compressive strength of rock core =		**36.00**	N/mm^2	As per IRC-78 Appendix-5 (709.3.1)
C_{us} = Ultimate shear along the socket of normal rock = $0.225 X (q_c)^{0.5}$		**1.35**	N/mm^2	
Raf = Ultimate side socket shear = As.Cus =		1527012	N	
		152.7012	T	
Factor of safety		3.5		
Safe Frictional resistsnce with factor of safety		43.63	T	

ultimate uplift capacity of pile (Q_{tu}) shall be given by

$$Q_{tu} = \text{frictional resistance} + W_p$$

where W_p = Submerged weight of pile = $(3.141/4)\times d^2\times L\times(2.5-1)$ T

W_p = 26.51 T

Frictional resistance = 43.63 T

So Q_{tu} = 70.136 T

say 70 T

Hence, the uplift load carrying capacity of the pile is **70 ton for the design**

Before execution of the construction work initial load test on pile shall be conducted as per IS:2911(Part-4)

ANNEXURE-D
CALCULATION OF SAFE BEARING CAPACITY

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF ABUTMENT (BH No-02)

Bh No		2	
Depth of Foundation =		2	m
Cohesion C =		0.28	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		10	Degree
ϕ' =		7	Degree
Void ratio	e =	0.7	Medium
Specific Gravity	Gs =	2.7	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.2	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
10	8.35	2.47	1.22		
7	7.234	1.93	0.758		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.420				

Depth Factors | **Inclination Factors**

dc = 1.06 **d_q=** 1.00 **d_γ =** 1.00 **i_c=i_q** 1.0 **i_γ** 1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure: Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 2.875 + 0.334 + 0.163

= 3.372 Kg/cm^2

For local shear failure: Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.660 + 0.228 + 0.109

= 1.997 Kg/cm^2

from interpolation Qd = 2.341

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 9 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF ABUTMENT (BH No-02)

Bh No		2	
Depth of Foundation =		3	m
Cohesion C =		0.28	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		10	Degree
ϕ' =		7	Degree
Void ratio	e =	0.7	Medium
Specific Gravity	Gs =	2.7	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.3	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
10	8.35	2.47	1.22		
7	7.234	1.93	0.758		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.420				

Depth Factors | **Inclination Factors**

dc =	1.089	**d_q=**	1.00	**d_γ =**	1.00	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure: Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 2.953 + 0.501 + 0.163

= 3.617 Kg/cm^2

For local shear failure: Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.706 + 0.341 + 0.109

= 2.156 Kg/cm^2

from interpolation Qd = 2.521

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 10 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF ABUTMENT (BH No-02)

Bh No		2	
Depth of Foundation =		4	m
Cohesion C =		0.28	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		10	Degree
ϕ' =		7	Degree
Void ratio	e =	0.7	Medium
Specific Gravity	Gs =	2.7	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
$q = (Df \times \gamma_{sub}) / 10$		0.4	Kg/cm^2
$B\gamma = (B \times \gamma_{sub}) / 10$		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
10	8.35	2.47	1.22		
7	7.234	1.93	0.758		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.420				

Depth Factors **Inclination Factors**

dc =	1.119	**d_q=**	1.00	**d_γ =**	1.00	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure $Qd = CNcscdcic + q(Nq - 1)sqdqiq + 0.5B\gamma N\gamma s\gamma d\gamma i\gamma W'$

= 3.035 + 0.668 + 0.163

= 3.866 Kg/cm^2

For local shear failure $Qd = 2/3CNc'sc'dc'ic' + q(Nq' - 1)sq'dq'iq' + 0.5B\gamma N\gamma's\gamma'd\gamma'i\gamma'W'$

= 1.753 + 0.454 + 0.109

= 2.316 Kg/cm^2

from interpolation Qd = 2.704

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 11 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF PIER (BH-03)

Bh No		3	
Depth of Foundation =		2	m
Cohesion C =		0.3	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		13	Degree
ϕ' =		9	Degree
Void ratio	e =	0.69	Medium
Specific Gravity	Gs =	2.68	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.2	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
13	9.928	3.352	2.078		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.580				

Depth Factors | **Inclination Factors**

dc = 1.063 **d_q=** 1.03 **d_γ =** 1.03 **i_c=i_q** 1.0 **i_γ** 1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 3.673 + 0.551 + 0.286

= 4.510 Kg/cm^2

For local shear failure Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.876 + 0.28 + 0.135

= 2.291 Kg/cm^2

from interpolation Qd = 2.957

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 12 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH-03)

Bh No		3	
Depth of Foundation =		3	m
Cohesion C =		0.3	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		13	Degree
ϕ' =		9	Degree
Void ratio	e =	0.69	Medium
Specific Gravity	Gs =	2.68	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.3	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
13	9.928	3.352	2.078		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.580				

Depth Factors | **Inclination Factors**

dc = 1.094 **d_q=** 1.05 **d_γ =** 1.05 **i_c=i_q** 1.0 **i_γ** 1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 3.780 + 0.84 + 0.29

= 4.910 Kg/cm^2

For local shear failure Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.930 + 0.426 + 0.137

= 2.493 Kg/cm^2

from interpolation Qd = 3.218

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 13 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH-03)

Bh No		3	
Depth of Foundation =		4	m
Cohesion C =		0.3	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		13	Degree
ϕ' =		9	Degree
Void ratio	e =	0.69	Medium
Specific Gravity	Gs =	2.68	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.4	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
13	9.928	3.352	2.078		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.580				

Depth Factors | **Inclination Factors**

dc =	1.126	**d_q=**	1.06	**d_γ =**	1.06	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 3.890 + 1.137 + 0.294

= 5.321 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.987 + 0.576 + 0.139

= 2.702 Kg/cm^2

from interpolation Qd = 3.488

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 14 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF PIER (BH NO-4)

Bh No		4	
Depth of Foundation =		2	m
Cohesion C =		0.28	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		14	Degree
ϕ' =		9	Degree
Void ratio	e =	0.65	Medium
Specific Gravity	Gs =	2.65	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.2	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
14	10.454	3.646	2.364		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.638				

Depth Factors | **Inclination Factors**

dc =	1.064	**d_q=**	1.03	**d_γ =**	1.03	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 3.613 + 0.621 + 0.325

= 4.559 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.752 + 0.28 + 0.135

= 2.167 Kg/cm^2

from interpolation Qd = 3.363

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 13 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH NO-4)

Bh No		4	
Depth of Foundation =		3	m
Cohesion C =		0.28	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		14	Degree
ϕ' =		9	Degree
Void ratio	e =	0.65	Medium
Specific Gravity	Gs =	2.65	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.3	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
14	10.454	3.646	2.364		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.638				

Depth Factors | **Inclination Factors**

dc =	1.096	**d_q=**	1.05	**d_γ =**	1.05	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 3.721 + 0.946 + 0.33

= 4.997 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.805 + 0.426 + 0.137

= 2.368 Kg/cm^2

from interpolation Qd = 3.683

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 15 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH NO-4)

Bh No		4	
Depth of Foundation =		4	m
Cohesion C =		0.28	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		14	Degree
ϕ' =		9	Degree
Void ratio	e =	0.65	Medium
Specific Gravity	Gs =	2.65	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.4	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
14	10.454	3.646	2.364		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.638				

Depth Factors | **Inclination Factors**

dc =	1.128	**d_q=**	1.06	**d_γ =**	1.06	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 3.830 + 1.28 + 0.335

= 5.445 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.858 + 0.577 + 0.139

= 2.574 Kg/cm^2

from interpolation Qd = 4.010

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 16 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF PIER (BH NO-5)

Bh No		5	
Depth of Foundation =		2	m
Cohesion C =		0.1	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		19	Degree
ϕ' =		13	Degree
Void ratio	e =	0.67	Medium
Specific Gravity	Gs =	2.67	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.2	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
19	14.06	5.908	4.842		
13	9.928	3.352	2.078		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.965				

Depth Factors | **Inclination Factors**

dc =	1.07	**d_q=**	1.04	**d_γ =**	1.04	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure $Qd = CNcscdcic + q(Nq - 1)sqdqiq + 0.5B\gamma N\gamma s\gamma d\gamma i\gamma W'$

= 1.745 + 1.155 + 0.668

= 3.568 Kg/cm^2

For local shear failure $Qd = 2/3CNc'sc'dc'ic' + q(Nq' - 1)sq'dq'iq' + 0.5B\gamma N\gamma's\gamma'd\gamma'i\gamma'W'$

= 0.822 + 0.596 + 0.308

= 1.726 Kg/cm^2

from interpolation Qd = 2.463

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 10 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH NO-5)

Bh No		5	
Depth of Foundation =		3	m
Cohesion C =		0.1	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		19	Degree
ϕ' =		13	Degree
Void ratio	e =	0.67	Medium
Specific Gravity	Gs =	2.67	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.3	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
19	14.06	5.908	4.842		
13	9.928	3.352	2.078		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.965				

Depth Factors | **Inclination Factors**

dc =	1.105	**d_q=**	1.05	**d_γ =**	1.05	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 1.802 + 1.763 + 0.68

= 4.245 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 0.848 + 0.908 + 0.314

= 2.070 Kg/cm^2

from interpolation Qd = 2.940

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 12 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH NO-5)

Bh No		5	
Depth of Foundation =		4	m
Cohesion C =		0.1	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		19	Degree
ϕ' =		13	Degree
Void ratio	e =	0.67	Medium
Specific Gravity	Gs =	2.67	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.4	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
19	14.06	5.908	4.842		
13	9.928	3.352	2.078		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.965				

Depth Factors **Inclination Factors**

dc =	1.14	**d_q=**	1.07	**d_γ =**	1.07	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 1.859 + 2.388 + 0.691

= 4.938 Kg/cm^2

For local shear failure Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 0.875 + 1.229 + 0.319

= 2.423 Kg/cm^2

from interpolation Qd = 3.429

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 14 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF PIER (BH NO-6)

Bh No		6	
Depth of Foundation =		2	m
Cohesion C =		0.12	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		17	Degree
ϕ' =		12	Degree
Void ratio	e =	0.67	Medium
Specific Gravity	Gs =	2.65	
Bulk density γ_b =		0.01791	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_b) / 10		0.004	Kg/cm^2
Bγ = (B x γ_b) / 10		0.014	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
17	12.52	4.924	3.746		
12	9.402	3.058	1.792		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.826				

Depth Factors | **Inclination Factors**

dc =	1.068	**d_q=**	1.03	**d_γ =**	1.03	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 1.861 + 0.922 + 0.516

= 3.299 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 0.932 + 0.521 + 0.266

= 1.719 Kg/cm^2

from interpolation Qd = 2.351

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 9 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH NO-6)

Bh No		6	
Depth of Foundation =		3	m
Cohesion C =		0.12	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		17	Degree
ϕ' =		12	Degree
Void ratio	e =	0.67	Medium
Specific Gravity	Gs =	2.65	
Bulk density γ_b =		0.01791	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
$q = (Df \times \gamma_b) / 10$		0.005	Kg/cm^2
$B\gamma = (B \times \gamma_b) / 10$		0.014	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
17	12.52	4.924	3.746		
12	9.402	3.058	1.792		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.826				

Depth Factors **Inclination Factors**

dc =	1.101	**d_q=**	1.05	**d_γ =**	1.05	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure $Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5B\gamma N\gamma s\gamma d\gamma i\gamma W'$

= 1.919 + 1.406 + 0.525

= 3.850 Kg/cm^2

For local shear failure $Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5B\gamma N\gamma's\gamma'd\gamma'i\gamma'W'$

= 0.961 + 0.793 + 0.27

= 2.024 Kg/cm^2

from interpolation Qd = 2.754

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 11 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH NO-6)

Bh No		6	
Depth of Foundation =		4	m
Cohesion C =		0.12	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		17	Degree
ϕ' =		12	Degree
Void ratio	e =	0.67	Medium
Specific Gravity	Gs =	2.65	
Bulk density γ_b =		0.001807	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_b) / 10		0.001	Kg/cm^2
Bγ = (B x γ_b) / 10		0.001	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
17	12.52	4.924	3.746		
12	9.402	3.058	1.792		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.826				

Depth Factors | **Inclination Factors**

dc =	1.135	**d_q=**	1.07	**d_γ =**	1.07	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 1.978 + 1.906 + 0.533

= 4.417 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 0.990 + 1.073 + 0.274

= 2.337 Kg/cm^2

from interpolation Qd = 3.169

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 13 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF PIER (BH NO-7)

Bh No		7	
Depth of Foundation =		2	m
Cohesion C =		0.02	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		26	Degree
ϕ' =		18	Degree
Void ratio	e =	0.66	Medium
Specific Gravity	Gs =	2.65	
Bulk density γ_b =		0.001789	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
$q = (Df \times \gamma_b) / 10$		0	Kg/cm^2
$B\gamma = (B \times \gamma_b) / 10$		0.001	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
26	22.604	12.208	13.184		
18	13.29	5.416	4.294		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	2.561				

Depth Factors **Inclination Factors**

dc =	1.08	**d_q=**	1.04	**d_γ =**	1.04	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure $Qd = CNcscdcic + q(Nq - 1)sqdqiq + 0.5B\gamma N\gamma s\gamma d\gamma i\gamma W'$

= 0.566 + 2.65 + 1.827

= 5.043 Kg/cm^2

For local shear failure $Qd = 2/3CNc'sc'dc'ic' + q(Nq' - 1)sq'dq'iq' + 0.5B\gamma N\gamma's\gamma'd\gamma'i\gamma'W'$

= 0.222 + 1.124 + 0.64

= 1.986 Kg/cm^2

from interpolation Qd = 3.362

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 13 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH NO-7)

Bh No		7	
Depth of Foundation =		3	m
Cohesion C =		0.02	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		26	Degree
ϕ' =		18	Degree
Void ratio	e =	0.66	Medium
Specific Gravity	Gs =	2.65	
Bulk density γ_b =		0.001789	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_b) / 10		0.001	Kg/cm^2
Bγ = (B x γ_b) / 10		0.001	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
26	22.604	12.208	13.184		
18	13.29	5.416	4.294		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	2.561				

Depth Factors | **Inclination Factors**

dc =	1.12	**d_q=**	1.06	**d_γ =**	1.06	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 0.587 + 4.052 + 1.863

= 6.502 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 0.230 + 1.716 + 0.652

= 2.598 Kg/cm^2

from interpolation Qd = 4.355

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 17 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH NO-7)

Bh No		7	
Depth of Foundation =		4	m
Cohesion C =		0.02	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		26	Degree
ϕ' =		18	Degree
Void ratio	e =	0.66	Medium
Specific Gravity	Gs =	2.65	
Bulk density γ_b =		0.001807	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_b) / 10		0.001	Kg/cm^2
Bγ = (B x γ_b) / 10		0.001	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
26	22.604	12.208	13.184		
18	13.29	5.416	4.294		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	2.561				

Depth Factors | **Inclination Factors**

dc =	1.16	**d_q=**	1.08	**d_γ =**	1.08	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure $Qd = CNcscdcic + q(Nq - 1)sqdqiq + 0.5B\gamma N\gamma s\gamma d\gamma i\gamma W'$

= 0.608 + 5.504 + 1.898

= 8.010 Kg/cm^2

For local shear failure $Qd = 2/3CNc'sc'dc'ic' + q(Nq' - 1)sq'dq'iq' + 0.5B\gamma N\gamma's\gamma'd\gamma'i\gamma'W'$

= 0.238 + 2.329 + 0.665

= 3.232 Kg/cm^2

from interpolation Qd = 5.382

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 22 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF PIER (BH NO-8)

Bh No		8	
Depth of Foundation =		2	m
Cohesion C =		0.13	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		17	Degree
ϕ' =		12	Degree
Void ratio	e =	0.65	Medium
Specific Gravity	Gs =	2.67	
Bulk density γ_b =		0.001811	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.001	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
17	12.52	4.924	3.746		
12	9.402	3.058	1.792		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.826				

Depth Factors | **Inclination Factors**

dc =	1.068	**d_q=**	1.03	**d_γ =**	1.03	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 2.016 + 0.922 + 0.516

= 3.454 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.009 + 0.521 + 0.266

= 1.796 Kg/cm^2

from interpolation Qd = 2.625

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 11 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH NO-8)

Bh No		8	
Depth of Foundation =		3	m
Cohesion C =		0.13	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		17	Degree
ϕ' =		12	Degree
Void ratio	e =	0.65	Medium
Specific Gravity	Gs =	2.67	
Bulk density γ_b =		0.001811	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.001	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.001	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
17	12.52	4.924	3.746		
12	9.402	3.058	1.792		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.826				

Depth Factors **Inclination Factors**

dc =	1.101	**d_q=**	1.05	**d_γ =**	1.05	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 2.079 + 1.406 + 0.525

= 4.010 Kg/cm^2

For local shear failure Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.041 + 0.793 + 0.27

= 2.104 Kg/cm^2

from interpolation Qd = 3.057

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 12 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH NO-8)

Bh No		8	
Depth of Foundation =		4	m
Cohesion C =		0.13	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		17	Degree
ϕ' =		12	Degree
Void ratio	e =	0.65	Medium
Specific Gravity	Gs =	2.67	
Bulk density γ_b =		0.001834	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.001	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.001	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
17	12.52	4.924	3.746		
12	9.402	3.058	1.792		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.826				

Depth Factors **Inclination Factors**

dc =	1.135	**d_q=**	1.07	**d_γ =**	1.07	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 2.143 + 1.906 + 0.533

= 4.582 Kg/cm^2

For local shear failure Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.073 + 1.073 + 0.274

= 2.420 Kg/cm^2

from interpolation Qd = 3.501

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 14 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH NO-9)

Bh No		9	
Depth of Foundation =		3	m
Cohesion C =		0.15	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		18	Degree
ϕ' =		12	Degree
Void ratio	e =	0.68	Medium
Specific Gravity	Gs =	2.69	
Submerged density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.3	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
18	13.29	5.416	4.294		
12	9.402	3.058	1.792		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.894				

Depth Factors **Inclination Factors**

dc =	1.103	**d_q=**	1.05	**d_γ =**	1.05	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 2.551 + 1.584 + 0.602

= 4.737 Kg/cm^2

For local shear failure Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.203 + 0.794 + 0.27

= 2.267 Kg/cm^2

from interpolation Qd = 3.132

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 13 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH NO-9)

Bh No		9	
Depth of Foundation =		4	m
Cohesion C =		0.15	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		18	Degree
ϕ' =		12	Degree
Void ratio	e =	0.68	Medium
Specific Gravity	Gs =	2.69	
Submerged density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.4	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
18	13.29	5.416	4.294		
12	9.402	3.058	1.792		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.894				

Depth Factors | **Inclination Factors**

dc =	1.138	**d_q=**	1.07	**d_γ =**	1.07	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 2.632 + 2.147 + 0.612

= 5.391 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.241 + 1.074 + 0.275

= 2.590 Kg/cm^2

from interpolation Qd = 3.570

Factor of Safety for Soil 2.5

Net Safe Bearing Capacity (NSBC)= 14 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF PIER (BH NO-11)

Bh No		11	
Depth of Foundation =		2	m
Cohesion C =		0.04	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		23	Degree
ϕ' =		16	Degree
Void ratio	e =	0.67	Medium
Specific Gravity	Gs =	2.67	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.2	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
23	18.364	8.956	8.684		
16	11.75	4.432	3.198		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	2.283				

Depth Factors | **Inclination Factors**

dc =	1.076	**d_q=**	1.04	**d_γ =**	1.04	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 0.917 + 1.878 + 1.201

= 3.996 Kg/cm^2

For local shear failure Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 0.391 + 0.872 + 0.476

= 1.739 Kg/cm^2

from interpolation Qd = 2.642

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 11 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH NO-11)

Bh No		11	
Depth of Foundation =		3	m
Cohesion C =		0.04	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		23	Degree
ϕ' =		16	Degree
Void ratio	e =	0.66	Medium
Specific Gravity	Gs =	2.67	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.3	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
23	18.364	8.956	8.684		
16	11.75	4.432	3.198		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	2.283				

Depth Factors | **Inclination Factors**

dc =	1.113	**d_q=**	1.06	**d_γ =**	1.06	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 0.948 + 2.868 + 1.223

= 5.039 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 0.405 + 1.33 + 0.484

= 2.219 Kg/cm^2

from interpolation Qd = 3.488

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 14 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH NO-11)

Bh No		11	
Depth of Foundation =		4	m
Cohesion C =		0.04	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		23	Degree
ϕ' =		16	Degree
Void ratio	e =	0.65	Medium
Specific Gravity	Gs =	2.67	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.4	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
23	18.364	8.956	8.684		
16	11.75	4.432	3.198		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	2.283				

Depth Factors | **Inclination Factors**

dc =	1.151	**d_q=**	1.08	**d_γ =**	1.08	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure $Qd = CNcscdcic + q(Nq - 1)sqdqiq + 0.5B\gamma N\gamma s\gamma d\gamma i\gamma W'$

= 0.981 + 3.893 + 1.245

= 6.119 Kg/cm^2

For local shear failure $Qd = 2/3CNc'sc'dc'ic' + q(Nq' - 1)sq'dq'iq' + 0.5B\gamma N\gamma's\gamma'd\gamma'i\gamma'W'$

= 0.418 + 1.803 + 0.493

= 2.714 Kg/cm^2

from interpolation Qd = 4.417

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 18 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 2.0 m DEPTH OF PIER (BH-11A)

Bh No		11A	
Depth of Foundation =		2	m
Cohesion C =		0.25	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		14	Degree
ϕ' =		9	Degree
Void ratio	e =	0.65	Medium
Specific Gravity	Gs =	2.68	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.2	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
14	10.454	3.646	2.364		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.638				

Depth Factors | **Inclination Factors**

dc =	1.064	**d_q=**	1.03	**d_γ =**	1.03	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 3.226 + 0.621 + 0.325

= 4.172 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.565 + 0.28 + 0.135

= 1.980 Kg/cm^2

from interpolation Qd = 3.076

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 12 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 3.0 m DEPTH OF PIER (BH-11A)

Bh No		11A	
Depth of Foundation =		3	m
Cohesion C =		0.25	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		14	Degree
ϕ' =		9	Degree
Void ratio	e =	0.64	Medium
Specific Gravity	Gs =	2.68	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
q = (Df x γ_{sub}) / 10		0.3	Kg/cm^2
Bγ = (B x γ_{sub}) / 10		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
14	10.454	3.646	2.364		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
Nϕ	1.638				

Depth Factors | **Inclination Factors**

dc =	1.096	**d_q=**	1.05	**d_γ =**	1.05	**i_c=i_q**	1.0
						i_γ	1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure — Qd = CNcscdcic + q(Nq -1)sqdqiq + 0.5BγNγsγdγiγW'

= 3.323 + 0.946 + 0.33

= 4.599 Kg/cm^2

For local shear failure — Qd = 2/3CNc'sc'dc'ic' + q(Nq' -1)sq'dq'iq' + 0.5BγNγ'sγ'dγ'iγ'W'

= 1.612 + 0.426 + 0.137

= 2.175 Kg/cm^2

from interpolation Qd = 3.508

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 14 T/m^2

CALCULATION OF SAFE BEARING CAPACITY

NET SAFE BEARING CAPACITY FROM STRENGTH PARAMETERS AT 4.0 m DEPTH OF PIER (BH-11A)

Bh No		11A	
Depth of Foundation =		4	m
Cohesion C =		0.25	Kg/cm^2
Inclination of load to the vertical	α	0	^{o}
Angle of shearing resistance ϕ =		14	Degree
ϕ' =		9	Degree
Void ratio	e =	0.63	Medium
Specific Gravity	Gs =	2.68	
Submerdeg density γ_{sub} =		1.000	g/cc
Type of footing		Rectangle	
Length of footing (L) =		10.00	m
Width of footing B =		8.00	m
Over burden pressure			
$q = (Df \times \gamma_{sub}) / 10$		0.4	Kg/cm^2
$B\gamma = (B \times \gamma_{sub}) / 10$		0.8	Kg/cm^2

Bearing capacity factors

ϕ & ϕ'	Nc & Nc'	Nq & Nq'	Nγ & Nγ'		
14	10.454	3.646	2.364		
9	7.606	2.11	0.912		
Sc =	1.16	**Sq =**	1.16	**Sγ =**	0.68
$N\phi$	1.638				

Depth Factors | **Inclination Factors**

dc = 1.128 **d_q=** 1.06 **d_γ =** 1.06 **$i_c=i_q$** 1.0 **i_γ** 1.0

Effect of Water Table = **W'** 0.500 (Considering worst condition)

For General shear failure $Qd = CNcscdcic + q(Nq - 1)sqdqiq + 0.5B\gamma N\gamma s\gamma d\gamma i\gamma W'$

= 3.420 + 1.28 + 0.335

= 5.035 Kg/cm^2

For local shear failure $Qd = 2/3CNc'sc'dc'ic' + q(Nq' - 1)sq'dq'iq' + 0.5B\gamma N\gamma's\gamma'd\gamma'i\gamma'W'$

= 1.659 + 0.577 + 0.139

= 2.375 Kg/cm^2

from interpolation Qd = 3.971

Factor of Safety for Sand 2.5

Net Safe Bearing Capacity (NSBC)= 16 T/m^2

Name of Project:	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.

CALCULATION OF SAFE BEARING CAPACITY

Calculation of Safe Bearing Capacity from Standard Penetration Test of PIER(BH NO-12) at 2.0 m Depth

Soil Investigation Data

Site Information

1	BH No		12	
2	Depth of Sample Collection	D_f	2.0	m
3	Inclination of load to the vertical	α	0	^{o}

Laboratory Investigations

	a) Avg. corrected N value	**N**	30.00	
1	Angle of Internal Friction	ϕ	36.0	^{o} *Ref: Fig.1 of IS 6403: 1981*
2	Specific Gravity of Soil	G	2.66	
3	Submerged Density of Soil	γ'	0.001	kg/cm^3

Assumptions

1	Width of Foundation	B	800	cm
2	Depth of Foundation	D_f	200	cm
3	Length of Foundation	L	1000	cm
4	Shape of Base		Square	
	Effect of Water Table	W'	0.500	Worst condition
5	Factor of Safety for	Sand	2.5	

Calculations

6	Submerged Density of Soil	γ'	0.001	kg/cm^3
		ϕ	36	^{o}
		Nϕ	3.852	

Surcharge Intensity = q = γ' D = 0.20 kg/cm^2

Bearing Capacity Factors for ϕ = 36 ^{o}

		Shape Factors		Depth Factors		Inclination Factors	
N_q	39.480	s_q	1.200	d_q	1.0490	i_q	1.0000
Nγ	60.306	s_γ	0.800	d_γ	1.0490	i_γ	1.0000

Angle of Internal Friction Φ' = **26**

N_q	12.208
Nγ	13.184
Difference in N_q	27.272
Difference in N_y	47.1220

From interpolation the required values of Nq & Ny are =

N_q = 39.480

N_y = 60.306

Ultimate Net Bearing Capacity q_d = $q(N_q - 1)\, s_q\, d_q\, i_q + \frac{1}{2} B \gamma\, N_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

= 0.200 x (39.480 - 1) x 1.200 x 1.049 x 1.000

+ ½ x 800.0 x 0.001 x 60.306 x 0.800 x 1.049 x 1.000 x 0.500 / 1000

= 9.6877 + 10.12

Ultimate Net Bearing Capacity q_d = **19.8095** kg/cm^2

Net Safe Bearing Capacity (NSBC)= 79 T/m^2

Name of Project:	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.

Calculation of Safe Bearing Capacity
Safe Bearing Capacity from Standard Penetration Test of Pier (BH NO-12) at 3.0 m Depth

Site Information

1 BH No		12	
2 Depth of foundation below Ground level	D_f	3.00	m
3 Inclination of load to the vertical	α	0	^{o}

Laboratory Investigations

a) Due to Dilatancy	N	37.00		
1 Angle of Internal Friction	ϕ	37.6	^{o}	*Ref: Fig.1 of IS 6403: 1981*
2 Submerged Density	γ'	0.001768	kg/cm^3	

Assumptions

1 Width of Foundation	B	800	cm
2 Depth of foundation below Ground level	D_f	300	cm
3 Length of Foundation	L	1000	cm
4 Shape of Base		Square	
5 ***Effect of Water Table***	W'	0.500	Worst condition
6 Factor of Safety for	Sand	2.5	

Calculations

Submerged Density	γ'	0.001768	kg/cm^3
	ϕ	37.6	^{o}
	Nϕ	4.130	

Surcharge Intensity = $q = \gamma' D$ = 0.53 kg/cm^2

Bearing Capacity Factors for ϕ = 37.6 ^{o}

		Shape Factors		Depth Factors		Inclination Factors	
N_q	49.368	s_q	1.200	d_q	1.0760	i_q	1.0000
Nγ	79.948	s_γ	0.800	d_γ	1.0760	i_γ	1.0000

Ultimate Net Bearing Capacity q_d = $q(N_q - 1)\, s_q\, d_q\, i_q + \frac{1}{2} B \gamma\, N_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

= 0.530 x (49.368 - 1) x 1.200 x 1.076 x 1.000
+ ½ x 800.0 x 0.002 x 79.948 x 0.800 x 1.076 x 1.000 x 0.500
= 33.1249 + 24.33

Ultimate Net Bearing Capacity q_d = **57.4594** kg/cm^2

Net Safe Bearing Capacity (NSBC)= **230 T/m^2**

Name of Project:	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.

Calculation of Safe Bearing Capacity
Safe Bearing Capacity from Standard Penetration Test of Pier (BH NO-12) at 4.0 m Depth

Site Information

1 BH No		12	
2 Depth of foundation below Ground level	D_f	4.00	m
3 Inclination of load to the vertical	α	0	^{o}

Laboratory Investigations

a) Due to Dilatancy	**N**	37.00	
1 Angle of Internal Friction	ϕ	37.6 ^{o}	*Ref: Fig.1 of IS 6403: 1981*
2 Submerged Density	γ'	0.001768	kg/cm^3

Assumptions

1 Width of Foundation	B	800	cm
2 Depth of foundation below Ground level	D_f	400	cm
3 Length of Foundation	L	1000	cm
4 Shape of Base		Square	
5 ***Effect of Water Table***	W'	0.500	Worst condition
6 Factor of Safety for	Sand	2.5	

Calculations

Submerged Density	γ'	0.001768	kg/cm^3
	ϕ	37.6 ^{o}	
	$N\phi$	4.130	

Surcharge Intensity = $q = \gamma' D$ = 0.71 kg/cm^2

Bearing Capacity Factors for ϕ = 37.6 ^{o}

		Shape Factors		Depth Factors		Inclination Factors	
N_q	49.368	s_q	1.200	d_q	1.1020	i_q	1.0000
$N\gamma$	79.948	s_γ	0.800	d_γ	1.1020	i_γ	1.0000

Ultimate Net Bearing Capacity q_d = $q (N_q - 1) s_q d_q i_q + ½ B \gamma N_\gamma s_\gamma d_\gamma i_\gamma W'$

= 0.707 x (49.368 - 1) x 1.200 x 1.102 x 1.000
+ ½ x 800.0 x 0.002 x 79.948 x 0.800 x 1.102 x 1.000 x 0.500
= 45.2338 + 24.92

Ultimate Net Bearing Capacity q_d = **70.1563** kg/cm^2

Net Safe Bearing Capacity (NSBC)= **281 T/m^2**

Name of Project:	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.

ANNEXURE-E
CALCULATION OF SETTLEMENT FOOTING

CALCULATION OF SETTLEMENT OF FOUNDATION
AS PER IS:8009 (Part -I)-1976
ABUTMENT (BH NO-2) AT 2.0 M DEPTH

Depth of foundation :	2.00	m		
Influennce Zone= 1.5 X B	12	m	(Below founding level)	
Size of foundation:	8.0 x 10.0	=> width B =	8.00	m
		Length L=	10.00	m

Due to imposed load	NSBC	**9.00**	t/m^2
Void ratio	e_0 =	0.7	
Submersible density =		1	g/cc
Height of Compressible layer (Ht) =		12.00	m

A Settlement of Foundation due to consolidation (Sc)

Compression Index (Cc) =	0.129	
Initial Pressure P_0 =	8.00	t/m^2
Area of footing =	80.00	m^2
Width of spread =	14.00	m
Length of spread =	16.00	m
Area of spread =	224.00	m^2
Pressure intensity (ΔP)=	3.21	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

1 $Sc = \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + \Delta P)/P_0]$

= 0.1336 m = 133.6 mm

B **Total Settlement Sc=** 134 mm

Depth factor =	0.95			
Sf= S total x Depth factor =	126.89	mm		
Rigidity factor =	0.8			
Final settlement (S) =	101.5	mm	(Say 102	mm)

Safe bearing capacity for 25mm settlement= 2.00 t/m^2

Safe bearing capacity for 50mm settlement= 4.00 t/m^2

CALCULATION OF SETTLEMENT OF FOUNDATION
AS PER IS:8009 (Part -I)-1976
ABUTMENT (BH NO-2) AT 3.0 M DEPTH

Depth of foundation :	3.00	m		
Influennce Zone= 1.5 X B	12	m	(Below founding level)	
Size of foundation:	8.0 x 10.0	=> width B =	8.00	m
		Length L=	10.00	m

Due to imposed load	NSBC	**10.00**	t/m^2
Void ratio	e_0 =	0.7	
Submersible density =		1	g/cc
Height of Compressible layer (Ht) =		12.00	m

A Settlement of Foundation due to consolidation (Sc)

Compression Index (Cc) =	0.129	
Initial Pressure P_0 =	9.00	t/m^2
Area of footing =	80.00	m^2
Width of spread =	14.00	m
Length of spread =	16.00	m
Area of spread =	224.00	m^2
Pressure intensity (ΔP)=	3.57	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

1 $Sc = \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + \Delta P)/P_0]$

= 0.1322 m = 132.2 mm

B **Total Settlement Sc=** 132 mm

Depth factor =	0.91			
Sf= S total x Depth factor =	120.27	mm		
Rigidity factor =	0.8			
Final settlement (S) =	96.2	mm	(Say 96	mm)

Safe bearing capacity for 25mm settlement= 3.00 t/m^2

Safe bearing capacity for 50mm settlement= 5.00 t/m^2

Name of Project:	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.

CALCULATION OF SETTLEMENT OF FOUNDATION
AS PER IS:8009 (Part -I)-1976
ABUTMENT (BH NO-2) AT 4.0 M DEPTH

Depth of foundation :	4.00	m		
Influennce Zone= 1.5 X B	12	m	(Below founding level)	
Size of foundation:	8.0 x 10.0	=> width B =	8.00	m
		Length L=	10.00	m

Due to imposed load	NSBC	**11.00**	t/m^2
Void ratio	e_0 =	0.7	
Submersible density =		1	g/cc
Height of Compressible layer (Ht) =		12.00	m

A Settlement of Foundation due to consolidation (Sc)

Compression Index (Cc) =	0.129	
Initial Pressure P_0 =	10.00	t/m^2
Area of footing =	80.00	m^2
Width of spread =	14.00	m
Length of spread =	16.00	m
Area of spread =	224.00	m^2
Pressure intensity (ΔP)=	3.93	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

1 $Sc = \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + \Delta P)/P_0]$

= 0.1310 m = 131.0 mm

B **Total Settlement Sc=** 131.0 mm

Depth factor =	0.87			
Sf= S total x Depth factor =	114.00	mm		
Rigidity factor =	0.8			
Final settlement (S) =	91.2	mm	(Say 91	mm)

Safe bearing capacity for 25mm settlement= 3.00 t/m^2

Safe bearing capacity for 50mm settlement= 6.00 t/m^2

CALCULATION OF SETTLEMENT OF FOUNDATION
AS PER IS:8009 (Part -I)-1976
PIER (BH NO-03) AT 2.0 M DEPTH

Depth of foundation :	2.00	m	
Influennce Zone= 1.5 X B	12.0	m	(Below founding level)
Depth consider from the founding level =	14.00	m	
Size of foundation:	10.0 x 8.0	=> width B =	8.00 m
		Length L=	10.00 m

The total depth of compressible layer is divided in to 3 layers.

First layer =	Clay layer =	7.00	m
Second layer =	Sand layer =	3.00	m
Third layer =	Clay layer =	2.00	m

Calculation of settlement for first layer (Clay layer)

Imposed load at founding level =	NSBC	**12.000**	t/m^2
Void ratio	e_0 =	0.69	
Submerged unit weight of soil (γ_{sub}) =		1.000	g/cc
Height of Compressible layer (Ht) =		7.00	m

A **Settlement of Foundation due to consolidation (Sc)**

Compression Index (Cc) =	0.126	
Initial Pressure P_0 =	5.500	t/m^2 [Ref. cl.no.8.1.1 from IS:8009 (part-1)-1998]
Area of footing =	80.00	m^2
Width of spread =	11.500	m
Length of spread =	13.500	m
Area of spread =	155.25	m^2
Pressure intensity (ΔP)=	6.18	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times Cc \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

= 0.1708 m = 170.8 mm

Due to clay layer resting on cohesionless soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 128.08 mm (Say 128 mm)

B Total Settlement Sc= 128 mm

Contd..

(For footing at 2.0 m depth)

Settlement of the cohesionless soil below the cohesive soil at 9.0 m depth upto 12.0 m depth.

Calculation of settlement for second layer (sand layer)

Depth of foundation	2.0	m	
Corrected average N Value	19.5		
Settelment from Fig No.9 of IS: 8009-1976	18	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	36.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976

Imposed load = **NSBC =** **12.00** t/m^2 t/m^2

Imposed load = $\sigma_z = I_B P$ **= 0.178 X 30 = 2.14** t/m^2

(Derived using Boussinesq chart (fig.18) of IS:8009(part-1))

Settlement for imposed load (Sf) = 7.69 mm

Contd..

(For footing at 2.0 m depth)
Settlement of the cohesive soil below the cohesionless soil at 12.0 m depth upto 14.0 m depth.

Calculation of settlement for third layer (Clay layer)

Depth of foundation (D)	2.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
imposed load at F.L.(P)	12.00	T/m^2
Depth from the F.L.	10.00	m
Width of spread	19	m
Length of spread	21	m
Depth from the G.L	12.00	m
Thickness of clay layer	2.00	m

Calculation of settlement :

Compression Index (Cc) =	0.120		
Initial void ratio (e_0) =	0.67		
Thickness of layer =	2.00	m	
Submerged unit weight of soil (γ_{sub}) =	1.00	g/cc	
Initial Pressure P_0 =	13.00	t/m^2	[Ref. cl.no.8.1.1 from IS:8009 (part-1)-1998]
Width of footing =	8.00	m	
Length of footing =	10.00	m	
Area of footing =	80.00	m^2	
Width of spread =	19.00	m	
Length of spread =	21.00	m	
Area of spread =	399.00	m^2	
Pressure intensity (ΔP)=	2.41	t/m^2	

A **Settlement of Foundation due to consolidation (Sc)**

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times Cc\ [\log_{10}(P_0 + \Delta P)/P_0]$$

Sf = 0.0106 m 10.6 mm

Due to clay layer resting on cohesionless soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 7.95 mm (Say 8 mm)

For footing at 2.0 m depth total calculated settlement in mm = 143.690 mm

Depth factor = 0.95 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 136.51 mm

Rigidity factor = 0.8

Final settlement (S) in mm= 109.20 mm (say 109.00 mm)

For 25 mm settlement safe bearing pressure= 3.00 t/m^2

For 50 mm settlement safe bearing pressure= 6.00 t/m^2

CALCULATION OF SETTLEMENT OF FOUNDATION
AS PER IS:8009 (Part -I)-1976
PIER (BH NO-03) AT 3.0 M DEPTH

Depth of foundation :	3.00	m		
Influennce Zone= 1.5 X B	12.0	m	(Below founding level)	
Depth consider from the founding level =	15.00	m		
Size of foundation:	10.0 x 8.0	=> width B =	8.00	m
		Length L=	10.00	m

The total depth of compressible layer is divided in to 3 layers.

First layer =	Clay layer =	6.00	m
Second layer =	Sand layer =	3.00	m
Third layer =	Clay layer =	3.00	m

Calculation of settlement for first layer (Clay layer)

Imposed load at founding level =	NSBC	**13.000**	t/m^2
Void ratio	e_0 =	0.69	
Submerged unit weight of soil (γ_{sub}) =		1.000	g/cc
Height of Compressible layer (Ht) =		6.00	m

A **Settlement of Foundation due to consolidation (Sc)**

Compression Index (Cc) =	0.126	
Initial Pressure P_0 =	6.000	t/m^2 [Ref. cl.no.8.1.1 from IS:8009 (part-1)-1998]
Area of footing =	80.00	m^2
Width of spread =	11.000	m
Length of spread =	13.000	m
Area of spread =	143.00	m^2
Pressure intensity (ΔP)=	7.27	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times Cc \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

= 0.1542 m = 154.2 mm

Due to clay layer resting on cohesionless soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 115.68 mm (Say 116 mm)

B Total Settlement Sc= 116 mm

Contd..

(For footing at 3.0 m depth)
Settlement of the cohesionless soil below the cohesive soil at 9.0 m depth upto 12.0 m depth.

Calculation of settlement for second layer (sand layer)

Depth of foundation		3.0	m	
Corrected average N Value		19.5		
Settelment from Fig No.9 of IS: 8009-1976		18	mm	(For 10 T/m^2)
Effect of water table (W')		0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement		36.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**13.00**	t/m^2	t/m^2
Imposed load =	$\sigma_z = I_B P$	**= 0.185 X 12 =**	**2.41**	t/m^2

(Derived using Boussinesq chart (fig.18) of IS:8009(part-1))

Settlement for imposed load (Sf) = 8.66 mm

Name of Project:	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.

Contd..

(For footing at 3.0 m depth)
Settlement of the cohesive soil below the cohesionless soil at 12.0 m depth upto 15.0 m depth.

Calculation of settlement for third layer (Clay layer)

Depth of foundation (D)	3.00 m
Length of foundation (L)	10.00 m
Width of foundation (B)	8.00 m
imposed load at F.L.(P)	13.00 T/m^2
Depth from the F.L.	9.00 m
Width of spread	18.5 m
Length of spread	20.5 m
Depth from the G.L	12.00 m
Thickness of clay layer	3.00 m

Calculation of settlement :

Compression Index (Cc) =	0.120	
Initial void ratio (e_0) =	0.67	
Thickness of layer =	3.00	m
Submerged unit weight of soil (γ_{sub}) =	1.00	g/cc
Initial Pressure P_0 =	13.50	t/m^2 [Ref. cl.no.8.1.1 from IS:8009 (part-1)-1998]
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	18.50	m
Length of spread =	20.50	m
Area of spread =	379.25	m^2
Pressure intensity (ΔP)=	2.74	t/m^2

A **Settlement of Foundation due to consolidation (Sc)**

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times Cc \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf = 0.0173 m 17.3 mm

Due to clay layer resting on cohesionless soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 12.98 mm (Say 13 mm)

For footing at 3.0 m depth total calculated settlement in mm = 137.658 mm

Depth factor = 0.91 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 125.27 mm

Rigidity factor = 0.8

Final settlement (S) in mm= 100.22 mm (say 100.00 mm)

For 25 mm settlement safe bearing pressure= 3.00 t/m^2

For 50 mm settlement safe bearing pressure= 7.00 t/m^2

CALCULATION OF SETTLEMENT OF FOUNDATION
AS PER IS:8009 (Part -I)-1976
PIER (BH NO-03) AT 4.0 M DEPTH

Depth of foundation :	4.00	m		
Influennce Zone= 1.5 X B	12.0	m	(Below founding level)	
Depth consider from the founding level =	16.00	m		
Size of foundation:	10.0 x 8.0	=> width B =	8.00	m
		Length L=	10.00	m

The total depth of compressible layer is divided in to 3 layers.

First layer =	Clay layer =	5.00	m
Second layer =	Sand layer =	3.00	m
Third layer =	Clay layer =	4.00	m

Calculation of settlement for first layer (Clay layer)

Imposed load at founding level =	NSBC	**14.000**	t/m^2
Void ratio	e_0 =	0.69	
Submerged unit weight of soil (γ_{sub}) =		1.000	g/cc
Height of Compressible layer (Ht) =		5.00	m

A **Settlement of Foundation due to consolidation (Sc)**

Compression Index (Cc) =	0.126	
Initial Pressure P_0 =	6.500	t/m^2 [Ref. cl.no.8.1.1 from IS:8009 (part-1)-1998]
Area of footing =	80.00	m^2
Width of spread =	10.500	m
Length of spread =	12.500	m
Area of spread =	131.25	m^2
Pressure intensity (ΔP)=	8.53	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times Cc \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

= 0.1357 m = 135.7 mm

Due to clay layer resting on cohesionless soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 101.81 mm (Say 102 mm)

B Total Settlement Sc= 102 mm

Contd..

(For footing at 4.0 m depth)
Settlement of the cohesionless soil below the cohesive soil at 9.0 m depth upto 12.0 m depth.

Calculation of settlement for second layer (sand layer)

Depth of foundation		4.0	m	
Corrected average N Value		19.5		
Settelment from Fig No.9 of IS: 8009-1976		18	mm	(For 10 T/m^2)
Effect of water table (W')		0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement		36.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**14.00**	t/m^2	t/m^2
Imposed load =	$\sigma_z = I_B P$	**= 0.204 X 13 =**	**2.86**	t/m^2

(Derived using Boussinesq chart (fig.18) of IS:8009(part-1))

Settlement for imposed load (Sf) = 10.28 mm

Contd..

(For footing at 4.0 m depth)
Settlement of the cohesive soil below the cohesionless soil at 12.0 m depth upto 16.0 m depth.

Calculation of settlement for third layer (Clay layer)

Depth of foundation (D)	4.00 m
Length of foundation (L)	10.00 m
Width of foundation (B)	8.00 m
imposed load at F.L.(P)	14.00 T/m^2
Depth from the F.L.	8.00 m
Width of spread	18 m
Length of spread	20 m
Depth from the G.L	12.00 m
Thickness of clay layer	4.00 m

Calculation of settlement :

Compression Index (Cc) =	0.120	
Initial void ratio (e_0) =	0.67	
Thickness of layer =	4.00 m	
Submerged unit weight of soil (γ_{sub}) =	1.00 g/cc	
Initial Pressure P_0 =	14.00 t/m^2	[Ref. cl.no.8.1.1 from IS:8009 (part-1)-1998]
Width of footing =	8.00 m	
Length of footing =	10.00 m	
Area of footing =	80.00 m^2	
Width of spread =	18.00 m	
Length of spread =	20.00 m	
Area of spread =	360.00 m^2	
Pressure intensity (ΔP)=	3.11 t/m^2	

A **Settlement of Foundation due to consolidation (Sc)**

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} X\ Cc\ [\log_{10}(P_0 + \Delta P)/P_0]$$

Sf = 0.0250 m 25.0 mm

Due to clay layer resting on cohesionless soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 18.79 mm (Say 19 mm)

For footing at 3.0 m depth total calculated settlement in mm = 131.282 mm

Depth factor = 0.87 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 114.21 mm

Rigidity factor = 0.8

Final settlement (S) in mm= 91.37 mm (say 91.00 mm)

For 25 mm settlement safe bearing pressure= 4.00 t/m^2

For 50 mm settlement safe bearing pressure= 8.00 t/m^2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER(BH NO-04) AT 2.0 M DEPTH

Depth of foundation (D) =	2.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	14.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	10.0	m depth below foundation level	
Corrected N Value	19		
Settelment from Fig No.9 of IS: 8009-1976	18	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	36.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**13.00** t/m^2	
Settlement for imposed load (Sf) =	46.80	mm	

Due to the cohesionless soil settlement = S_1 = 46.80 mm

Contd...

(For footing at 2.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 12.0 m depth up to 14.0 m depth.

Depth of foundation (D)	2.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	13.00	T/m^2
At the mid height of clay layer width of spread =	19.00	m
Depth of clay layer from G.L	12.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	2.00	m

Calculation of settlement :

Compression Index (Cc) =	0.111	
Initial void ratio (e_0) =	0.64	
Thickness of layer =	2.00	m
Submersible density =	1.000	g/cc
Initial Pressure P_0 =	13.00	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	19.00	m
Length of spread =	21.00	m
Area of spread =	399.00	m^2
Pressure intensity (ΔP)=	2.61	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10}(P_0 + \Delta P)/P_0]$$

Sf_1 = 0.0107 m

10.7 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 8.06 mm (Say 8.00 mm)

Total settlemen in mm = S_1+S_c= 54.8 mm

Depth factor = 0.95 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 52.06 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 41.6 mm (Say 42mm)

For 25 mm settlement safe bearing pressure = 8.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER(BH NO-04) AT 3.0 M DEPTH

Depth of foundation (D) =	3.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	15.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	9.0	m depth below foundation level	
Corrected N Value	21		
Settelment from Fig No.9 of IS: 8009-1976	17	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	34.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**15.00** t/m^2	
Settlement for imposed load (Sf) =	51.00	mm	

Due to the cohesionless soil settlement = S_1 = 51.00 mm

Contd...

(For footing at 3.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 12.0 m depth up to 15.0 m depth.

Depth of foundation (D)	3.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	15.00	T/m^2
At the mid height of clay layer width of spread =	18.50	m
Depth of clay layer from G.L	12.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	3.00	m

Calculation of settlement :

Compression Index (Cc) =	0.111	
Initial void ratio (e_0) =	0.64	
Thickness of layer =	3.00	m
Submersible density =	1.000	g/cc
Initial Pressure P_0 =	13.50	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	18.50	m
Length of spread =	20.50	m
Area of spread =	379.25	m^2
Pressure intensity (ΔP)=	3.16	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10}(P_0 + \Delta P)/P_0]$$

Sf_1 = 0.0186 m

18.6 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 13.93 mm (Say 14.00 mm)

Total settlemen in mm = S_1+S_c= 65.0 mm

Depth factor = 0.91 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 59.15 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 47.3 mm (Say 47mm)

For 25 mm settlement safe bearing pressure = 8.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER(BH NO-04) AT 4.0 M DEPTH

Depth of foundation (D) =	4.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	16.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	8.0	m depth below foundation level	
Corrected N Value	21		
Settelment from Fig No.9 of IS: 8009-1976	17	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	34.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**16.00** t/m^2	
Settlement for imposed load (Sf) =	54.40	mm	

Due to the cohesionless soil settlement = S_1 = 54.40 mm

Contd...

(For footing at 4.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 12.0 m depth up to 16.0 m depth.

Depth of foundation (D)	4.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	16.00	T/m^2
At the mid height of clay layer width of spread =	18.00	m
Depth of clay layer from G.L	12.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	4.00	m

Calculation of settlement :

Compression Index (Cc) =	0.111	
Initial void ratio (e_0) =	0.64	
Thickness of layer =	4.00	m
Submersible density =	1.000	g/cc
Initial Pressure P_0 =	14.00	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	18.00	m
Length of spread =	20.00	m
Area of spread =	360.00	m^2
Pressure intensity (ΔP)=	3.56	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0266 m
26.6 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 19.96 mm (Say 20.00 mm)

Total settlemen in mm = S_1+S_c= 74.4 mm

Depth factor = 0.87 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 64.73 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 51.8 mm (Say 52mm)

For 25 mm settlement safe bearing pressure = 8.0 T/m2
For 50 mm settlement safe bearing pressure = 15.0 T/m2

SETTLEMENT ANALYSIS

PIER (BH No-5) at 2.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	2.0	m	
Corrected N Value	18		
Settelment from Fig No.9 of IS: 8009-1976	18	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	36.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**10.00**	t/m^2
Settlement for imposed load (Sf) =	36.00	mm	
Depth factor =	0.95		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	34.20	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	27.4	mm	
say	27	mm	
For 25mm settlement safe bearing pressure =	9.00	t/m^2	

SETTLEMENT ANALYSIS

PIER (BH No-5) at 3.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	3.0	m	
Corrected N Value	20		
Settelment from Fig No.9 of IS: 8009-1976	17	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	34.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**12.00**	t/m^2
Settlement for imposed load (Sf) =	40.80	mm	
Depth factor =	0.91		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	37.13	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	29.7	mm	
say	30	mm	
For 25mm settlement safe bearing pressure =		10.00	t/m^2

SETTLEMENT ANALYSIS

PIER (BH No-5) at 4.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	4.0	m	
Corrected N Value	23		
Settelment from Fig No.9 of IS: 8009-1976	15	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	30.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**14.00**	t/m^2
Settlement for imposed load (Sf) =	42.00	mm	
Depth factor =	0.87		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	36.54	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	29.2	mm	
say	29	mm	
For 25mm settlement safe bearing pressure =		12.00	t/m^2

SETTLEMENT ANALYSIS

PIER (BH No-6) at 2.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	2.0	m	
Corrected N Value	24		
Settelment from Fig No.9 of IS: 8009-1976	14	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	28.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**9.00**	t/m^2
Settlement for imposed load (Sf) =	25.20	mm	
Depth factor =	0.95		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	23.94	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	19.2	mm	
say	19	mm	

SETTLEMENT ANALYSIS

PIER (BH No-6) at 3.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	3.0	m	
Corrected N Value	29		
Settelment from Fig No.9 of IS: 8009-1976	11	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	22.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**11.00**	t/m^2
Settlement for imposed load (Sf) =	24.20	mm	
Depth factor =	0.91		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	22.02	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	17.6	mm	
say	18	mm	

SETTLEMENT ANALYSIS

PIER (BH No-6) at 4.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	4.0	m	
Corrected N Value	30		
Settelment from Fig No.9 of IS: 8009-1976	10	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	20.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**13.00**	t/m^2
Settlement for imposed load (Sf) =	26.00	mm	
Depth factor =	0.87		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	22.62	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	18.1	mm	
say	18	mm	

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-07) AT 2.0 M DEPTH

Depth of foundation (D) =	2.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	14.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	7.0	m depth below foundation level	
Corrected N Value	27		
Settelment from Fig No.9 of IS: 8009-1976	13	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	26.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**13.00** t/m^2	
Settlement for imposed load (Sf) =	33.80	mm	

Due to the cohesionless soil settlement = S_1 = 33.80 mm

Contd...

(For footing at 2.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 9.0 m depth up to 14.0 m depth.

Depth of foundation (D)	2.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	13.00	T/m^2
At the mid height of clay layer width of spread =	17.50	m
Depth of clay layer from G.L	9.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	5.00	m

Calculation of settlement :

Compression Index (Cc) =	0.117	
Initial void ratio (e_0) =	0.66	
Thickness of layer =	5.00	m
Bulk density =	1.794	g/cc
Initial Pressure P_0 =	20.63	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	17.50	m
Length of spread =	19.50	m
Area of spread =	341.25	m^2
Pressure intensity (ΔP)=	3.05	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0211 m

21.1 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 15.82 mm (Say 16.00 mm)

Total settlemen in mm = S_1+S_c= 49.8 mm

Depth factor = 0.95 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 47.31 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 37.8 mm (Say 38mm)

For 25 mm settlement safe bearing pressure = 9.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-07) AT 3.0 M DEPTH

Depth of foundation (D) =	3.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	15.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	6.0	m depth below foundation level	
Corrected N Value	36		
Settelment from Fig No.9 of IS: 8009-1976	8.5	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	17.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**17.00** t/m^2	
Settlement for imposed load (Sf) =	28.90	mm	

Due to the cohesionless soil settlement = S_1 = 28.90 mm

Contd...

(For footing at 3.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 9.0 m depth up to 15.0 m depth.

Depth of foundation (D)	3.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	17.00	T/m^2
At the mid height of clay layer width of spread =	17.00	m
Depth of clay layer from G.L	9.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	6.00	m

Calculation of settlement :

Compression Index (Cc) =	0.117	
Initial void ratio (e_0) =	0.66	
Thickness of layer =	6.00	m
Bulk density =	1.794	g/cc
Initial Pressure P_0 =	21.53	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	17.00	m
Length of spread =	19.00	m
Area of spread =	323.00	m^2
Pressure intensity (ΔP)=	4.21	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0328 m

32.8 mm

Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 24.61 mm (Say 25.00 mm)

Total settlemen in mm = S_1+S_c= 53.9 mm

Depth factor = 0.91 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 49.05 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 39.2 mm (Say 39mm)

For 25 mm settlement safe bearing pressure = 11.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-07) AT 4.0 M DEPTH

Depth of foundation (D) =	4.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	16.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	5.0	m depth below foundation level	
Corrected N Value	36		
Settelment from Fig No.9 of IS: 8009-1976	8.5	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	17.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**22.00** t/m^2	
Settlement for imposed load (Sf) =	37.40	mm	

Due to the cohesionless soil settlement = S_1 = 37.40 mm

Contd...

(For footing at 4.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 9.0 m depth up to 16.0 m depth.

Depth of foundation (D)	4.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	22.00	T/m^2
At the mid height of clay layer width of spread =	16.50	m
Depth of clay layer from G.L	9.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	7.00	m

Calculation of settlement :

Compression Index (Cc) =	0.117	
Initial void ratio (e_0) =	0.66	
Thickness of layer =	7.00	m
Bulk density =	1.819	g/cc
Initial Pressure P_0 =	22.74	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	16.50	m
Length of spread =	18.50	m
Area of spread =	305.25	m^2
Pressure intensity (ΔP)=	5.77	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0484 m

48.4 mm

Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 36.32 mm (Say 36.00 mm)

Total settlemen in mm = S_1+S_c= 73.4 mm

Depth factor = 0.87 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 63.86 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 51.1 mm (Say 51mm)

For 25 mm settlement safe bearing pressure = 11.0 T/m2

For 50 mm settlement safe bearing pressure = 22.0 T/m2

SETTLEMENT ANALYSIS

PIER (BH No-8) at 2.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	2.0	m	
Corrected N Value	47		
Settelment from Fig No.9 of IS: 8009-1976	6	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	12.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**11.00**	t/m^2
Settlement for imposed load (Sf) =	13.20	mm	
Depth factor =	0.95		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	12.54	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	10.0	mm	
say	10	mm	

SETTLEMENT ANALYSIS

PIER (BH No-8) at 3.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	3.0	m	
Corrected N Value	46		
Settelment from Fig No.9 of IS: 8009-1976	6.2	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	12.40	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**12.00** t/m^2	
Settlement for imposed load (Sf) =	14.88	mm	
Depth factor =	0.91		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	13.54	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	10.8	mm	
say	11	mm	

SETTLEMENT ANALYSIS

PIER (BH No-8) at 4.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	4.0	m	
Corrected N Value	39		
Settelment from Fig No.9 of IS: 8009-1976	7.2	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	14.40	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**14.00**	t/m^2
Settlement for imposed load (Sf) =	20.16	mm	
Depth factor =	0.87		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	17.54	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	14.0	mm	
say	14	mm	

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-09) AT 3.0 M DEPTH

Depth of foundation (D) =	3.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	15.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	6.0	m depth below foundation level	
Corrected N Value	15		
Settelment from Fig No.9 of IS: 8009-1976	24	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	48.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**13.00** t/m^2	
Settlement for imposed load (Sf) =	62.40	mm	

Due to the cohesionless soil settlement = S_1 = 62.40 mm

Contd...

(For footing at 3.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 9.0 m depth up to 15.0 m depth.

Depth of foundation (D)	3.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	13.00	T/m^2
At the mid height of clay layer width of spread =	17.00	m
Depth of clay layer from G.L	9.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	6.00	m

Calculation of settlement :

Compression Index (Cc) =	0.123	
Initial void ratio (e_0) =	0.68	
Thickness of layer =	6.00	m
Submerged density =	1.000	g/cc
Initial Pressure P_0 =	12.00	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	17.00	m
Length of spread =	19.00	m
Area of spread =	323.00	m^2
Pressure intensity (ΔP)=	3.22	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0453 m

45.3 mm

Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 34.01 mm (Say 34.00 mm)

Total settlemen in mm = S_1+S_c= 96.4 mm

Depth factor = 0.91 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 87.72 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 70.2 mm (Say 70mm)

For 25 mm settlement safe bearing pressure = 5.0 T/m2

For 50 mm settlement safe bearing pressure = 9.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-09) AT 4.0 M DEPTH

Depth of foundation	(D) =	4.0	m	
Legth of foundation	(L) =	10.0	m	
Width of foundation	(B) =	8.0	m	
Influence Zone to be extended up to		1.5 B.		
Depth of influence zone =		12.0	m depth below foundation level.	
Depth of end of influence zone below the ground Level		16.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	5.0	m depth below foundation level	
Average submerged Density for sand layer	1.000	g/cc	
Corrected N Value	15		
Settelment from Fig No.9 of IS: 8009-1976	24	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	48.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**14.00** t/m^2	
Settlement for imposed load (Sf) =	67.20	mm	

Due to the cohesionless soil settlement = S_1 = 67.00 mm

Contd…

(For footing at 4.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 9.0 m depth up to 15.0 m depth.

Depth of foundation (D)	4.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (2.0 m depth below existing G.L, NSBC)=	14.00	T/m^2
At the mid height of clay layer width of spread =	16.00	m
Depth of clay layer from G.L	9.00	m
Thickness of clay layer	6.00	m

Calculation of settlement :

Compression Index (Cc) =	0.123	
Initial void ratio (e_0) =	0.68	
Thickness of layer =	6.00	m
Submerged density =	1.000	g/cc
Initial Pressure P_0 =	12.00	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	16.00	m
Length of spread =	18.00	m
Area of spread =	288.00	m^2
Pressure intensity (ΔP)=	3.89	t/m^2

a As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10}(P_0 + \Delta P)/P_0]$$

Sf_1 = 0.0536 m

53.6 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 40.17 mm (Say 40.00 mm)

Contd..

(For footing at 4.0 m depth)

Settlement of the cohesionless soil below the cohesive soil at 15.0 m depth up to 16.0 m depth.

Depth of foundation	4.0	m	
Average submerged Density for sand	1.000	g/cc	
Cohesionless strata exist upto	1.0	m below	considering depth of influence zone
Corrected average N Value	18		
Settelment from Fig No.9 of IS: 8009-1976	18	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	36.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976

Imposed load = $\sigma_z = I_B P$ **= 0.148 X14= 2.07** t/m^2

(Derived using Boussinesq chart (fig.18) of IS:8009(part-1))

Settlement for imposed load S_3 (Sf) = 7.00 mm

For footing at 4.50 m depth total calculated settlement in mm = 114.00

Depth factor = 0.87 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 99.18 mm

Rigidity factor = 0.8

Final settlement (S) in mm= 79 mm

For 25 mm settlement safe bearing pressure = 4.0 t/m^2

For 50 mm settlement safe bearing pressure = 9.0 t/m^2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-11) AT 2.0 M DEPTH

Depth of foundation (D) =	2.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	14.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	7.0	m depth below foundation level	
Corrected N Value	13		
Settelment from Fig No.9 of IS: 8009-1976	27	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	54.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**11.00** t/m^2	
Settlement for imposed load (Sf) =	59.40	mm	

Due to the cohesionless soil settlement = S_1 = 59.40 mm

Contd...

(For footing at 2.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 9.0 m depth up to 14.0 m depth.

Depth of foundation (D)	2.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	11.00	T/m^2
At the mid height of clay layer width of spread =	17.50	m
Depth of clay layer from G.L	9.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	5.00	m

Calculation of settlement :

Compression Index (Cc) =	0.117	
Initial void ratio (e_0) =	0.66	
Thickness of layer =	5.00	m
Submerged density =	1.000	g/cc
Initial Pressure P_0 =	11.50	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	17.50	m
Length of spread =	19.50	m
Area of spread =	341.25	m^2
Pressure intensity (ΔP)=	2.58	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0310 m

31.0 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 23.22 mm (Say 23.00 mm)

Total settlemen in mm = S_1+S_c= 82.4 mm

Depth factor = 0.95 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 78.28 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 62.6 mm (Say 63mm)

For 25 mm settlement safe bearing pressure = 4.0 T/m2

For 50 mm settlement safe bearing pressure = 9.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-11) AT 3.0 M DEPTH

Depth of foundation (D) =	3.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	15.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	6.0	m depth below foundation level	
Corrected N Value	13		
Settelment from Fig No.9 of IS: 8009-1976	27	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	54.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**14.00** t/m^2	
Settlement for imposed load (Sf) =	75.60	mm	

Due to the cohesionless soil settlement = S_1 = 75.60 mm

Contd...

(For footing at 3.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 9.0 m depth up to 15.0 m depth.

Depth of foundation (D)	2.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	14.00	T/m^2
At the mid height of clay layer width of spread =	17.00	m
Depth of clay layer from G.L	9.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	6.00	m

Calculation of settlement :

Compression Index (Cc) =	0.117	
Initial void ratio (e_0) =	0.66	
Thickness of layer =	6.00	m
Submerged density =	1.000	g/cc
Initial Pressure P_0 =	12.00	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	17.00	m
Length of spread =	19.00	m
Area of spread =	323.00	m^2
Pressure intensity (ΔP)=	3.47	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0466 m

46.6 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 34.96 mm (Say 35.00 mm)

Total settlemen in mm = S_1+S_c= 110.6 mm

Depth factor = 0.95 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 105.07 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 84.1 mm (Say 84mm)

For 25 mm settlement safe bearing pressure = 4.0 T/m2

For 50 mm settlement safe bearing pressure = 8.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-11) AT 4.0 M DEPTH

Depth of foundation	(D) =	4.0	m
Legth of foundation	(L) =	10.0	m
Width of foundation	(B) =	8.0	m
Influence Zone to be extended up to		1.5 B.	
Depth of influence zone =		12.0	m depth below foundation level.
Depth of end of influence zone below the ground Level		16.0	m

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto		5.0	m depth below foundation level
Average submerged Density for sand layer		1.000	g/cc
Corrected N Value		13	
Settelment from Fig No.9 of IS: 8009-1976		27	mm (For 10 T/m^2)
Effect of water table (W')		0.5	Insert fig of fig 9, IS:8009-1976
Corrected Settlement		54.00	mm As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**18.00** t/m^2	
Settlement for imposed load (Sf) =		97.20	mm

Due to the cohesionless soil settlement = S_1 = 97.00 mm

Contd…

(For footing at 4.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 9.0 m depth up to 15.0 m depth.

Depth of foundation (D)	4.00 m
Length of foundation (L)	10.00 m
Width of foundation (B)	8.00 m
Load intensity at FL (2.0 m depth below existing G.L, NSBC)=	18.00 T/m^2
At the mid height of clay layer width of spread =	16.00 m
Depth of clay layer from G.L	9.00 m
Thickness of clay layer	6.00 m

Calculation of settlement :

Compression Index (Cc) =	0.117
Initial void ratio (e_0) =	0.66
Thickness of layer =	6.00 m
Submerged density =	1.000 g/cc
Initial Pressure P_0 =	12.00 t/m^2
Width of footing =	8.00 m
Length of footing =	10.00 m
Area of footing =	80.00 m^2
Width of spread =	16.00 m
Length of spread =	18.00 m
Area of spread =	288.00 m^2
Pressure intensity (ΔP)=	5.00 t/m^2

a As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10}(P_0 + \Delta P)/P_0]$$

Sf_1 = 0.0640 m

64.0 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 47.98 mm (Say 48.00 mm)

Contd..

(For footing at 4.0 m depth)

Settlement of the cohesionless soil below the cohesive soil at 15.0 m depth up to 16.0 m depth.

Depth of foundation	4.0	m	
Average submerged Density for sand	1.000	g/cc	
Cohesionless strata exist upto	1.0	m below	considering depth of influence zone
Corrected average N Value	20		
Settelment from Fig No.9 of IS: 8009-1976	17	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	34.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976

Imposed load = $\sigma_z = I_B P$ **= 0.148 X18= 2.66** t/m^2

(Derived using Boussinesq chart (fig.18) of IS:8009(part-1))

Settlement for imposed load S_3 (Sf) =	9.00	mm	
For footing at 4.50 m depth total calculated settlement in mm =			154.00
Depth factor =	0.87		As per Fig No.12 of IS 8009(P-1)-1976
$S_{fd} = S_f$ x Depth factor =	133.98	mm	
Rigidity factor =	0.8		
Final settlement (S) in mm=	107	mm	
For 25 mm settlement safe bearing pressure =		4.0	t/m^2
For 50 mm settlement safe bearing pressure =		8.0	t/m^2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-11A) AT 2.0 M DEPTH

Depth of foundation (D) =	2.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	14.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	4.0	m depth below foundation level	
Corrected N Value	7.5		
Settelment from Fig No.9 of IS: 8009-1976	150	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	300.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**12.00** t/m^2	
Settlement for imposed load (Sf) =	360.00	mm	

Due to the cohesionless soil settlement = S_1 = 360.00 mm

Contd...

(For footing at 2.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 6.0 m depth up to 14.0 m depth.

Depth of foundation (D)	2.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	12.00	T/m^2
At the mid height of clay layer width of spread =	16.00	m
Depth of clay layer from G.L	6.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	8.00	m

Calculation of settlement :

Compression Index (Cc) =	0.111	
Initial void ratio (e_0) =	0.64	
Thickness of layer =	8.00	m
Submerged density =	1.000	g/cc
Initial Pressure P_0 =	10.00	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	16.00	m
Length of spread =	18.00	m
Area of spread =	288.00	m^2
Pressure intensity (ΔP)=	3.33	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0676 m

67.6 mm

2 Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 50.74 mm (Say 51.00 mm)

Total settlemen in mm = S_1+S_c= 411.0 mm

Depth factor = 0.95 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 390.45 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 312.4 mm (Say 312mm)

For 25 mm settlement safe bearing pressure = 1.0 T/m2

For 50 mm settlement safe bearing pressure = 2.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER (BH NO-11A) AT 3.0 M DEPTH

Depth of foundation (D) =	3.0	m	
Width of foundation (B) =	8.0	m	
Influence Zone to be extended up to	1.5 B.		
Depth of influence zone =	12.0	m depth below foundation level.	
Depth of end of influence zone from G.L	15.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	3.0	m depth below foundation level	
Corrected N Value	7.5		
Settelment from Fig No.9 of IS: 8009-1976	150	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	300.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**14.00** t/m^2	
Settlement for imposed load (Sf) =	420.00	mm	

Due to the cohesionless soil settlement = S_1 = 420.00 mm

Contd...

(For footing at 3.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 6.0 m depth up to 15.0 m depth.

Depth of foundation (D)	2.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (3.0m depth below existing G.L, NSBC)=	14.00	T/m^2
At the mid height of clay layer width of spread =	15.50	m
Depth of clay layer from G.L	6.00	m
Depth of clay strata from depth of consideration below FL to end of influence zone =	9.00	m

Calculation of settlement :

Compression Index (Cc) =	0.111	
Initial void ratio (e_0) =	0.64	
Thickness of layer =	9.00	m
Submerged density =	1.000	g/cc
Initial Pressure P_0 =	10.50	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	15.50	m
Length of spread =	17.50	m
Area of spread =	271.25	m^2
Pressure intensity (ΔP)=	4.13	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} \times C_c \left[\log_{10} (P_0 + \Delta P)/P_0 \right]$$

Sf_1 = 0.0877 m

87.7 mm

Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 65.80 mm (Say 66.00 mm)

Total settlemen in mm = S_1+S_c= 486.0 mm

Depth factor = 0.91 As per Fig No.12 of IS 8009(P-1)-1976

$S_{fd} = S_f$ x Depth factor = 442.26 mm

Rigidity factor = 0.8

Final settlement= (Sfd x Rigidity Factor) 353.8 mm (Say 354mm)

For 25 mm settlement safe bearing pressure = 1.0 T/m2

For 50 mm settlement safe bearing pressure = 2.0 T/m2

CALCULATION OF SETTLEMENT OF FOUNDATION

AS PER IS:8009 (Part -I)-1976

PIER(BH NO-11A) AT 4.0 M DEPTH

Depth of foundation	(D) =	4.0	m	
Legth of foundation	(L) =	10.0	m	
Width of foundation	(B) =	8.0	m	
Influence Zone to be extended up to		1.5 B.		
Depth of influence zone =		12.0	m depth below foundation level.	
Depth of end of influence zone below the ground Level		16.0	m	

a) Settlement due to cohesionless soil beneath foundation level

Cohesionless strata exist upto	2.0	m depth below foundation level	
Average submerged Density for sand layer	1.000	g/cc	
Corrected N Value	7.5		
Settelment from Fig No.9 of IS: 8009-1976	150	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	300.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**16.00** t/m^2	
Settlement for imposed load (Sf) =	480.00	mm	

Due to the cohesionless soil settlement = S_1 = 480.00 mm

Contd…

(For footing at 4.0 m depth)

Settlement of the cohesive soil below the cohesionless soil at 6.0 m depth up to 16.0 m depth.

Depth of foundation (D)	4.00	m
Length of foundation (L)	10.00	m
Width of foundation (B)	8.00	m
Load intensity at FL (2.0 m depth below existing G.L, NSBC)=	16.00	T/m^2
At the mid height of clay layer width of spread =	14.50	m
Depth of clay layer from G.L	6.00	m
Thickness of clay layer	9.00	m

Calculation of settlement :

Compression Index (Cc) =	0.111	
Initial void ratio (e_0) =	0.64	
Thickness of layer =	9.00	m
Submerged density =	1.000	g/cc
Initial Pressure P_0 =	10.50	t/m^2
Width of footing =	8.00	m
Length of footing =	10.00	m
Area of footing =	80.00	m^2
Width of spread =	14.50	m
Length of spread =	16.50	m
Area of spread =	239.25	m^2
Pressure intensity (ΔP)=	5.35	t/m^2

As per clause 9.2.2 of IS : 8009 (Part-I) -1976

$$S_f = \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10}(P_0 + \Delta P)/P_0]$$

Sf_1 = 0.1089 m

108.9 mm

Due to clay layer resting on cohesion less soil, value of λ = 0.75 As per tabel-1 of IS:8009(Pt-1)

Consolidated settlement (Sc) = Sfd x λ = 81.71 mm (Say 82.00 mm)

Contd..

(For footing at 4.0 m depth)

Settlement of the cohesionless soil below the cohesive soil at 15.0 m depth up to 16.0 m depth.

Depth of foundation	4.0	m	
Average submerged Density for sand	1.000	g/cc	
Cohesionless strata exist upto	1.0	m below	considering depth of influence zone
Corrected average N Value	28		
Settelment from Fig No.9 of IS: 8009-1976	10.4	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	20.80	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976

Imposed load = $\sigma_z = I_B P$ **= 0.148 X16= 2.37** t/m^2

(Derived using Boussinesq chart (fig.18) of IS:8009(part-1))

Settlement for imposed load S_3 (Sf) =	5.00	mm	
For footing at 4.50 m depth total calculated settlement in mm =			567.00
Depth factor =	0.87		As per Fig No.12 of IS 8009(P-1)-1976
$S_{fd} = S_f$ x Depth factor =	493.29	mm	
Rigidity factor =	0.8		
Final settlement (S) in mm=	395	mm	
For 25 mm settlement safe bearing pressure =		1.0	t/m^2
For 50 mm settlement safe bearing pressure =		2.0	t/m^2

SETTLEMENT ANALYSIS

PIER (BH No-12) at 2.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	2.0	m	
Corrected N Value	30		
Settelment from Fig No.9 of IS: 8009-1976	10	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	20.00	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**79.00**	t/m^2
Settlement for imposed load (Sf) =	158.00	mm	
Depth factor =	0.95		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	150.10	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	120.1	mm	
say	120	mm	
For 25mm settlement safe bearing pressure =		16.00	t/m^2
For 50mm settlement safe bearing pressure =		33.00	t/m^2

SETTLEMENT ANALYSIS

PIER (BH No-12) at 3.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	3.0	m	
Corrected N Value	37		
Settelment from Fig No.9 of IS: 8009-1976	7.8	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	15.60	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**230.00** t/m^2	
Settlement for imposed load (Sf) =	358.80	mm	
Depth factor =	0.91		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	326.51	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	261.2	mm	
say	261	mm	
For 25mm settlement safe bearing pressure =		22.00 t/m^2	
For 75mm settlement safe bearing pressure =		44.00 t/m^2	

SETTLEMENT ANALYSIS

PIER (BH No-12) at 4.0 m depth

AS PER IS:8009 (Part -I)-1976

Depth of foundation	4.0	m	
Corrected N Value	37		
Settelment from Fig No.9 of IS: 8009-1976	7.8	mm	(For 10 T/m^2)
Effect of water table (W')	0.5		Insert fig of fig 9, IS:8009-1976
Corrected Settlement	15.60	mm	As per cl. No. 9.1.4 of IS 8009(P-1)-1976
Imposed load =	**NSBC =**	**281.00**	t/m^2
Settlement for imposed load (Sf) =	438.36	mm	
Depth factor =	0.87		As per IS 8009(P-1)-1976 of fig.12
$S_{fd} = S_f$ x Depth factor =	381.37	mm	
Rigidity factor =	0.8		
Final settlement (S) = (Sfd x Rigidity Factor)	305.1	mm	
say	305	mm	
For 25mm settlement safe bearing pressure =		23.00	t/m^2
For 75mm settlement safe bearing pressure =		46.00	t/m^2

ANNEXURE -F
LIQUEFACTION CALCULATION

Liquefaction Analysis Using SPT Data

Bore hole: BH 03 | Water Table = 2.5 m | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Pore water Pressure (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
9.00	SM	24	18.15	8.15	38.95	163.350	63.765	99.585	0.931	0.238	101.41	1.009	24.219	0.500	1.200	29.56	0.44	1.19	NA	NA	1.00	1.00	0.52	2.20	Non Liquefiable
21.00	ML	50	19	9	62.17	391.350	181.485	209.865	0.613	0.178	101.56	0.696	34.783	0.500	1.200	42.24	---	---	---	---	---	---	---	---	Non Liquefiable
24.00	SM	50	19	9	33.05	448.350	210.915	237.435	0.560	0.165	101.60	0.654	32.707	4.884	1.180	43.48	---	---	---	---	---	---	---	---	Non Liquefiable
27.00	SM	50	19	9	27.12	505.350	240.345	265.005	0.560	0.167	101.64	0.619	30.965	4.489	1.131	39.52	---	---	---	---	---	---	---	---	Non Liquefiable
30.00	SM	50	19	9	30.52	562.350	269.775	292.575	0.560	0.168	101.68	0.590	29.475	4.740	1.159	38.89	---	---	---	---	---	---	---	---	Non Liquefiable
32.00	SM	50	19	9	34.55	600.350	289.395	310.955	0.560	0.169	101.70	0.572	28.594	4.957	1.193	39.07	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Liquefaction Analysis Using SPT Data

Bore hole: BH 04 | Water Table = 2 m | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Pore water Pressure (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
1.50	ML	16	17.68	7.68	62.17	26.520	---	26.520	0.989	0.154	101.32	1.700	27.200	0.500	1.200	33.14	---	---	---	---	---	---	---	---	Non Liquefiable
3.00	ML	17	17.68	7.68	33.05	53.040	9.810	43.230	0.977	0.187	101.34	1.531	26.028	4.884	1.180	35.60	---	---	---	---	---	---	---	---	Non Liquefiable
4.50	SM	18	17.81	7.81	27.12	79.755	24.525	55.230	0.966	0.218	101.36	1.355	24.384	4.489	1.131	32.07	---	---	---	---	---	---	---	---	Non Liquefiable
6.00	SM	27	17.95	7.95	30.52	106.680	39.240	67.440	0.954	0.235	101.38	1.226	33.103	4.740	1.159	43.09	---	---	---	---	---	---	---	---	Non Liquefiable
9.00	SM	36	18.19	8.19	34.55	161.250	68.670	92.580	0.931	0.253	101.41	1.047	37.678	4.957	1.193	49.91	---	---	---	---	---	---	---	---	Non Liquefiable
21.00	SM	50	19	9	39.01	389.250	186.390	202.860	0.613	0.184	101.56	0.708	35.378	0.500	1.200	42.95	---	---	---	---	---	---	---	---	Non Liquefiable
24.00	SM	50	19	9	38.82	446.250	215.820	230.430	0.560	0.169	101.60	0.664	33.201	0.500	1.200	40.34	---	---	---	---	---	---	---	---	Non Liquefiable
27.00	SM	50	19	9	41.17	503.250	245.250	258.000	0.560	0.170	101.64	0.628	31.382	0.500	1.200	38.16	---	---	---	---	---	---	---	---	Non Liquefiable
30.00	SM	50	19	9	37.27	560.250	274.680	285.570	0.560	0.171	101.68	0.597	29.835	0.500	1.200	36.30	---	---	---	---	---	---	---	---	Non Liquefiable
32.00	SM	50	19	9	36.23	598.250	294.300	303.950	0.560	0.172	101.70	0.578	28.922	0.500	1.200	35.21	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Name of Project:	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.

Liquefaction Analysis Using SPT Data

Bore hole: BH 05 | Water Table = 3 m | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Pore water Pressure (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
1.50	ML	15	17.63	7.63	68.81	26.445	---	26.445	0.989	0.154	101.32	1.700	25.500	0.500	1.200	31.10	---	---	---	---	---	---	---	---	Non Liquefiable
3.00	SC	19	17.63	7.63	46.08	52.890	0.000	52.890	0.977	0.152	101.34	1.384	26.300	0.500	1.200	32.06	---	---	---	---	---	---	---	---	Non Liquefiable
4.50	ML	23	17.74	7.74	53.54	79.500	14.715	64.785	0.966	0.185	101.36	1.251	28.768	0.500	1.200	35.02	---	---	---	---	---	---	---	---	Non Liquefiable
6.00	SC	25	17.84	7.84	32.89	106.260	29.430	76.830	0.954	0.206	101.38	1.149	28.717	4.876	1.179	38.72	---	---	---	---	---	---	---	---	Non Liquefiable
9.00	SC	28	18.05	8.05	46.34	160.410	58.860	101.550	0.931	0.229	101.41	0.999	27.981	0.500	1.200	34.08	---	---	---	---	---	---	---	---	Non Liquefiable
12.00	SC	39	18.26	8.26	47.3	215.190	88.290	126.900	0.854	0.226	101.45	0.894	34.871	0.500	1.200	42.34	---	---	---	---	---	---	---	---	Non Liquefiable
15.00	SC	50	18.51	8.51	48.48	270.720	117.720	153.000	0.774	0.214	101.49	0.814	40.722	0.500	1.200	49.37	---	---	---	---	---	---	---	---	Non Liquefiable
30.00	SC	50	19.34	9.34	46.8	560.820	264.870	295.950	0.560	0.166	101.68	0.586	29.307	0.500	1.200	35.67	---	---	---	---	---	---	---	---	Non Liquefiable
32.00	SC	50	19.34	9.34	46.63	599.500	284.490	315.010	0.560	0.166	101.70	0.568	28.410	0.500	1.200	34.59	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Liquefaction Analysis Using SPT Data

Bore hole: BH 06 | Water Table = Not Found | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
1.50	ML	15	17.58	7.58	61.49	26.370	26.370	0.989	0.154	101.32	1.700	25.500	0.500	1.200	31.10	---	---	---	---	---	---	---	---	Non Liquefiable
3.00	ML	20	17.58	7.58	58.79	52.740	52.740	0.977	0.152	101.34	1.386	27.723	0.500	1.200	33.77	---	---	---	---	---	---	---	---	Non Liquefiable
4.50	ML	25	17.76	7.76	58.57	79.380	79.380	0.966	0.151	101.36	1.130	28.249	0.500	1.200	34.40	---	---	---	---	---	---	---	---	Non Liquefiable
6.00	SM	32	17.94	7.94	36.4	106.830	106.830	0.954	0.149	101.38	0.974	31.172	0.500	1.200	37.91	---	---	---	---	---	---	---	---	Non Liquefiable
9.00	SM	39	18.05	8.05	39.19	161.790	161.790	0.931	0.145	101.41	0.792	30.877	0.500	1.200	37.55	---	---	---	---	---	---	---	---	Non Liquefiable
12.00	SM	43	18.16	8.16	44.43	216.930	216.930	0.854	0.133	101.45	0.684	29.406	0.500	1.200	35.79	---	---	---	---	---	---	---	---	Non Liquefiable
15.00	ML	47	18.40	8.395	61.84	273.105	273.105	0.774	0.121	101.49	0.610	28.651	0.500	1.200	34.88	---	---	---	---	---	---	---	---	Non Liquefiable
18.00	ML	50	18.63	8.63	60.61	331.815	331.815	0.693	0.108	101.53	0.553	27.657	0.500	1.200	33.69	---	---	---	---	---	---	---	---	Non Liquefiable
21.00	ML	50	18.79	8.79	56.27	391.710	391.710	0.613	0.096	101.56	0.509	25.460	0.500	1.200	31.05	---	---	---	---	---	---	---	---	Non Liquefiable
24.00	SM	50	18.95	8.95	41.47	451.440	451.440	0.560	0.087	101.60	0.474	23.720	0.500	1.200	28.96	0.41	1.19	NA	NA	1.00	1.00	0.49	5.58	Non Liquefiable
27.00	SM	50	19.19	9.19	44.08	512.370	512.370	0.560	0.087	101.64	0.445	22.269	0.500	1.200	27.22	0.34	1.19	NA	NA	1.00	1.00	0.41	4.71	Non Liquefiable
30.00	SM	50	19.43	9.43	35.54	576.420	576.420	0.560	0.087	101.68	0.420	20.999	0.500	1.200	25.70	0.31	1.19	NA	NA	1.00	1.00	0.37	4.18	Non Liquefiable
32.00	SM	50	19.43	9.43	37.86	621.760	621.760	0.560	0.087	101.70	0.404	20.222	0.500	1.200	24.77	0.29	1.19	NA	NA	1.00	1.00	0.34	3.92	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Name of Project:	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.

Liquefaction Analysis Using SPT Data

Bore hole: BH 07 | Water Table = Not Found | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
1.50	SP-SM	18	17.72	7.72	10.38	26.580	26.580	0.989	0.154	101.32	1.700	30.600	0.997	1.023	32.31	---	---	---	---	---	---	---	---	Non Liquefiable
3.00	SM	27	17.72	7.72	24.05	53.160	53.160	0.977	0.152	101.34	1.381	37.278	4.185	1.108	45.49	---	---	---	---	---	---	---	---	Non Liquefiable
4.50	SP	36	17.83	7.83	0.81	79.905	79.905	0.966	0.151	101.36	1.126	40.545	0.000	1.000	40.55	---	---	---	---	---	---	---	---	Non Liquefiable
6.00	SM	43	17.94	7.94	29.11	106.815	106.815	0.954	0.149	101.38	0.974	41.891	4.645	1.147	52.70	---	---	---	---	---	---	---	---	Non Liquefiable
18.00	SP-SM	50	18.94	8.94	6.94	334.095	334.095	0.693	0.108	101.53	0.551	27.563	0.112	1.008	27.90	0.37	1.19	NA	NA	1.00	1.00	0.44	4.04	Non Liquefiable
27.00	SM	50	19.82	9.82	46.34	512.475	512.475	0.560	0.087	101.64	0.445	22.267	0.500	1.200	27.22	0.34	1.19	NA	NA	1.00	1.00	0.41	4.71	Non Liquefiable
30.00	SM	50	19.92	9.92	46.67	572.235	572.235	0.560	0.087	101.68	0.422	21.076	0.500	1.200	25.79	0.31	1.19	NA	NA	1.00	1.00	0.37	4.21	Non Liquefiable
32.00	SM	50	19.92	9.92	48.45	612.075	612.075	0.560	0.087	101.70	0.408	20.381	0.500	1.200	24.96	0.29	1.19	NA	NA	1.00	1.00	0.35	3.97	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Liquefaction Analysis Using SPT Data

Bore hole: BH 08 | Water Table = Not Found | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
1.50	ML	50	17.58	7.58	52.82	26.370	26.370	0.989	0.154	101.32	1.700	85.000	0.500	1.200	102.50	---	---	---	---	---	---	---	---	Non Liquefiable
3.00	ML	50	17.58	7.58	52.61	52.740	52.740	0.977	0.152	101.34	1.386	69.308	0.500	1.200	83.67	---	---	---	---	---	---	---	---	Non Liquefiable
4.50	ML	50	17.85	7.85	59.3	79.515	79.515	0.966	0.151	101.36	1.129	56.451	0.500	1.200	68.24	---	---	---	---	---	---	---	---	Non Liquefiable
6.00	ML	50	18.12	8.12	53.84	106.695	106.695	0.954	0.149	101.38	0.975	48.738	0.500	1.200	58.99	---	---	---	---	---	---	---	---	Non Liquefiable
9.00	ML	50	18.37	8.37	54.97	161.805	161.805	0.931	0.145	101.41	0.792	39.584	0.500	1.200	48.00	---	---	---	---	---	---	---	---	Non Liquefiable
12.00	ML	50	18.63	8.63	62.5	217.695	217.695	0.854	0.133	101.45	0.683	34.133	0.500	1.200	41.46	---	---	---	---	---	---	---	---	Non Liquefiable
15.00	SC	50	18.79	8.79	49.32	274.065	274.065	0.774	0.121	101.49	0.609	30.426	0.500	1.200	37.01	---	---	---	---	---	---	---	---	Non Liquefiable
18.00	SC	50	18.95	8.95	44.86	330.915	330.915	0.693	0.108	101.53	0.554	27.695	0.500	1.200	33.73	---	---	---	---	---	---	---	---	Non Liquefiable
20.00	SC	50	18.95	8.95	42.06	368.815	368.815	0.640	0.100	101.55	0.525	26.236	0.500	1.200	31.98	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Name of Project:	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.

Liquefaction Analysis Using SPT Data

Bore hole: BH 09 | Water Table = 1.9 m | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Pore water Pressure (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
1.50	ML	5	17.55	7.55	58.23	26.325	---	26.325	0.989	0.154	101.32	1.700	8.500	0.500	1.200	10.70	0.12	1.19	NA	NA	1.00	1.00	0.14	0.92	Liquefiable
6.00	SM	19	17.93	7.93	46.8	107.010	40.221	66.789	0.954	0.238	101.38	1.232	23.408	0.500	1.200	28.59	0.39	1.19	NA	NA	1.00	1.00	0.47	1.96	Non Liquefiable
18.00	ML	25	19	9	69.97	335.010	157.941	177.069	0.693	0.205	101.53	0.757	18.930	0.500	1.200	23.22	0.26	1.19	NA	NA	1.00	1.00	0.31	1.52	Non Liquefiable
24.00	ML	29	19.26	9.26	73.58	450.570	216.801	233.769	0.533	0.160	101.60	0.659	19.118	0.500	1.200	23.44	0.26	1.19	NA	NA	1.00	1.00	0.31	1.96	Non Liquefiable
30.00	SM	50	19.26	9.26	46.34	566.130	275.661	290.469	0.373	0.113	101.68	0.592	29.582	0.500	1.200	36.00	---	---	---	---	---	---	---	---	Non Liquefiable
33.00	SM	50	19.26	9.26	48.57	623.910	305.091	318.819	0.293	0.089	101.71	0.565	28.241	0.500	1.200	34.39	---	---	---	---	---	---	---	---	Non Liquefiable
36.00	SM	50	19.26	9.26	42.04	681.690	334.521	347.169	0.213	0.065	101.75	0.541	27.069	0.500	1.200	32.98	---	---	---	---	---	---	---	---	Non Liquefiable
39.00	SM	50	19.26	9.26	33.87	739.470	363.951	375.519	0.560	0.172	101.79	0.521	26.032	4.925	1.187	35.83	---	---	---	---	---	---	---	---	Non Liquefiable
40.00	SM	50	19.26	9.26	45.01	758.730	373.761	384.969	0.560	0.172	101.80	0.514	25.712	0.500	1.200	31.35	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Liquefaction Analysis Using SPT Data

Bore hole: BH 10 | Water Table = 2.4 m | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Pore water Pressure (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
3.00	SM	5	17.74	7.74	38.14	53.220	5.886	47.334	0.977	0.171	101.34	1.463	7.316	0.500	1.200	9.28	0.11	1.19	NA	NA	1.00	1.00	0.13	0.74	Liquefiable
6.00	SM	11	18.01	8.01	36.29	107.250	35.316	71.934	0.954	0.222	101.38	1.187	13.058	0.500	1.200	16.17	0.17	1.19	NA	NA	1.00	1.00	0.21	0.92	Liquefiable
18.00	SM	17	18.88	8.88	42.28	333.810	153.036	180.774	0.693	0.200	101.53	0.749	12.740	0.500	1.200	15.79	0.17	1.19	NA	NA	1.00	1.00	0.20	1.00	Non Liquefiable
24.00	SM	30	19.19	9.19	35.99	448.950	211.896	237.054	0.533	0.158	101.60	0.655	19.640	0.500	1.200	24.07	0.27	1.19	NA	NA	1.00	1.00	0.33	2.08	Non Liquefiable
30.00	SM	50	19.43	9.43	37.45	565.530	270.756	294.774	0.373	0.112	101.68	0.587	29.365	0.500	1.200	35.74	---	---	---	---	---	---	---	---	Non Liquefiable
33.00	ML	50	19.43	9.43	66.25	623.820	300.186	323.634	0.293	0.088	101.71	0.561	28.030	0.500	1.200	34.14	---	---	---	---	---	---	---	---	Non Liquefiable
36.00	SM	50	19.43	9.43	33.38	682.110	329.616	352.494	0.213	0.064	101.75	0.537	26.863	4.901	1.183	36.68	---	---	---	---	---	---	---	---	Non Liquefiable
39.00	SM	50	19.43	9.43	35.23	740.400	359.046	381.354	0.560	0.170	101.79	0.517	25.832	0.500	1.200	31.50	---	---	---	---	---	---	---	---	Non Liquefiable
40.00	SM	50	19.43	9.43	45.14	759.830	368.856	390.974	0.560	0.170	101.80	0.510	25.513	0.500	1.200	31.12	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Name of Project:	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.

Liquefaction Analysis Using SPT Data

Bore hole: BH 11 | Water Table = 1.8 m | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Pore water Pressure (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
3.00	SM	9	17.75	7.75	41.83	53.250	11.772	41.478	0.977	0.196	101.34	1.563	14.068	0.500	1.200	17.38	0.18	1.19	NA	NA	1.00	1.00	0.22	1.13	Non Liquefiable
6.00	SM	18	18.29	8.29	15.64	108.120	41.202	66.918	0.954	0.240	101.38	1.231	22.155	2.673	1.052	25.98	0.31	1.19	NA	NA	1.00	1.00	0.37	1.55	Non Liquefiable
18.00	SM	32	19.02	9.02	35.29	336.360	158.922	177.438	0.693	0.205	101.53	0.756	24.205	0.500	1.200	29.55	0.44	1.19	NA	NA	1.00	1.00	0.52	2.55	Non Liquefiable
24.00	SM	37	19.37	9.37	41.71	452.580	217.782	234.798	0.533	0.160	101.60	0.658	24.339	0.500	1.200	29.71	0.45	1.19	NA	NA	1.00	1.00	0.53	3.34	Non Liquefiable
30.00	SM	50	19.56	9.56	15	569.940	276.642	293.298	0.373	0.113	101.68	0.589	29.439	2.498	1.048	33.35	---	---	---	---	---	---	---	---	Non Liquefiable
33.00	SM	50	19.56	9.56	17.17	628.620	306.072	322.548	0.293	0.089	101.71	0.562	28.078	3.051	1.061	32.85	---	---	---	---	---	---	---	---	Non Liquefiable
36.00	SM	50	19.56	9.56	16.26	687.300	335.502	351.798	0.213	0.065	101.75	0.538	26.890	2.833	1.056	31.22	---	---	---	---	---	---	---	---	Non Liquefiable
39.00	SM	50	19.56	9.56	15.97	745.980	364.932	381.048	0.560	0.171	101.79	0.517	25.842	2.759	1.054	29.99	---	---	---	---	---	---	---	---	Non Liquefiable
40.00	SM	50	19.56	9.56	13.38	765.540	374.742	390.798	0.560	0.171	101.80	0.510	25.519	2.011	1.039	28.52	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Liquefaction Analysis Using SPT Data

Bore hole: BH 11A | Water Table = 6.5 m | Reference Standard: IS 1893 (Part 1) : 2016
Sesmic Zone: IV | Magnitude (M_w) = 7

Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Pore water Pressure (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
3.00	SM	5	17.89	7.89	24.42	53.670	---	53.670	0.977	0.152	101.34	1.374	6.871	4.227	1.111	11.86	0.13	1.19	NA	NA	1.00	1.00	0.15	1.02	Non Liquefiable
18.00	SM	50	19.03	9.03	29.78	339.120	112.815	339.120	0.693	0.108	101.53	0.547	27.358	4.692	1.153	36.22	---	---	---	---	---	---	---	---	Non Liquefiable
21.00	SM	50	19.03	9.03	22.38	396.210	142.245	253.965	0.613	0.149	101.56	0.632	31.619	3.978	1.096	38.63	---	---	---	---	---	---	---	---	Non Liquefiable
24.00	SM	50	19.03	9.03	21.25	453.300	171.675	281.625	0.533	0.134	101.60	0.601	30.032	3.816	1.088	36.49	---	---	---	---	---	---	---	---	Non Liquefiable
27.00	SM	50	19.03	9.03	23.43	510.390	201.105	309.285	0.453	0.117	101.64	0.573	28.663	4.112	1.103	35.74	---	---	---	---	---	---	---	---	Non Liquefiable
30.00	SM	50	19.03	9.03	21.51	567.480	230.535	336.945	0.373	0.098	101.68	0.549	27.466	3.855	1.090	33.79	---	---	---	---	---	---	---	---	Non Liquefiable
33.00	SM	50	19.03	9.03	17.43	624.570	259.965	364.605	0.293	0.078	101.71	0.528	26.409	3.110	1.063	31.18	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Name of Project:	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.

Bore hole	BH 12					Water Table =		Not Found									Reference Standard			IS 1893 (Part 1) : 2016		
Sesmic Zone	IV					Magnitude (M_w) =		7														

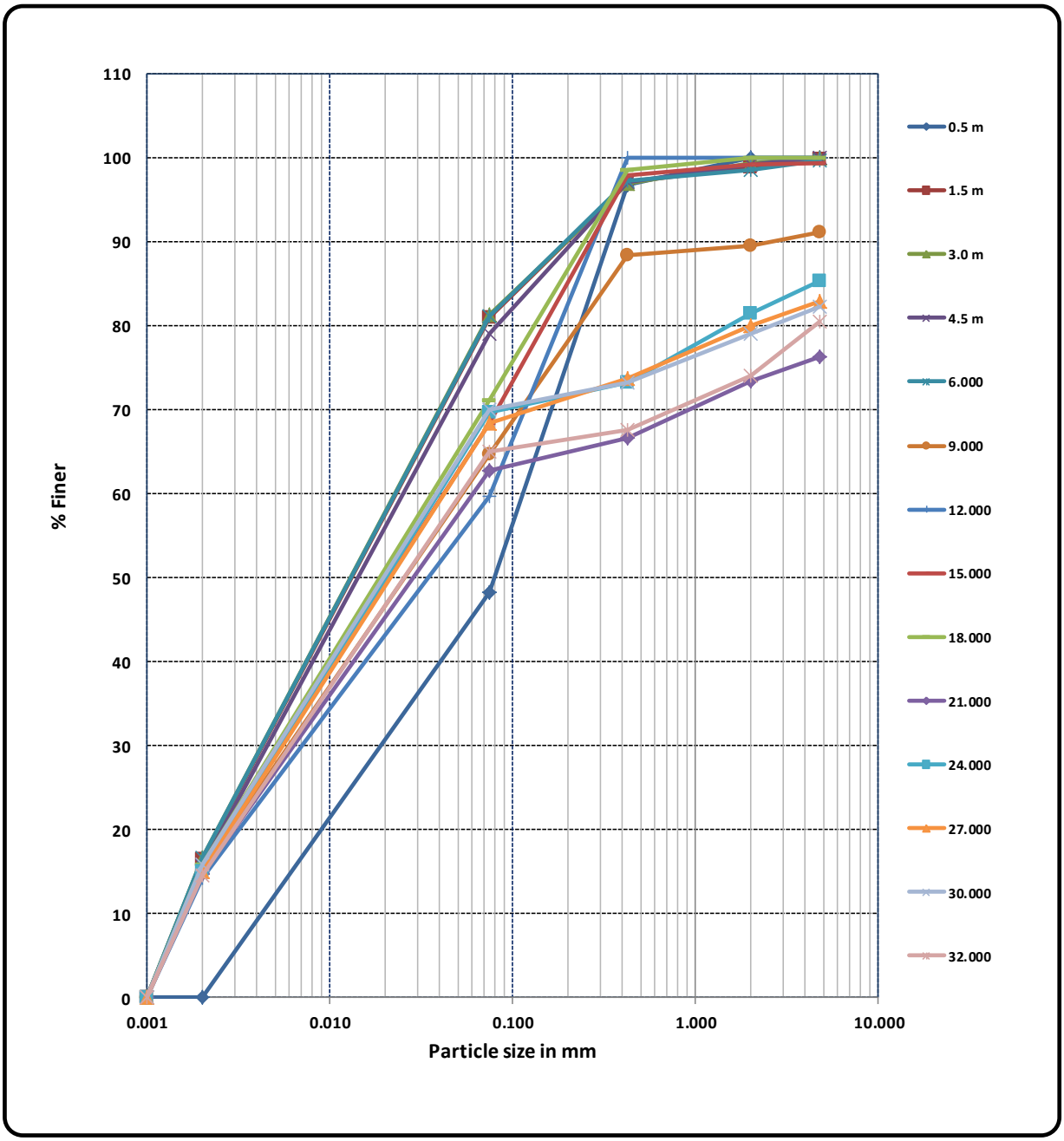
Depth Below G.L (z) in m	Soil Classification	Observed SPT Value	Bulk Density (kN/m³)	Submerged Density (kN/m³)	Fine Content (%)	Total Vertical Overburden Stress_σ_{vo} (kPa)	Effective Vertical Overburden Stress_σ'_{vo} (kPa)	Stress Reduction Coefficient (rd)	Cyclic Stress Ratio (CSR)	Atmospheric Pressure_P_a (kPa)	Overburden Correction Factor (C_N)	$(N_1)_{60}$	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$	MSF	Relative Density_D_r	f	K_σ	K_α	CRR	FS	Condition
0.50	ML	17	17.9	7.9	51.90	8.95	8.95	0.996	0.155	101.306	1.700	28.900	0.500	1.200	35.18	---	---	---	---	---	---	---	---	Non Liquefiable
1.50	ML	24	17.9	7.9	50.74	26.85	26.85	0.989	0.154	101.319	1.700	40.800	0.500	1.200	49.46	---	---	---	---	---	---	---	---	Non Liquefiable
3.00	ML	50	17.9	7.9	50.36	53.70	53.70	0.977	0.152	101.338	1.374	68.686	0.500	1.200	82.92	---	---	---	---	---	---	---	---	Non Liquefiable

Since the value of (N1)60cs is graeter than equal to 30, so the soil are too densed to liquefy and are classed as nonliquefiable.

Name of Project:	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.

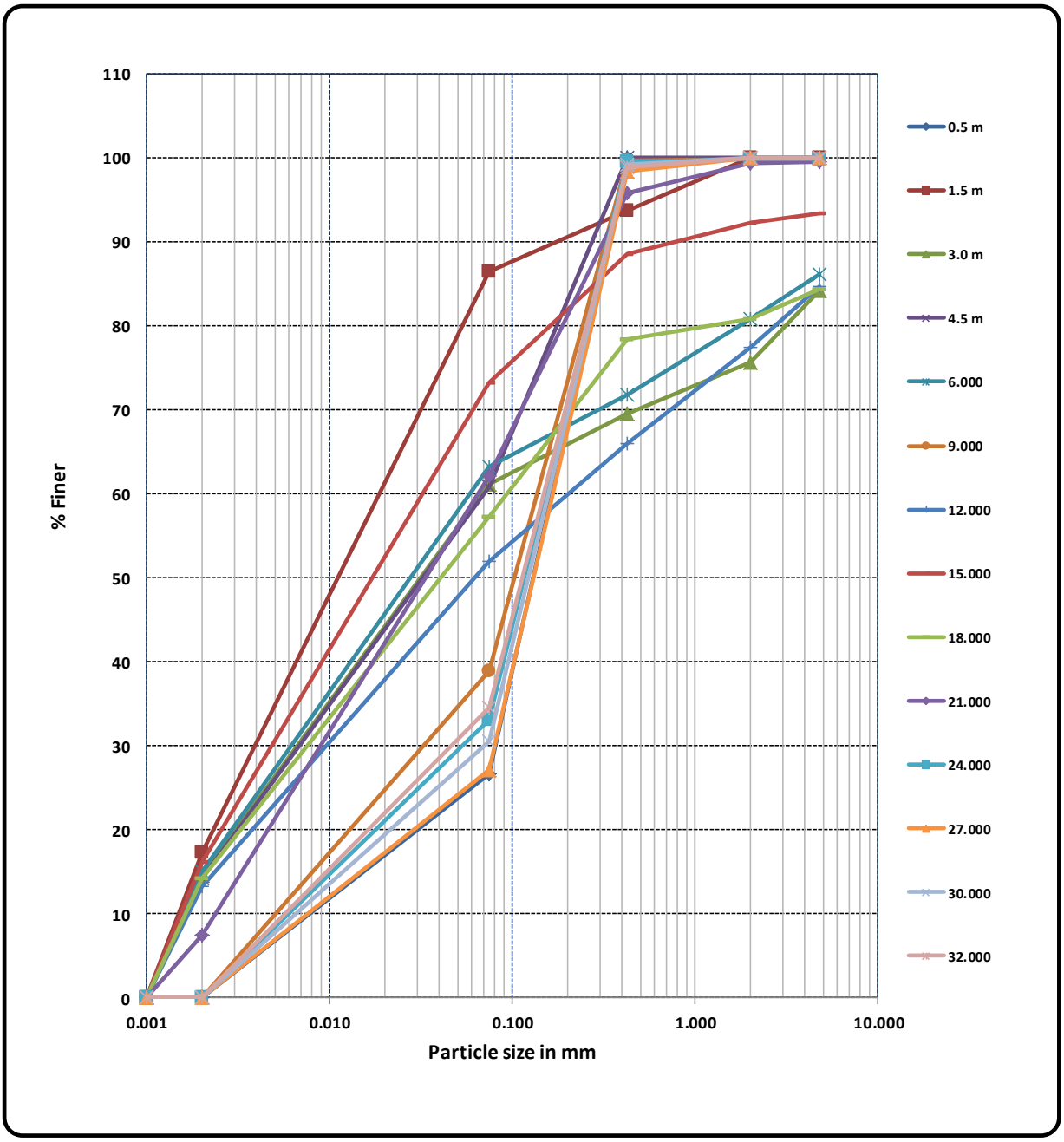
ANNEXURE -G
GRAIN SIZE DISTRIBUTION CURVE

GRAIN SIZE DISTRIBUTION CURVE OF ABUTMENT (BH NO-2)



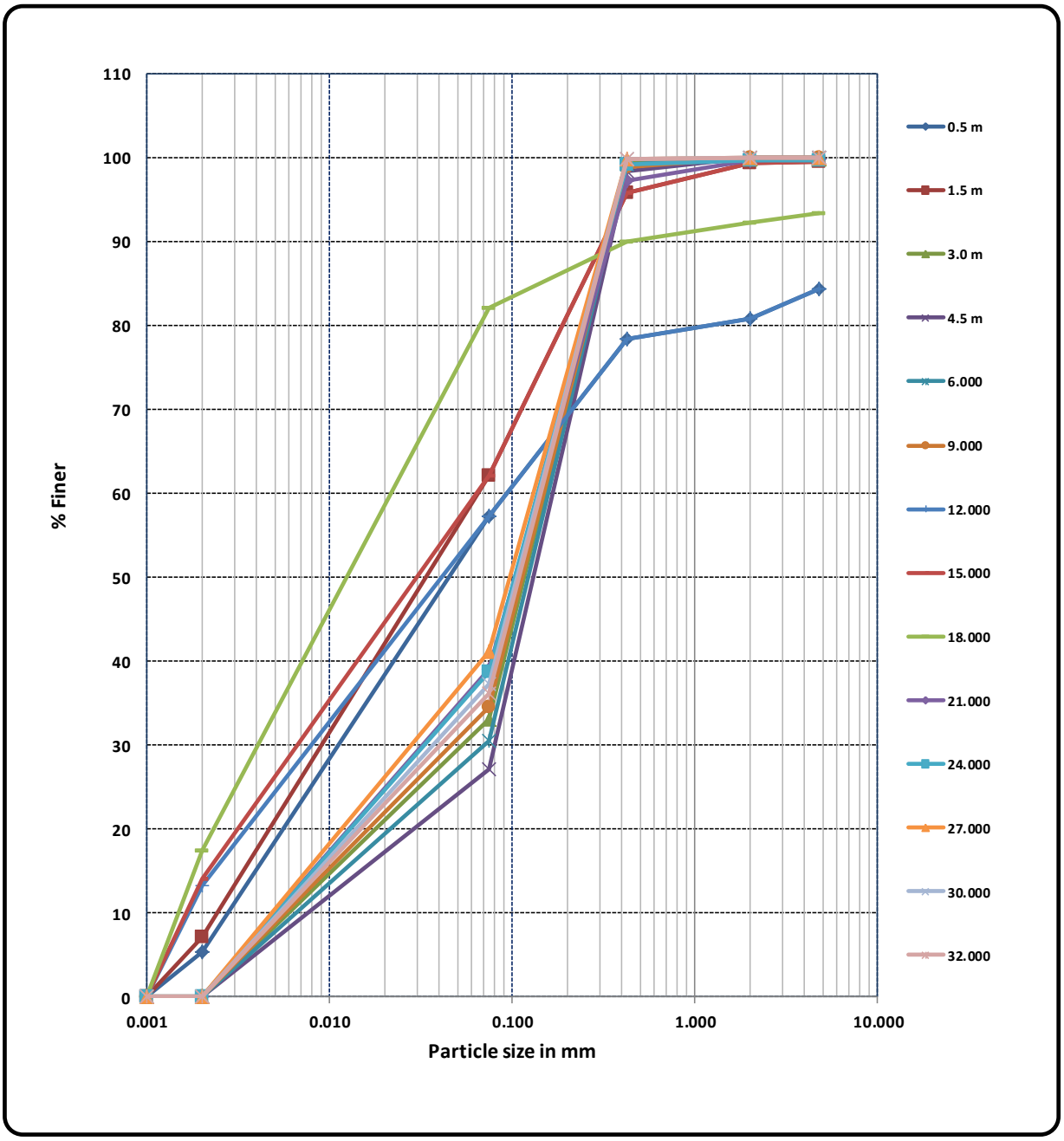
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-3)



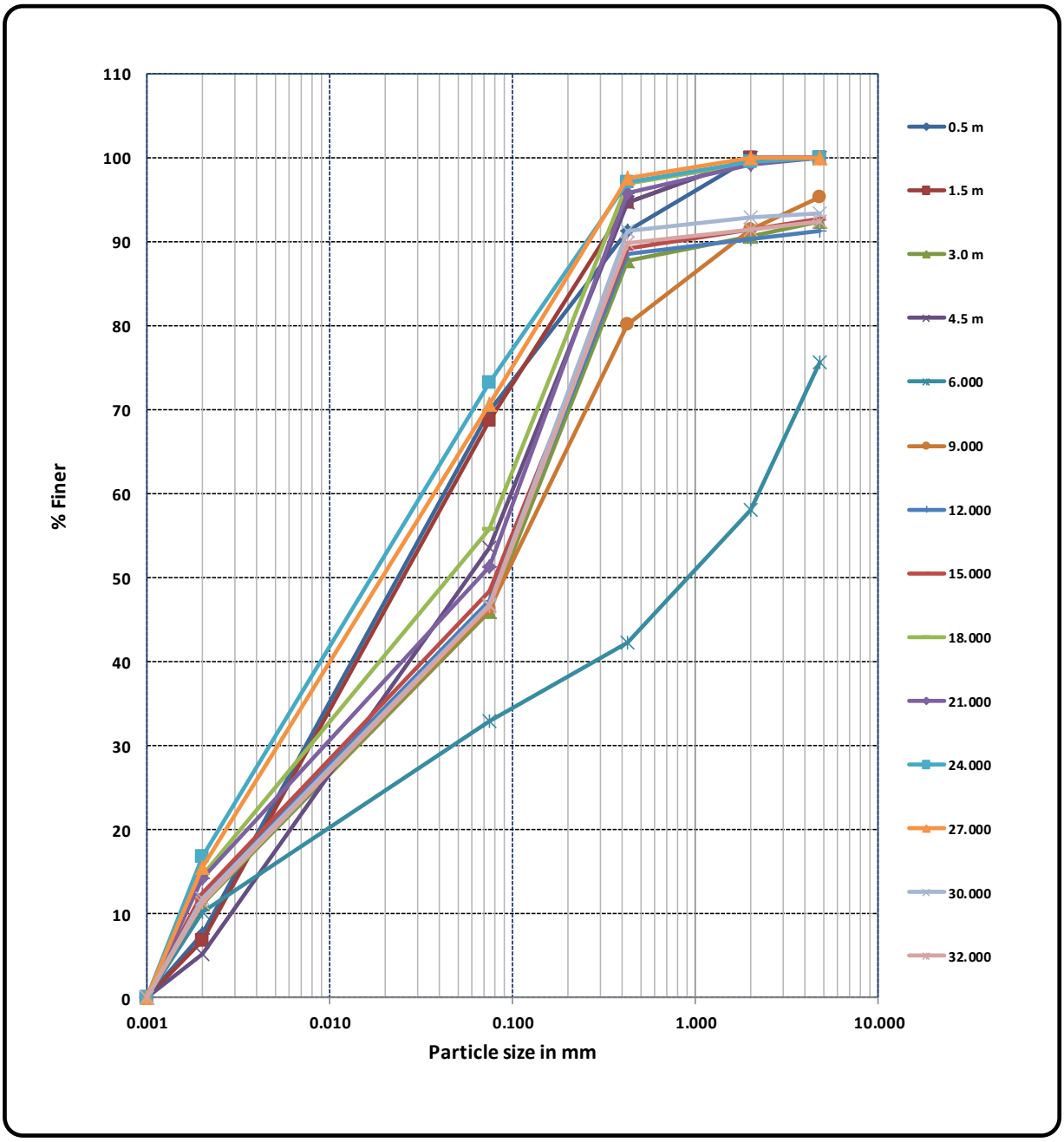
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-4)



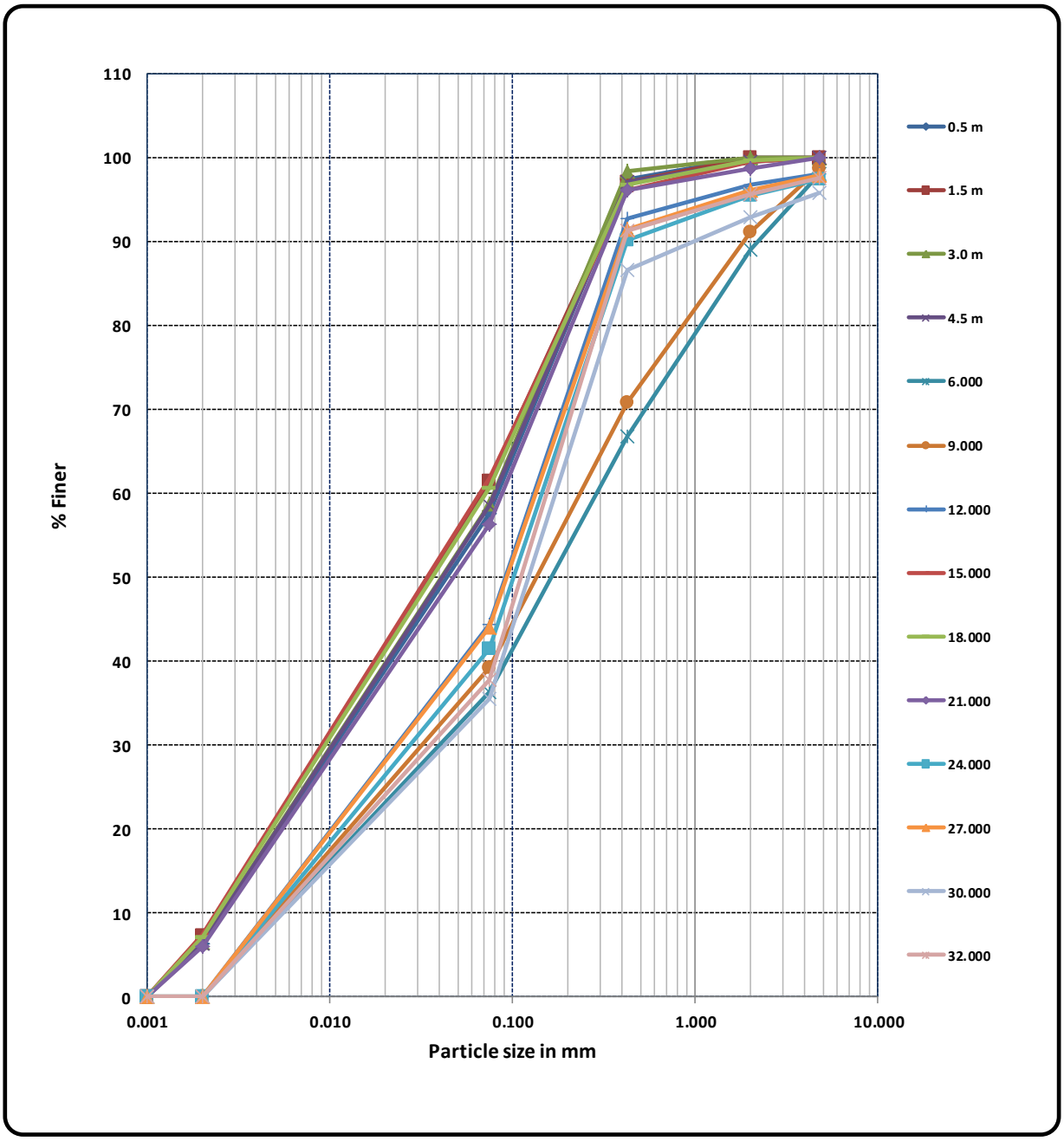
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-5)



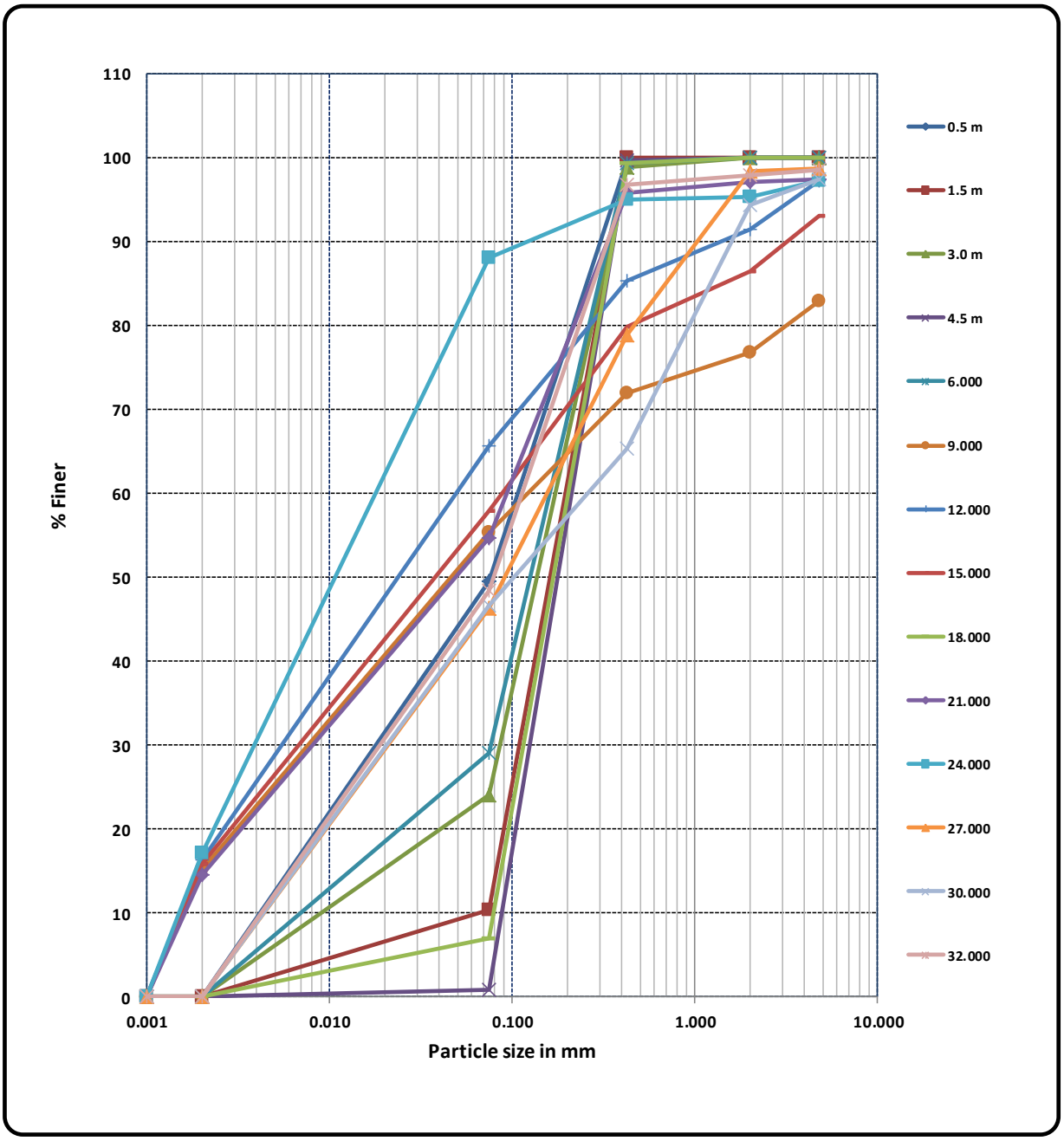
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-6)



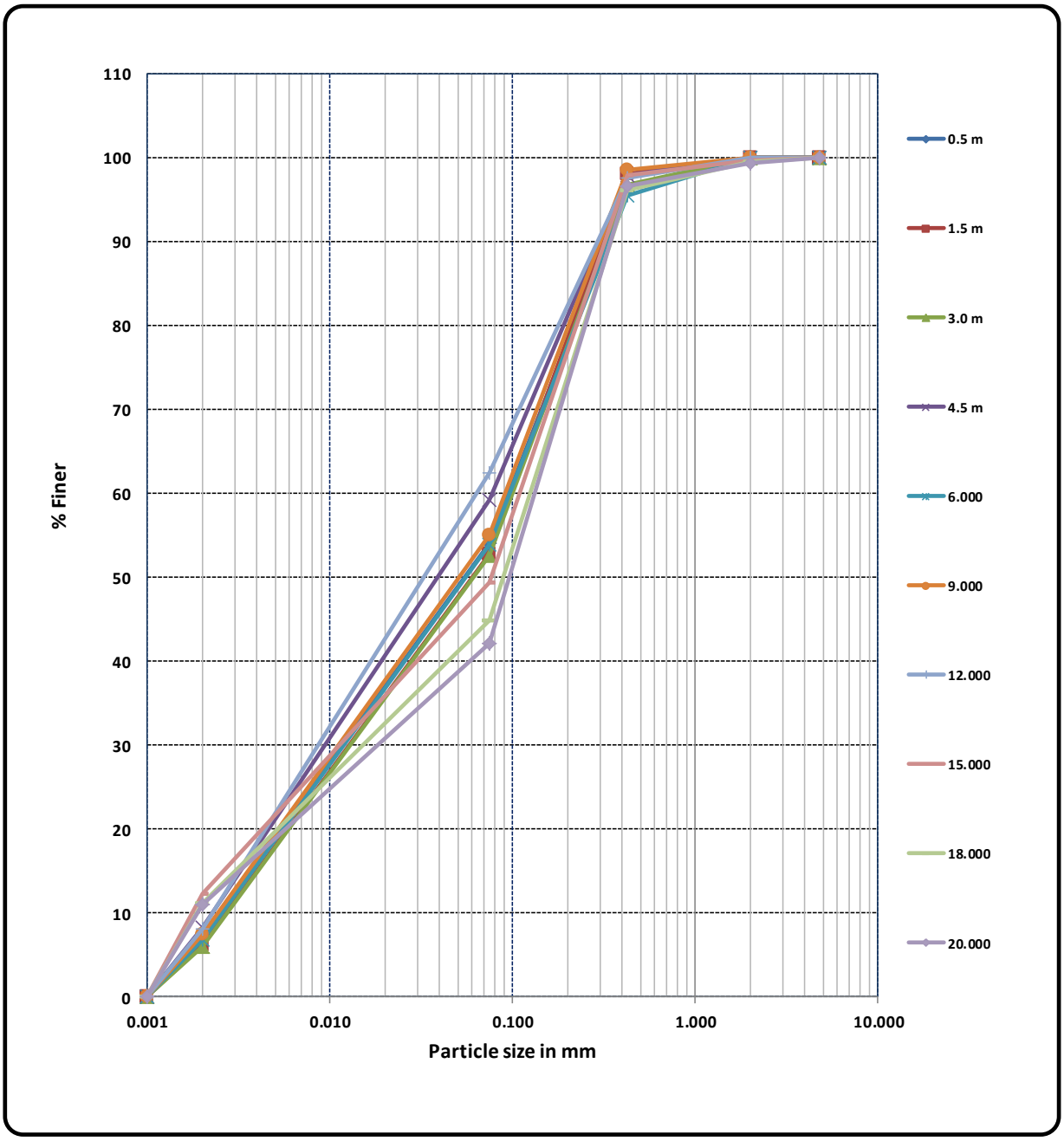
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-7)



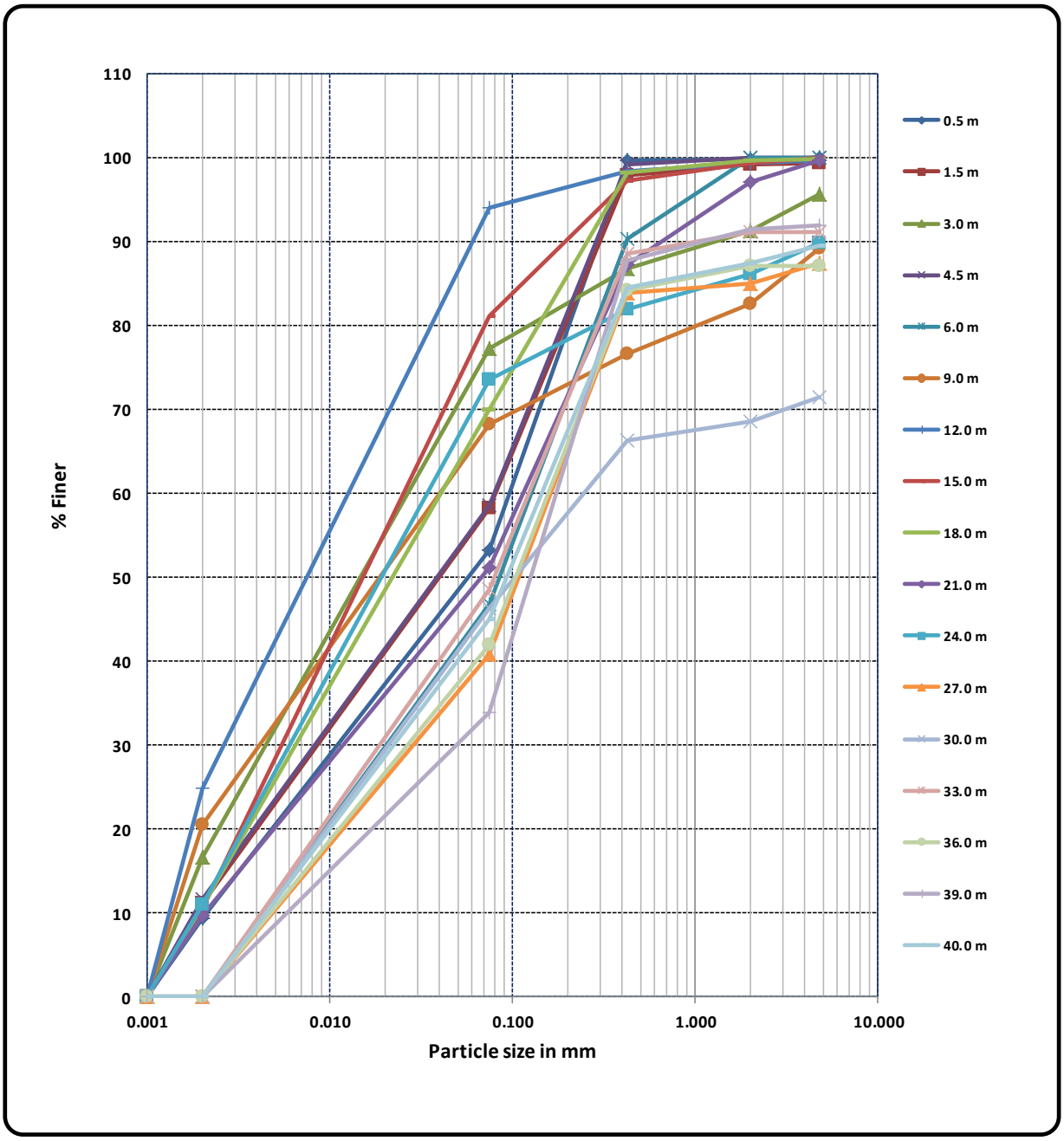
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-8)



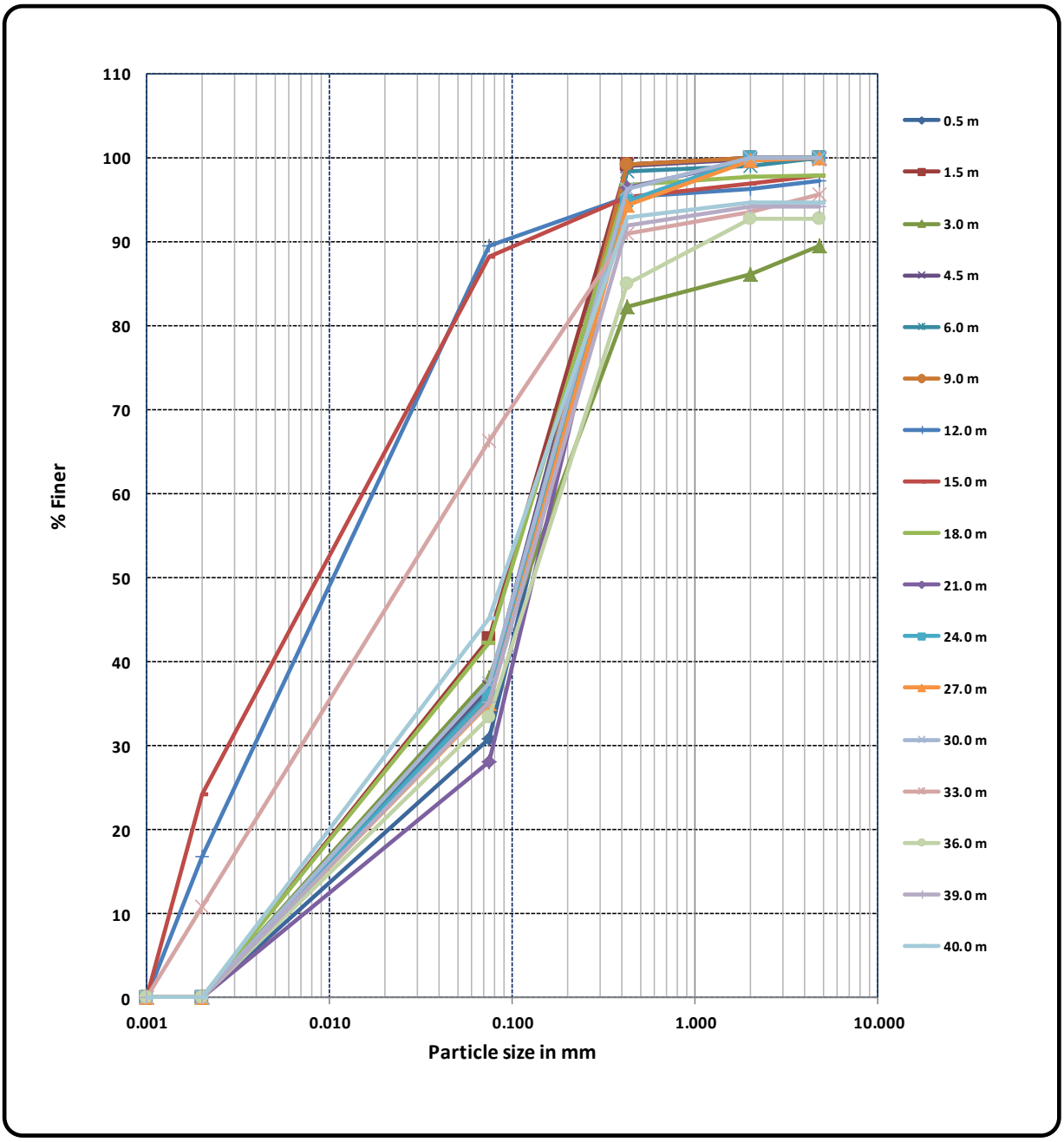
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-9)



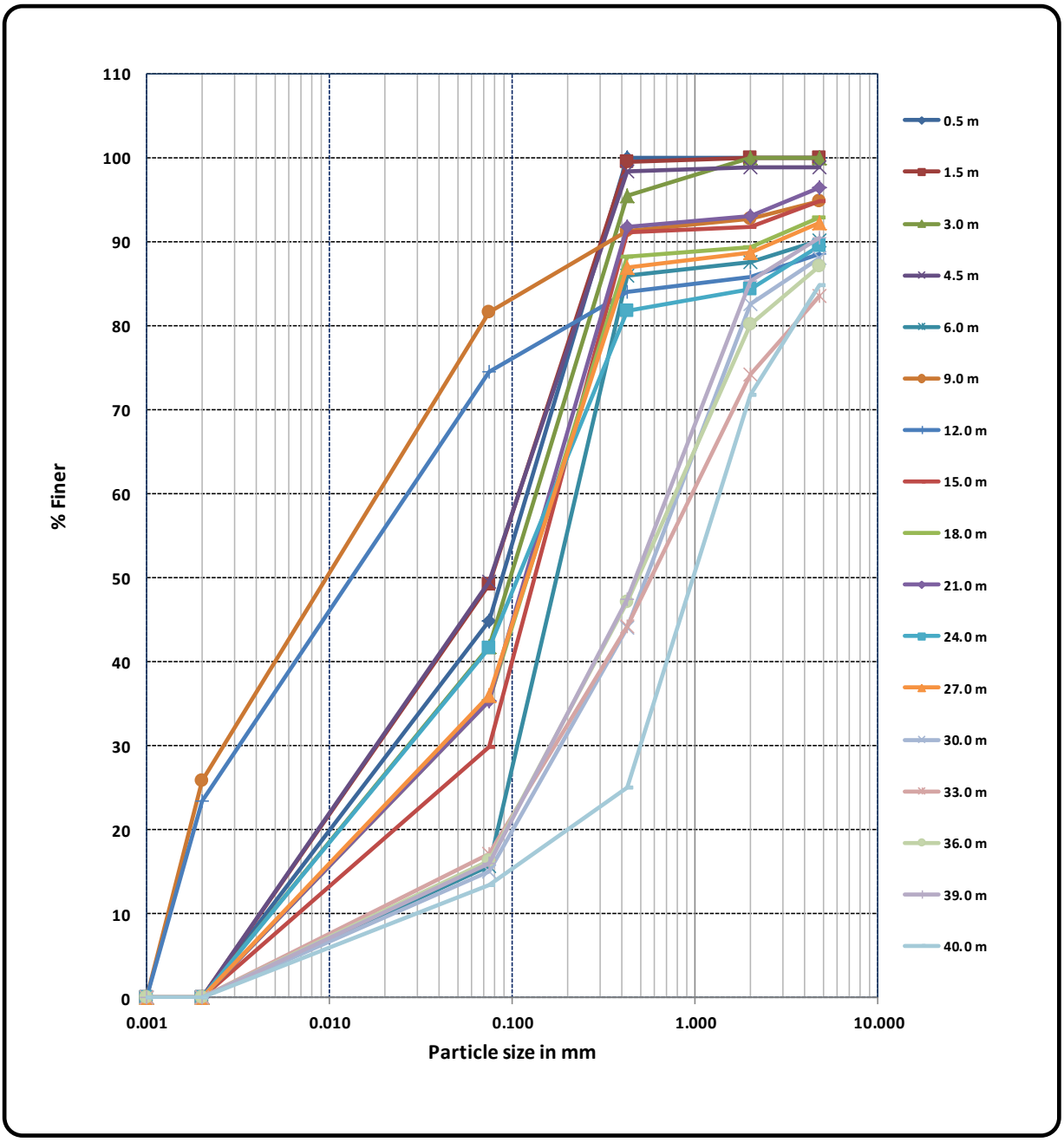
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-10)



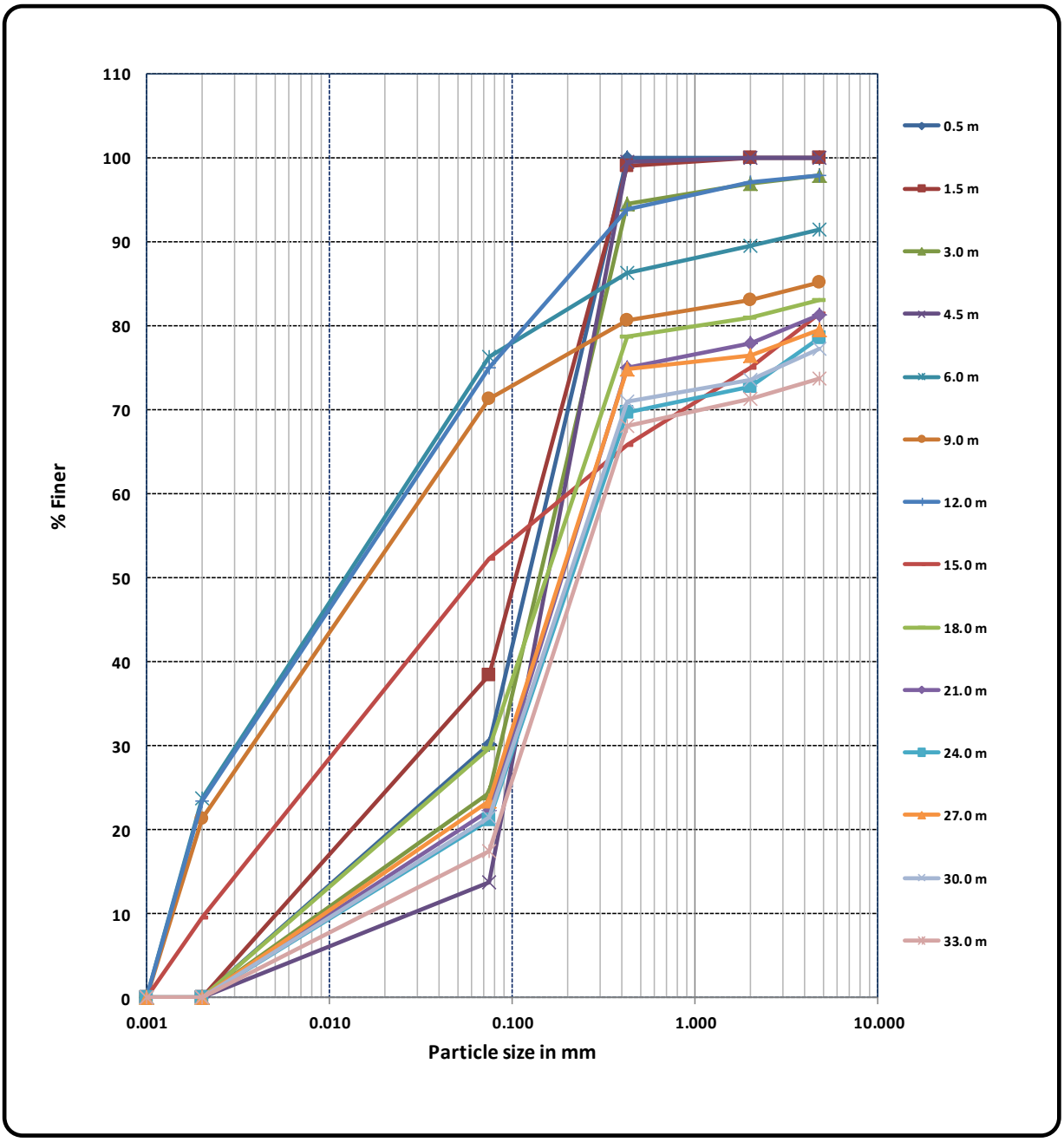
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-11)



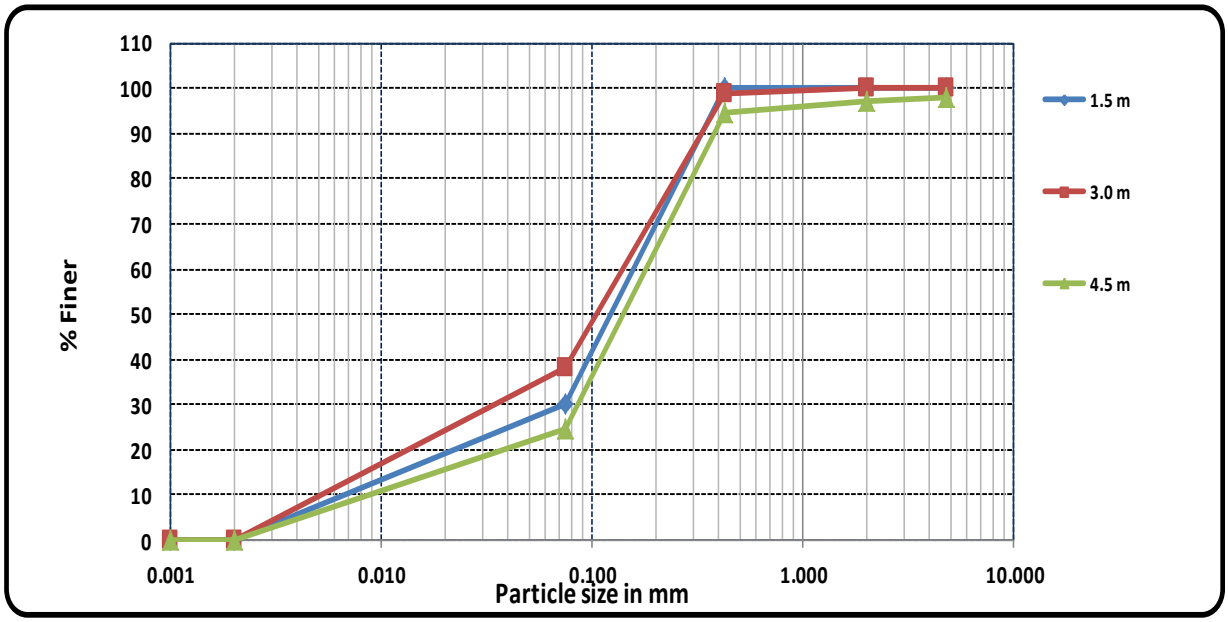
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-11A)



Name of Project:	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.

GRAIN SIZE DISTRIBUTION CURVE OF PIER (BH NO-12)



ANNEXURE -H
COMPUTATION OF CORRECTED N VALUE

COMPUTATION OF SELECTED N VALUE)

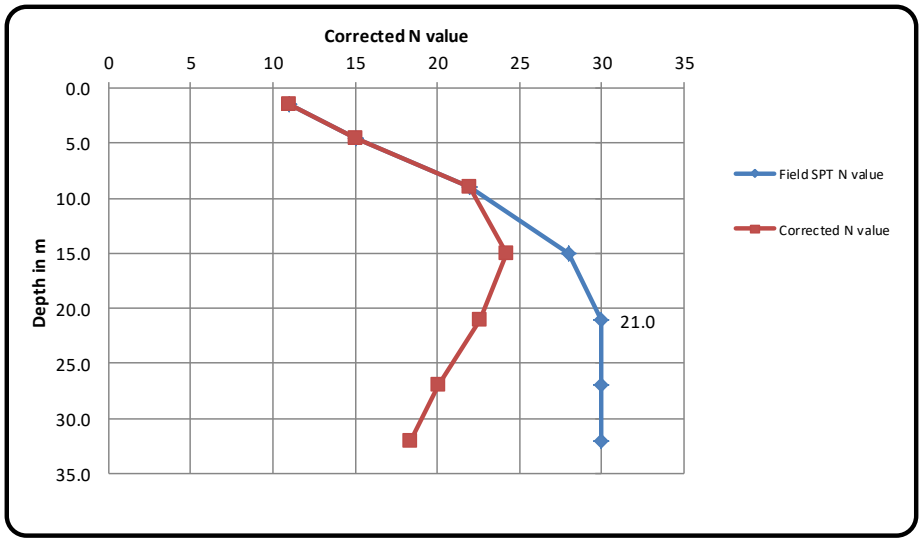
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	ABUTMENT (BH-02)	1.5	1.5	CL	11		1.000	0.150	1.00	11.00	11.00
2		4.5		CL	15		1.000	0.450	1.00	15.00	15.00
3		9.0		CL	22		1.000	0.900	1.00	22.00	22.00
4		15.0		CL	28		1.000	1.500	0.87	24.25	24.25
5		21.0		CL	48	30	1.000	2.100	0.75	22.61	22.61
6		27.0		CL	54	30	1.000	2.700	0.67	20.09	20.09
7		32.0		CL	66	30	1.000	3.200	0.61	18.38	18.38

Note: 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.

STANDARD PENETRATION TEST OF BH NO-02(ABUTMENT)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

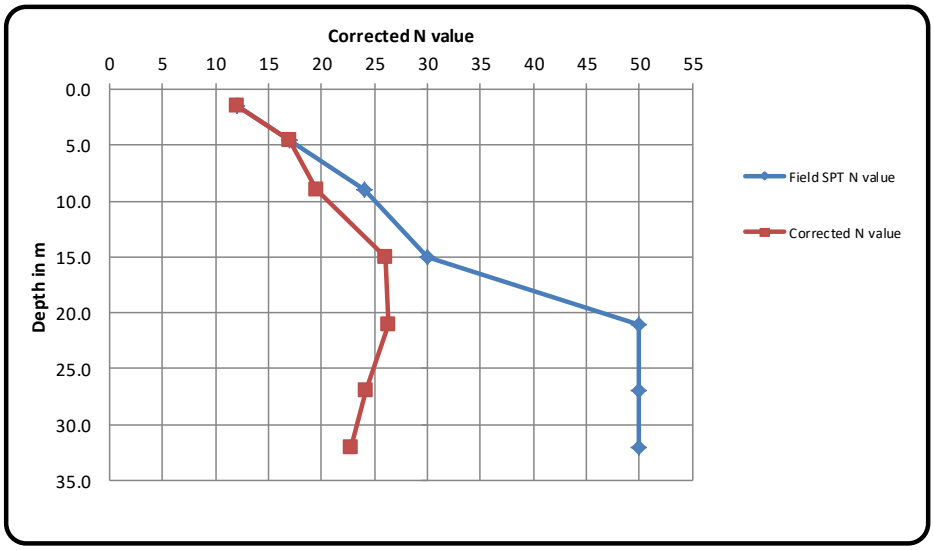
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-03)	1.5	2.5	CL	12		1.762	0.264	1.00	12.0	12.00
2		4.5		CL	17		1.000	0.450	1.00	17.0	17.00
3		9.0		SM	24		1.000	0.900	1.00	24.0	19.50
4		15.0		CL	32	30	1.000	1.500	0.87	26.0	25.99
5		21.0		ML	59	50	1.000	2.100	0.75	37.7	26.3
6		27.0		SM	68	50	1.000	2.700	0.67	33.5	24.2
7		32.0		SM	77	50	1.000	3.200	0.61	30.6	22.8

Note: 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.

STANDARD PENETRATION TEST OF BH NO-03(PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

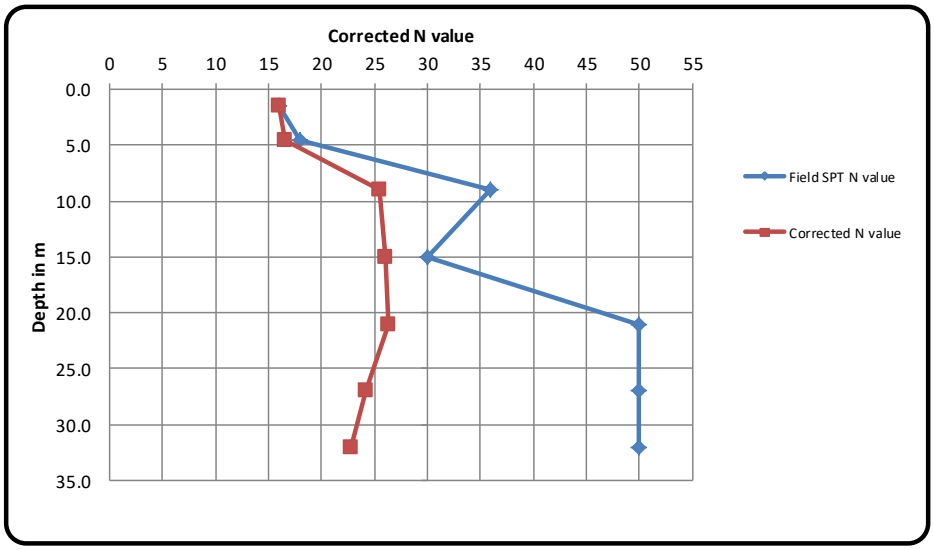
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-04)	1.5	2.00	ML	16		1.768	0.265	1.00	16.0	16.0
2		4.5		SM	18		1.000	0.450	1.00	18.0	16.5
3		9.0		SM	36		1.000	0.900	1.00	36.0	25.5
4		15.0		CL	52	30	1.000	1.500	0.87	26.0	25.99
5		21.0		SM	65	50	1.000	2.100	0.75	37.7	26.3
6		27.0		SM	76	50	1.000	2.700	0.67	33.5	24.2
7		32.0		SM	85	50	1.000	3.200	0.61	30.6	22.8

Note: 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.

STANDARD PENETRATION TEST OF BH NO- 04(PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

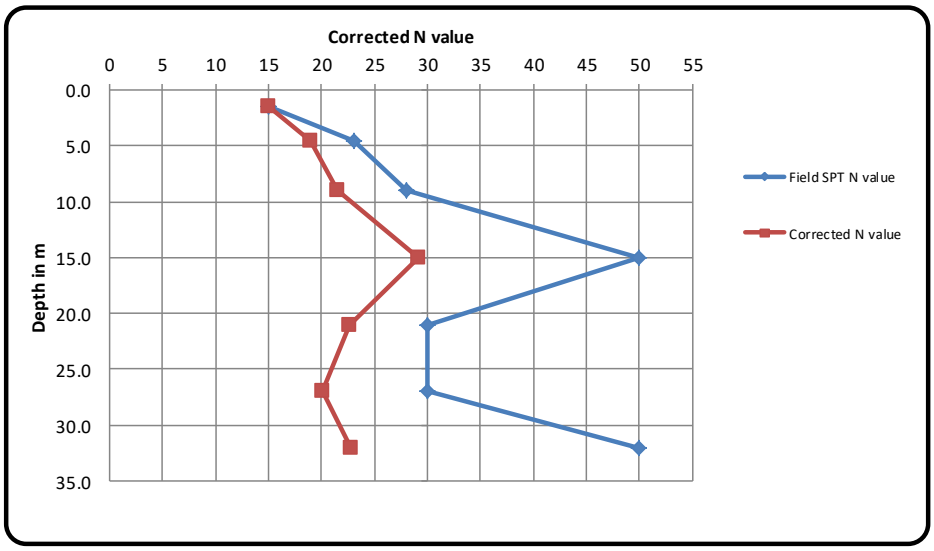
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-5)	1.5	3.00	ML	15		1.763	0.264	1.00	15.0	15.0
2		4.5		ML	23		1.000	0.450	1.00	23.0	19.0
3		9.0		SC	28		1.000	0.900	1.00	28.0	21.5
4		15.0		SC	50		1.000	1.500	0.87	43.3	29.2
5		21.0		CL	61	30	1.000	2.100	0.75	22.6	22.6
6		27.0		CL	70	30	1.000	2.700	0.67	20.1	20.1
7		32.0		SC	73	50	1.000	3.200	0.61	30.6	22.8

Note: 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.

STANDARD PENETRATION TEST OF BH NO-5(PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

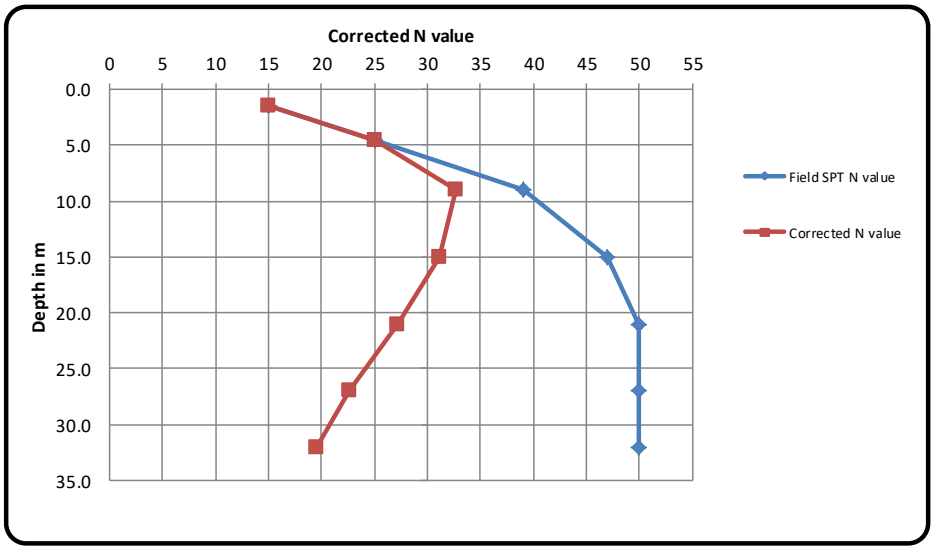
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-6)	1.5	NOT FOUND	ML	15		1.758	0.264	1.00	15.0	15.0
2		4.5		ML	25		1.776	0.799	1.00	25.0	25.0
3		9.0		SM	39		1.805	1.625	0.84	32.7	32.7
4		15.0		ML	47		1.840	2.759	0.66	31.1	31.1
5		21.0		ML	60	50	1.879	3.946	0.54	27.1	27.1
6		27.0		SM	71	50	1.919	5.181	0.45	22.6	22.6
7		32.0		SM	83	50	1.943	6.218	0.39	19.5	19.5

Note: 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.

STANDARD PENETRATION TEST OF BH NO-6(PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

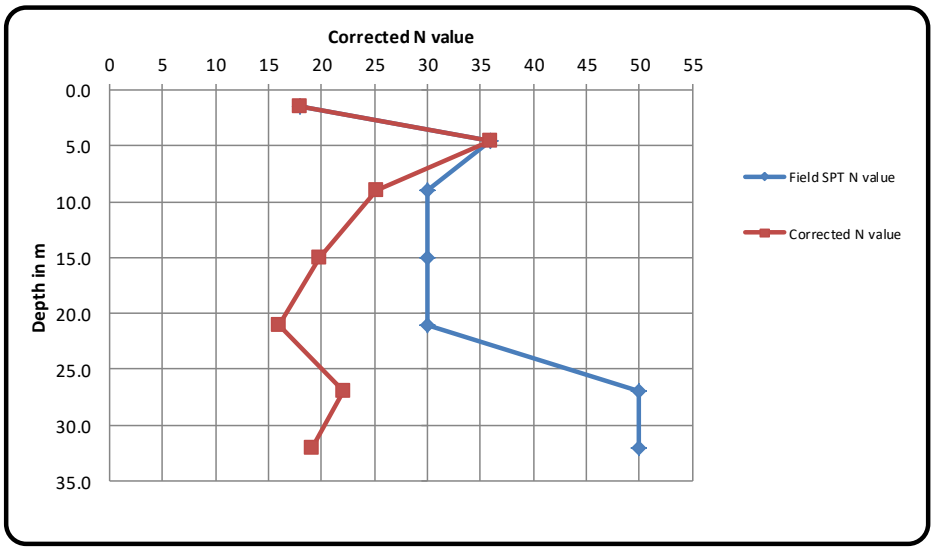
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-7)	1.5	NOT FOUND	SP-SM	18		1.772	0.266	1.00	18.0	18.0
2		4.5		SP	36		1.783	0.802	1.00	36.0	36.0
3		9.0		CL	50	30	1.794	1.615	0.84	25.2	25.2
4		15.0		CL	54	30	1.844	2.766	0.66	19.8	19.8
5		21.0		CL	68	30	1.934	4.060	0.53	16.0	16.0
6		27.0		SM	79	50	1.983	5.353	0.44	22.0	22.0
7		32.0		SM	88	50	1.992	6.374	0.38	19.1	19.1

Note: 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.

STANDARD PENETRATION TEST OF BH NO-7(PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

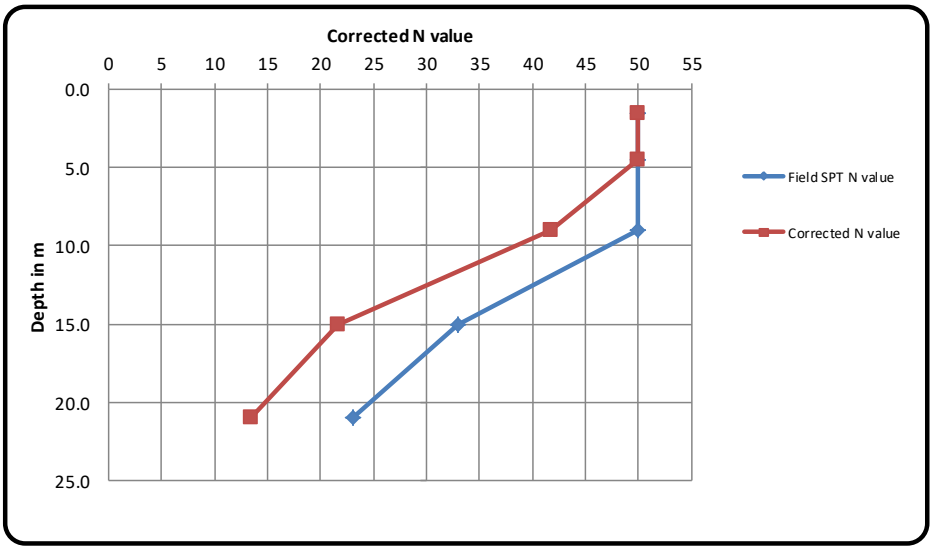
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-8)	1.5	NOT FOUND	ML	50		1.758	0.264	1.00	50.0	50.0
2		4.5		ML	51	50	1.785	0.803	1.00	50.0	50.0
3		9.0		ML	59	50	1.838	1.654	0.83	41.7	41.7
4		15.0		SC	33		1.879	2.819	0.66	21.6	21.6
5		21.0		SC	25		1.895	3.980	0.54	13.5	13.5

Note: 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.

STANDARD PENETRATION TEST OF BH NO-8(PIER)



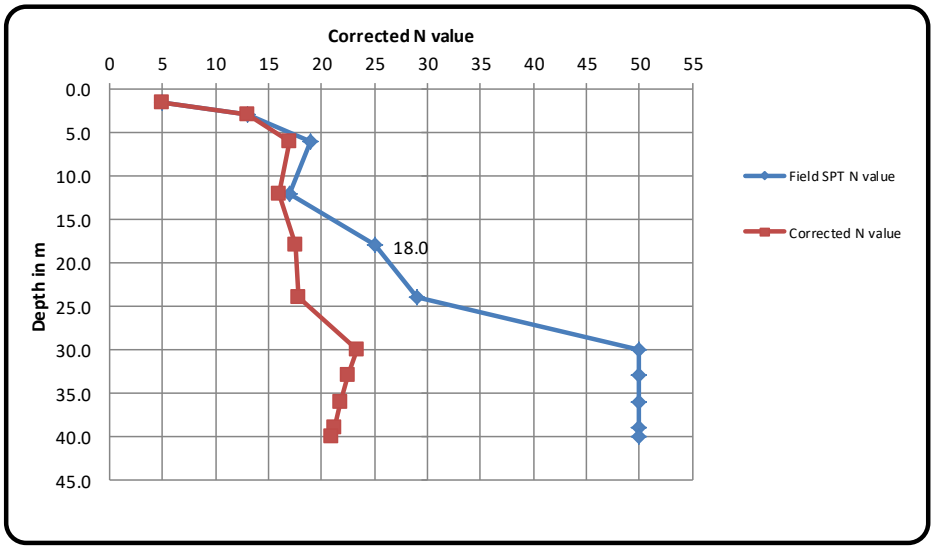
COMPUTATION OF SELECTED N VALUE)

Sl 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	PIER (BH-9)	1.5	1.9	ML	5		1.000	0.150	1.00	5.00	5
2		3.0		ML-CL	13		1.000	0.300	1.00	13.00	13
3		6.0		SM	19		1.000	0.600	1.00	19.00	17
4		12.0		CL	17		1.000	1.200	0.94	15.99	15.99
5		18.0		ML	25		1.000	1.800	0.81	20.13	18
6		24.0		ML	29		1.000	2.400	0.71	20.56	18
7		30.0		SM	61	50	1.000	3.000	0.63	31.72	23
8		33.0		SM	77	50	1.000	3.300	0.60	30.13	23
9		36.0		SM	>50	50	1.000	3.600	0.57	28.67	22
10		39.0		SM	>50	50	1.000	3.900	0.55	27.33	21
11		40.0		SM	>50	50	1.000	4.000	0.54	26.91	21

Note: 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.

STANDARD PENETRATION TEST OF BH NO-9 (PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

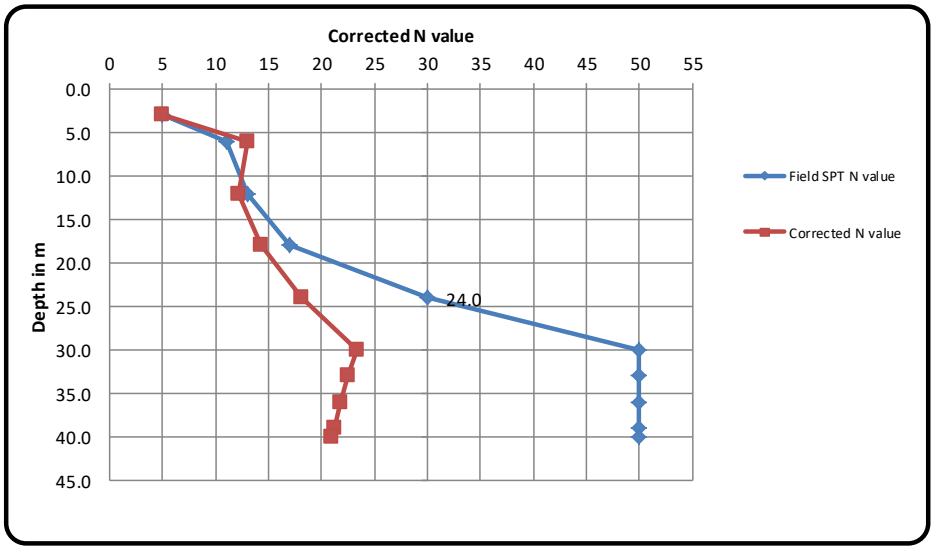
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-10)	3.0	2.4	SM	5		1.000	0.300	1.00	5.00	5
2		6.0		SM	11		1.000	0.600	1.00	11.00	13
3		12.0		ML-CL	13		1.000	1.200	0.94	12.23	12.23
4		18.0		SM	17		1.000	1.800	0.81	13.69	14
5		24.0		SM	30		1.000	2.400	0.71	21.27	18
6		30.0		SM	64	50	1.000	3.000	0.63	31.72	23
7		33.0		ML	77	50	1.000	3.300	0.60	30.13	23
8		36.0		SM	84	50	1.000	3.600	0.57	28.67	22
9		39.0		SM	>50	50	1.000	3.900	0.55	27.33	21
10		40.0		SM	>50	50	1.000	4.000	0.54	26.91	21

Note: 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.

STANDARD PENETRATION TEST OF BH NO-10(PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

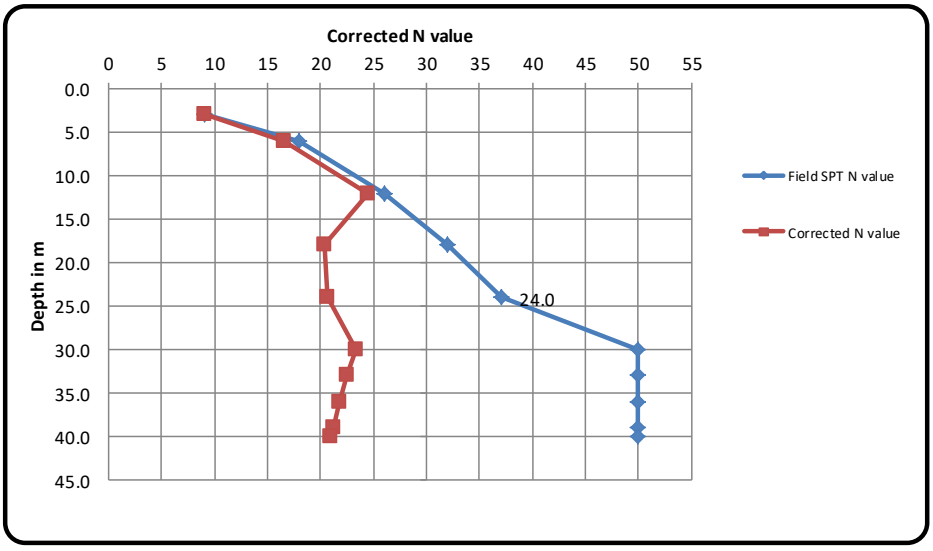
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-11)	3.0	1.8	SM	9		1.000	0.300	1.00	9.00	9
2		6.0		SM	18		1.000	0.600	1.00	18.00	17
3		12.0		CL	26		1.000	1.200	0.94	24.46	24.46
4		18.0		SM	32		1.000	1.800	0.81	25.77	20
5		24.0		SM	37		1.000	2.400	0.71	26.23	21
6		30.0		SM	85	50	1.000	3.000	0.63	31.72	23
7		33.0		SM	>50	50	1.000	3.300	0.60	30.13	23
8		36.0		SM	>50	50	1.000	3.600	0.57	28.67	22
9		39.0		SM	>50	50	1.000	3.900	0.55	27.33	21
10		40.0		SM	>50	50	1.000	4.000	0.54	26.91	21

Note: 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.

STANDARD PENETRATION TEST OF BH NO-11 (PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

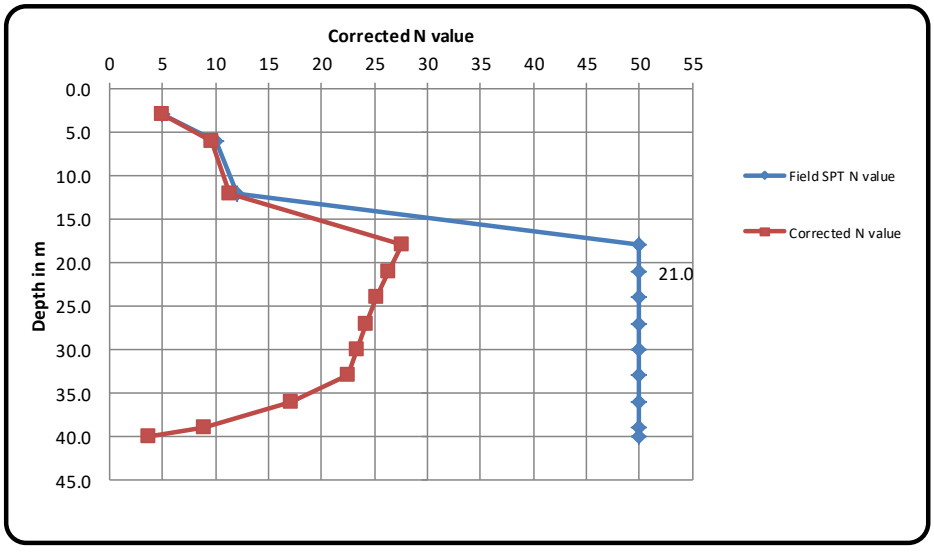
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-11A)	3.0	6.5	SM	5		1.789	0.537	1.00	5.00	5
2		6.0		CL	10		1.839	1.103	0.97	9.69	10
3		12.0		CL	12		1.000	1.200	0.94	11.29	11
4		18.0		SM	56	50	1.000	1.800	0.81	40.26	28
5		21.0		SM	67	50	1.000	2.100	0.75	37.68	26
6		24.0		SM	74	50	1.000	2.400	0.71	35.45	25
7		27.0		SM	>50	50	1.000	2.700	0.67	33.48	24
8		30.0		SM	>50	50	1.000	3.000	0.63	31.72	23
9		33.0		SM	>50	50	1.000	3.300	0.60	30.13	23
10		36.0		Pebble	>50	50	2.000	7.200	0.34	17.08	17
11		39.0		Pebble	>50	50	3.000	11.700	0.18	8.96	8.96
12		40.0		Pebble	>50	50	4.000	16.000	0.07	3.73	3.73

Note: 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.

STANDARD PENETRATION TEST OF BH NO-11A (PIER)



Name of Project:	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.

COMPUTATION OF SELECTED N VALUE)

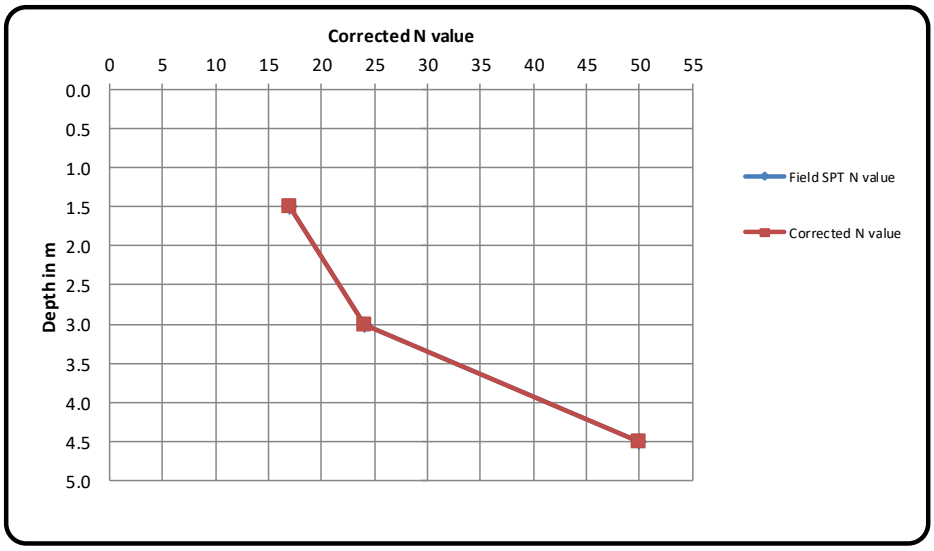
Sl No.	Bridge No.	Depth from G.L in m.	Water table in m	Group of soil	Field SPT N value		Density gm/cm^3	overburden pressure in kg/cm^2	overburden correction factor	Corrected N value due to overburden	Corrected N value due to Dilatancy
1	PIER (BH-12)	1.5	NOT FOUND	SM	17		1.768	0.265	1.00	17.00	17
2		3.0		ML	24		1.768	0.530	1.00	24.00	24
3		4.5		ML	>50	50	1.768	0.796	1.00	50.00	50

Note: Above Strength parameters (C& ϕ) are calculated theoritically from N value.

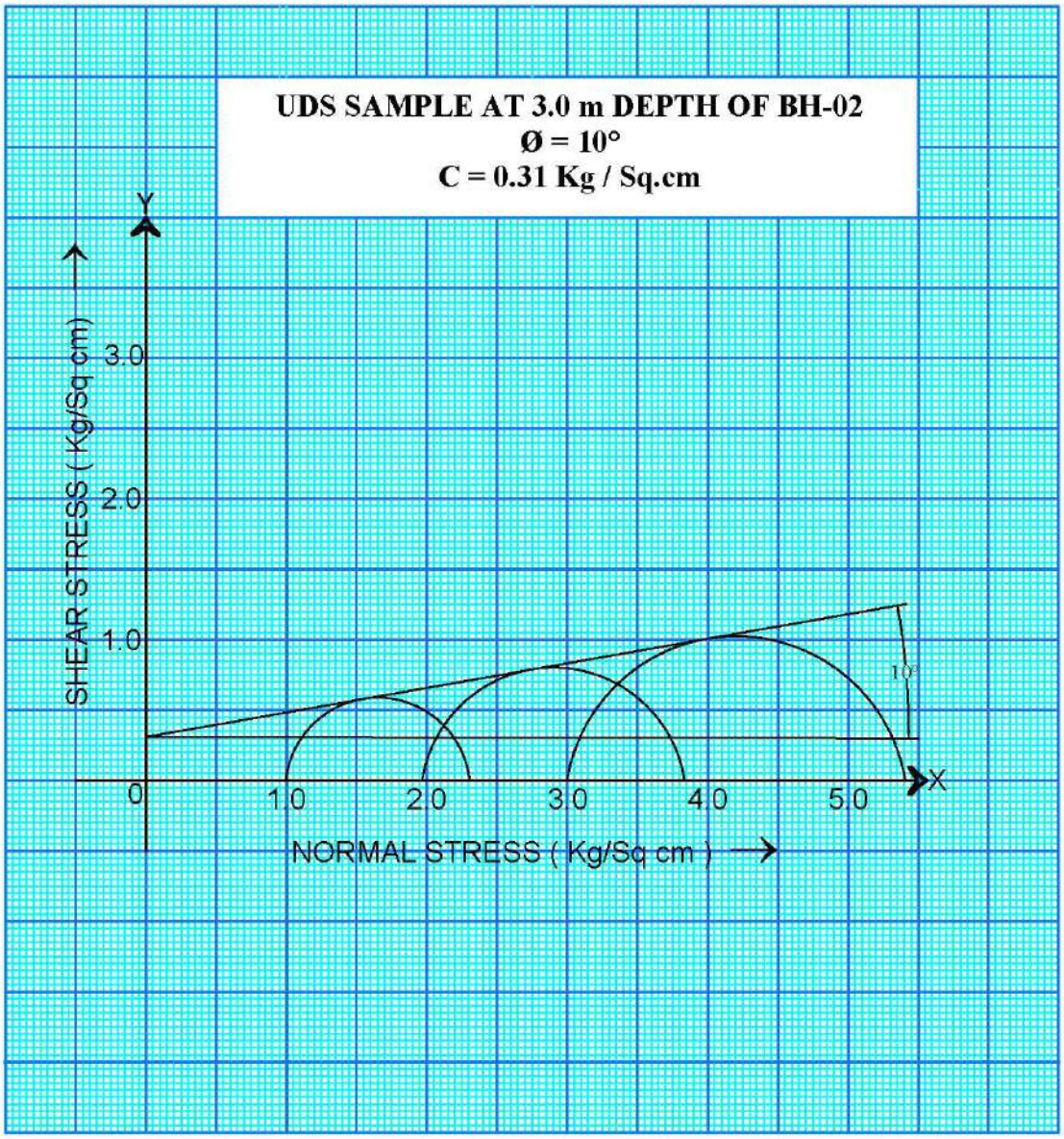
1. As per Terzaghi & Peck, in case of cohesive soil there is a relationship between N value & consistency.

   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.

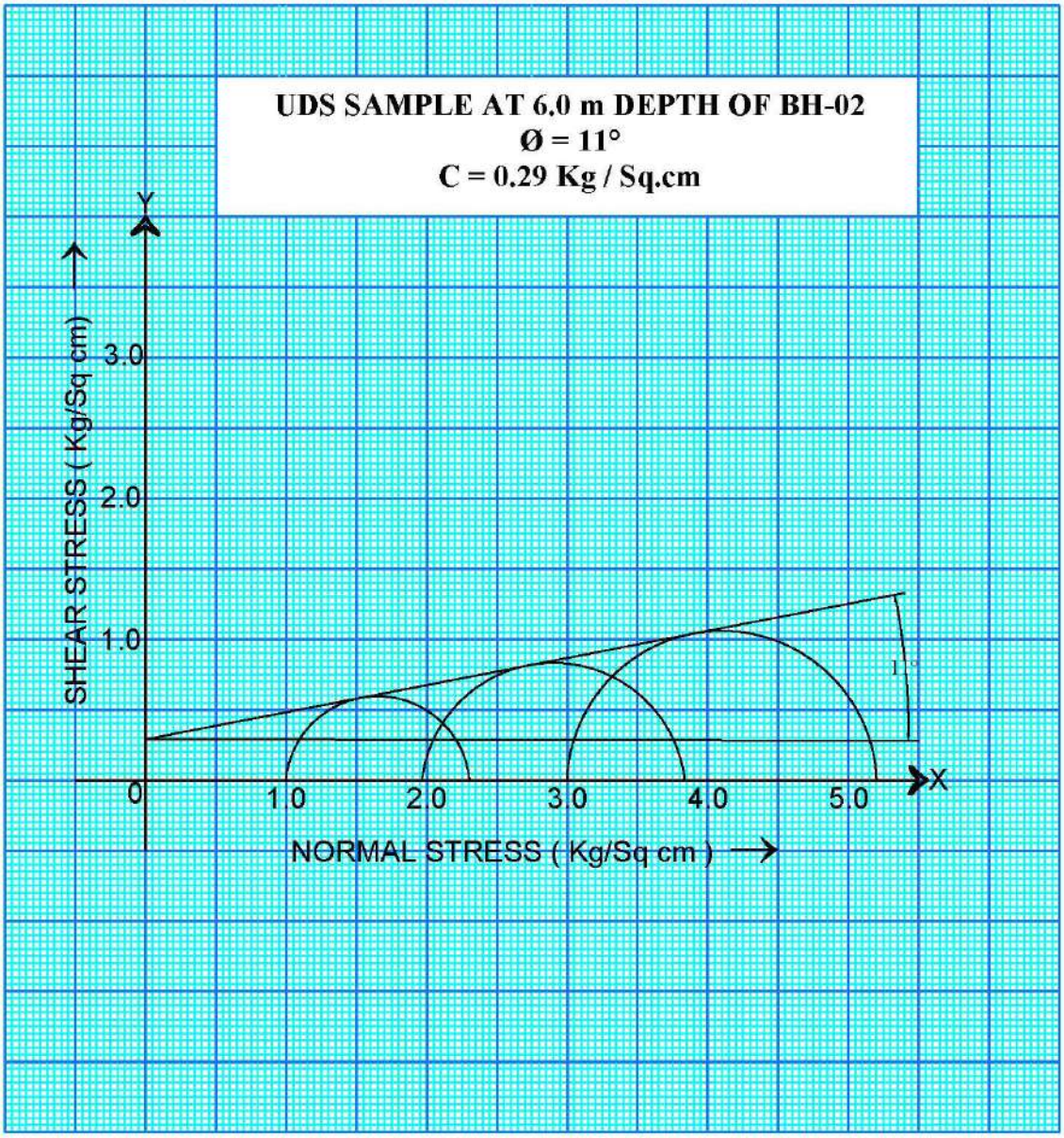
STANDARD PENETRATION TEST OF BH NO-12 (PIER)



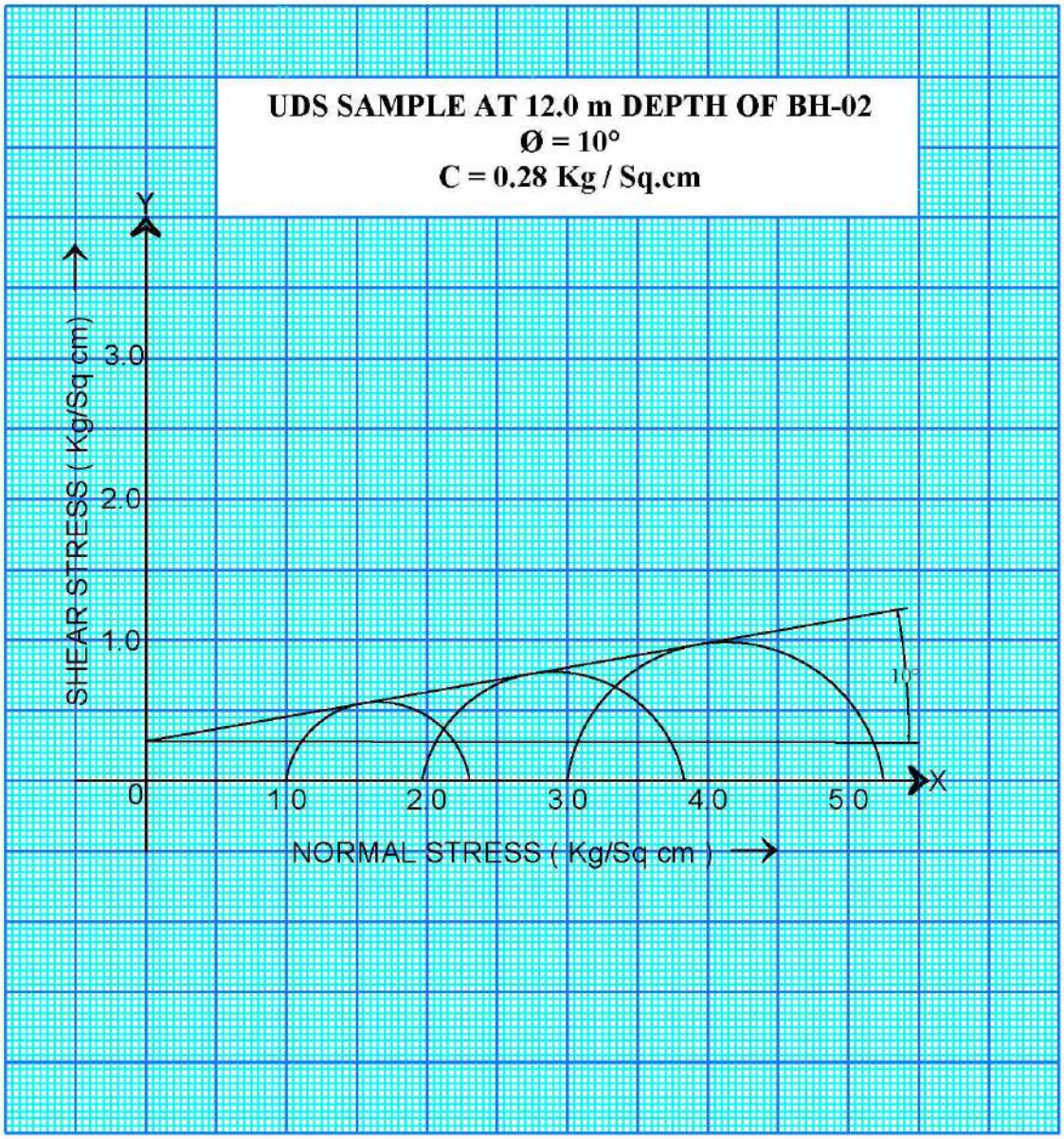
ANNEXURE -I
GRAPHICAL REPRESENTATION OF SHEAR STRENGTH PARAMETER



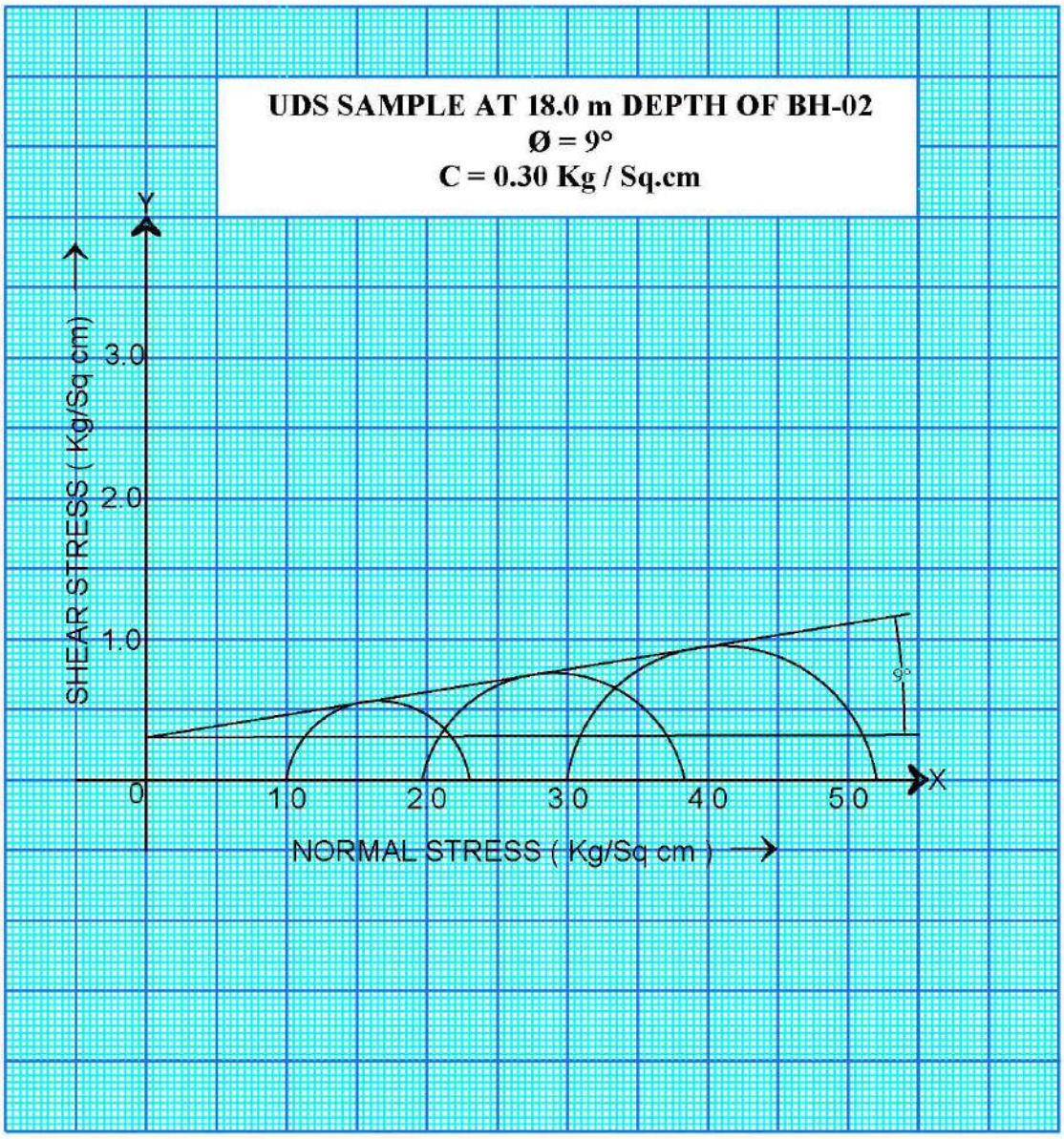
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



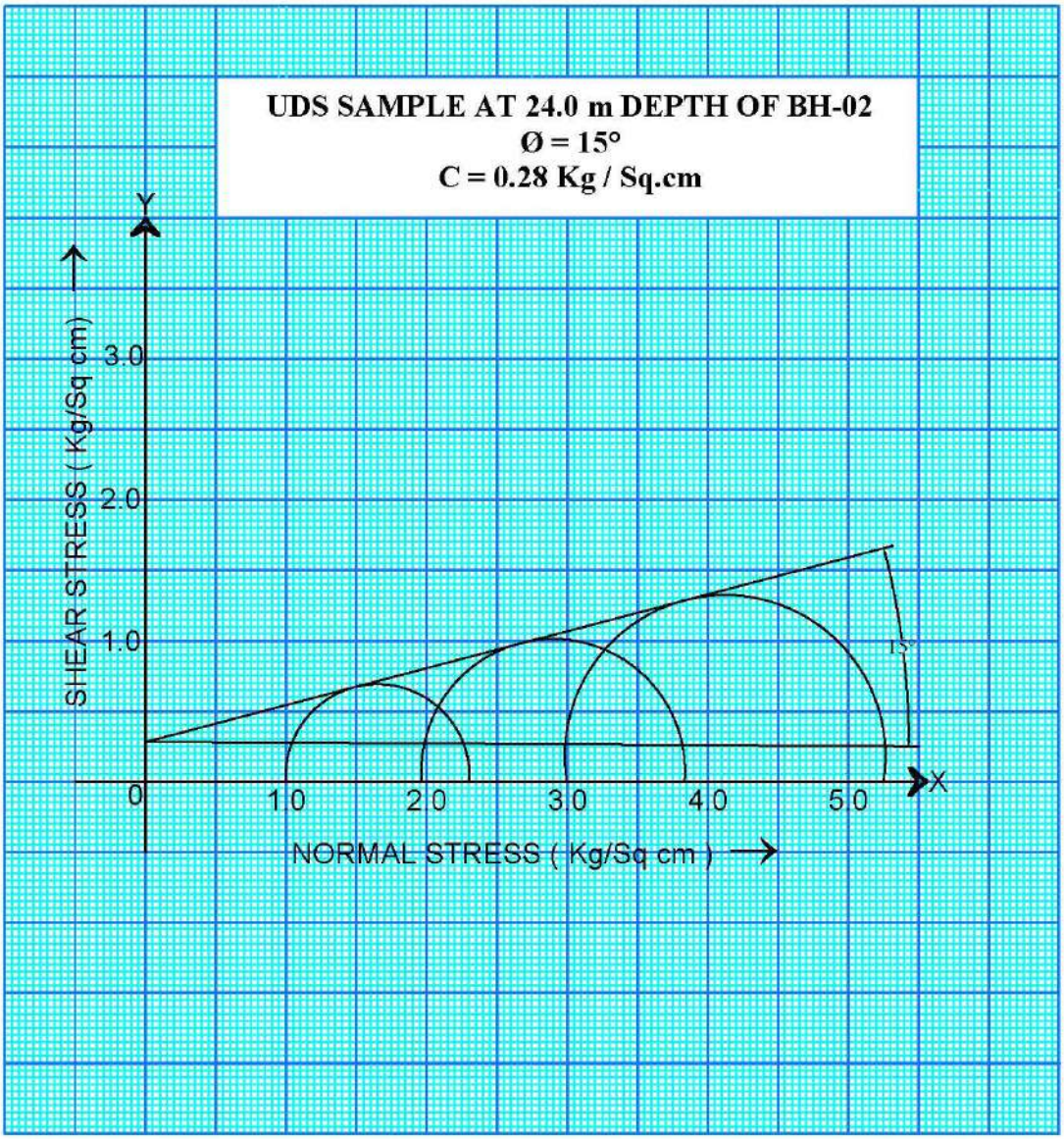
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



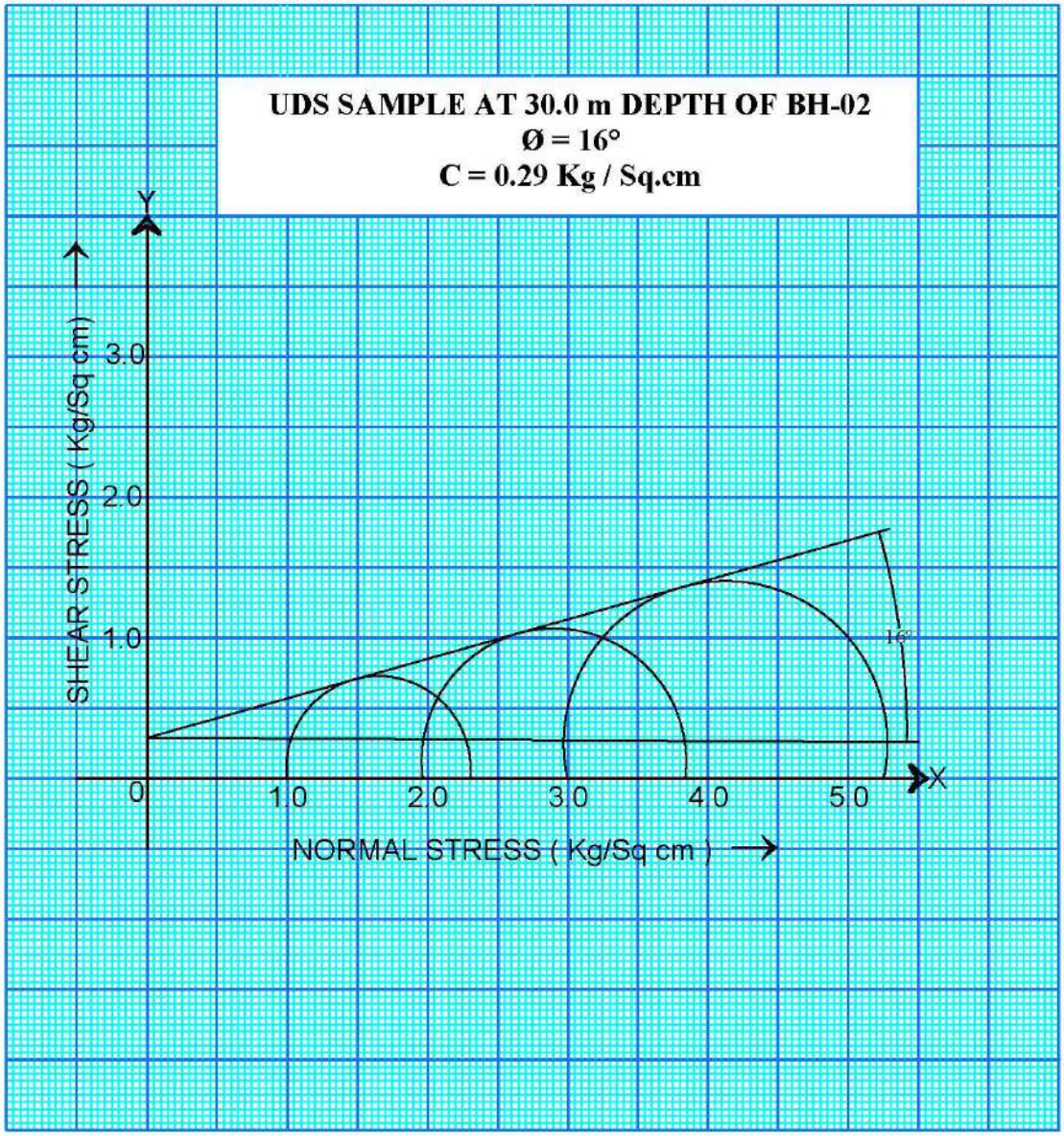
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



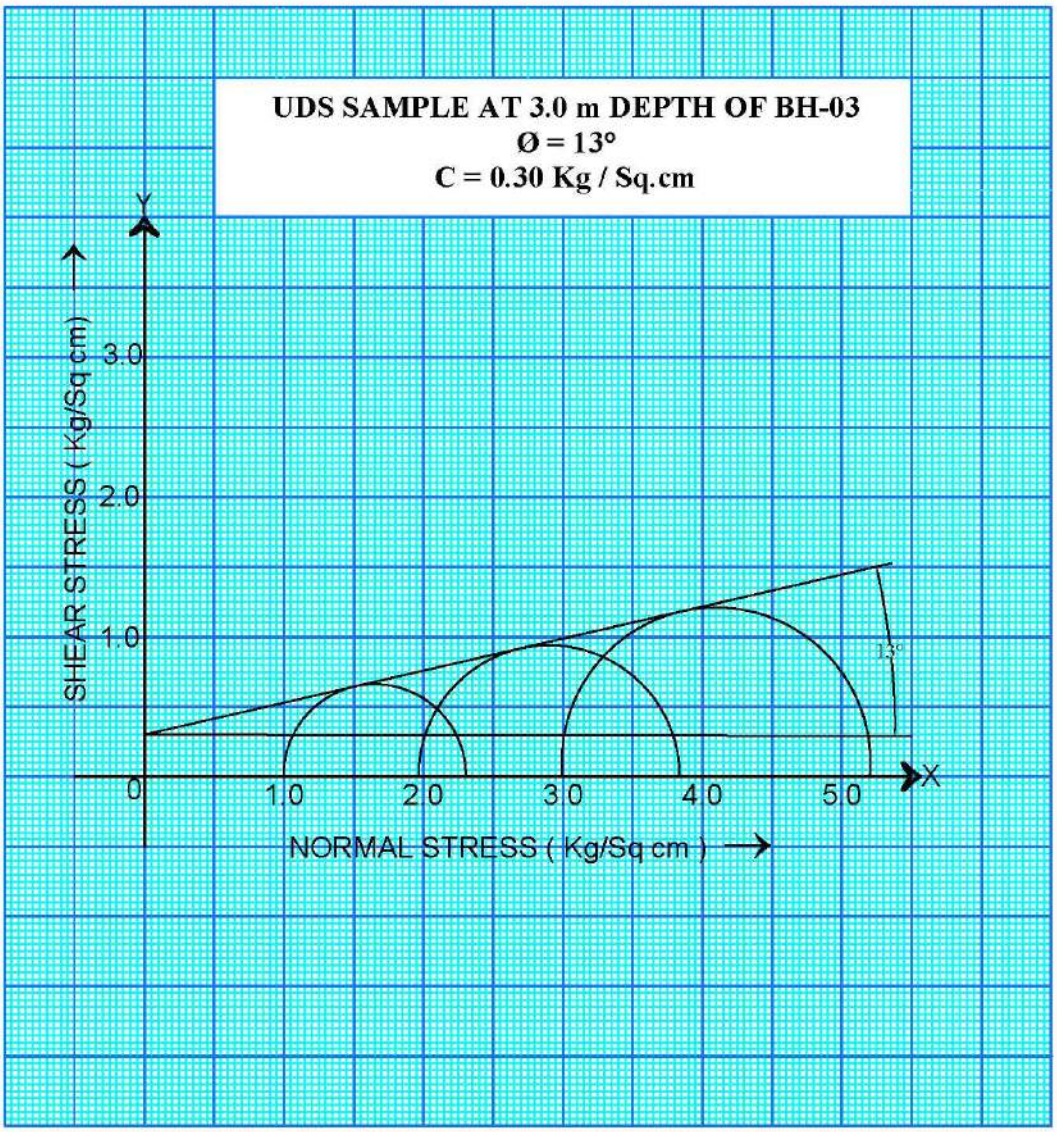
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



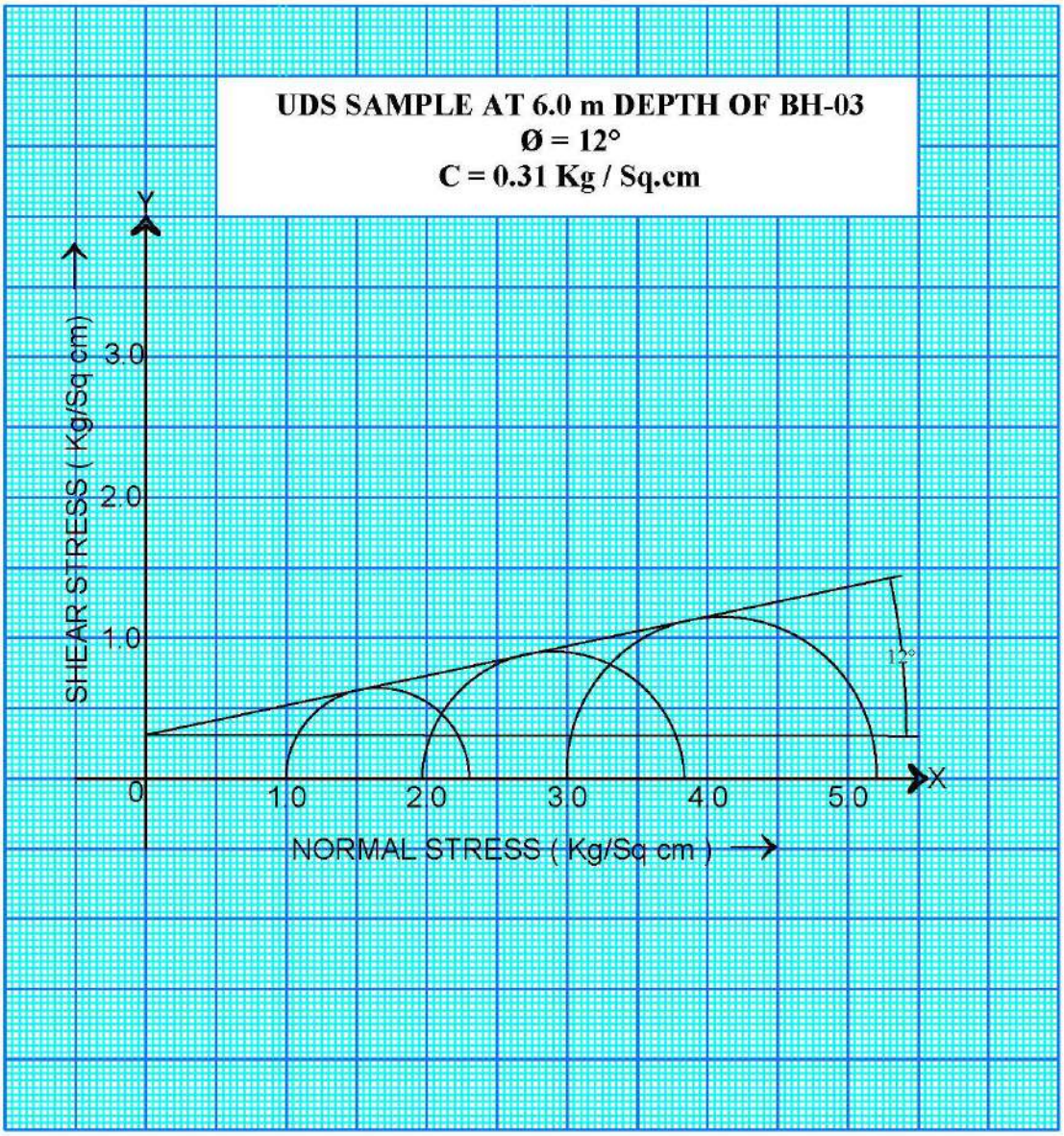
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



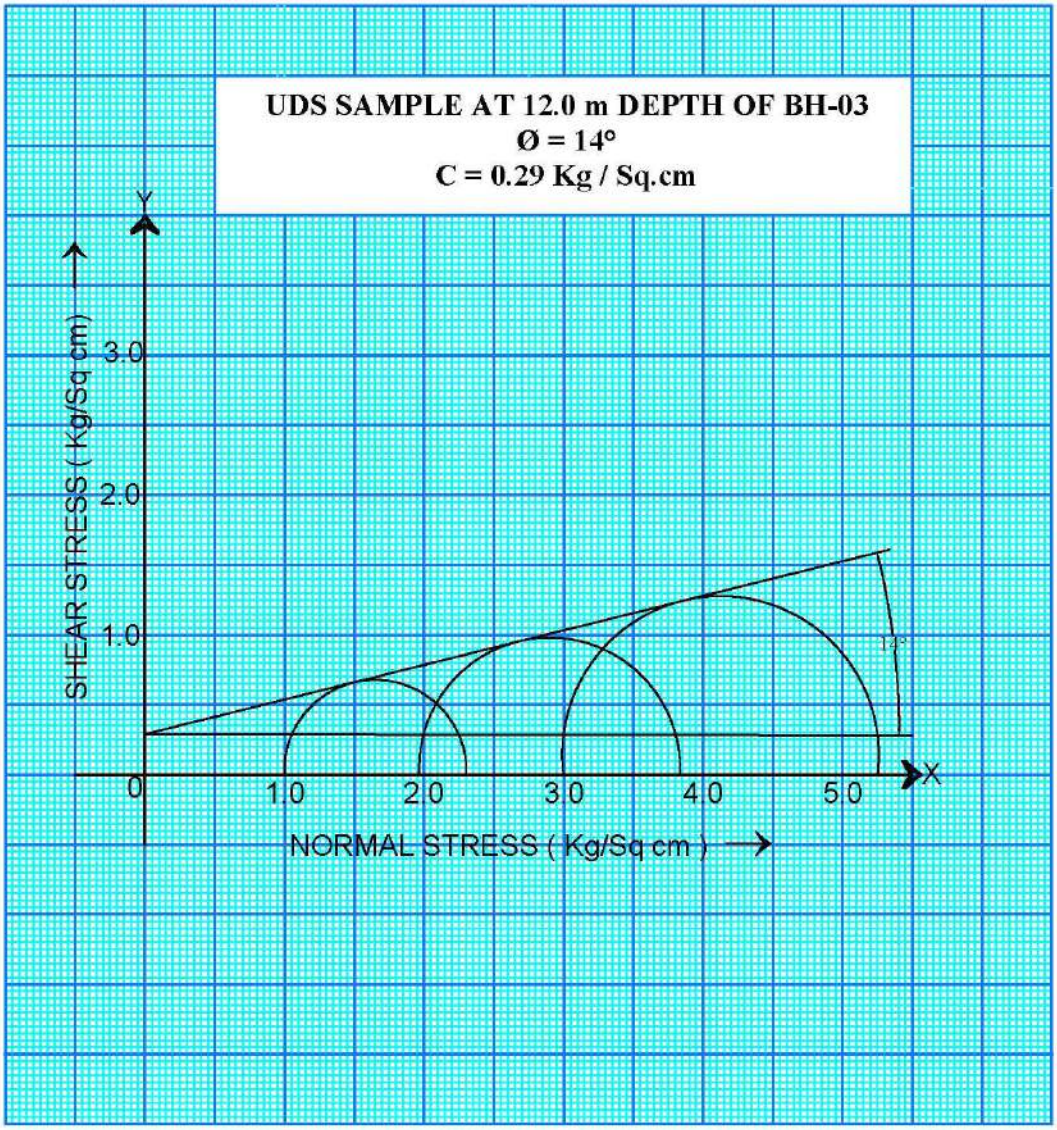
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



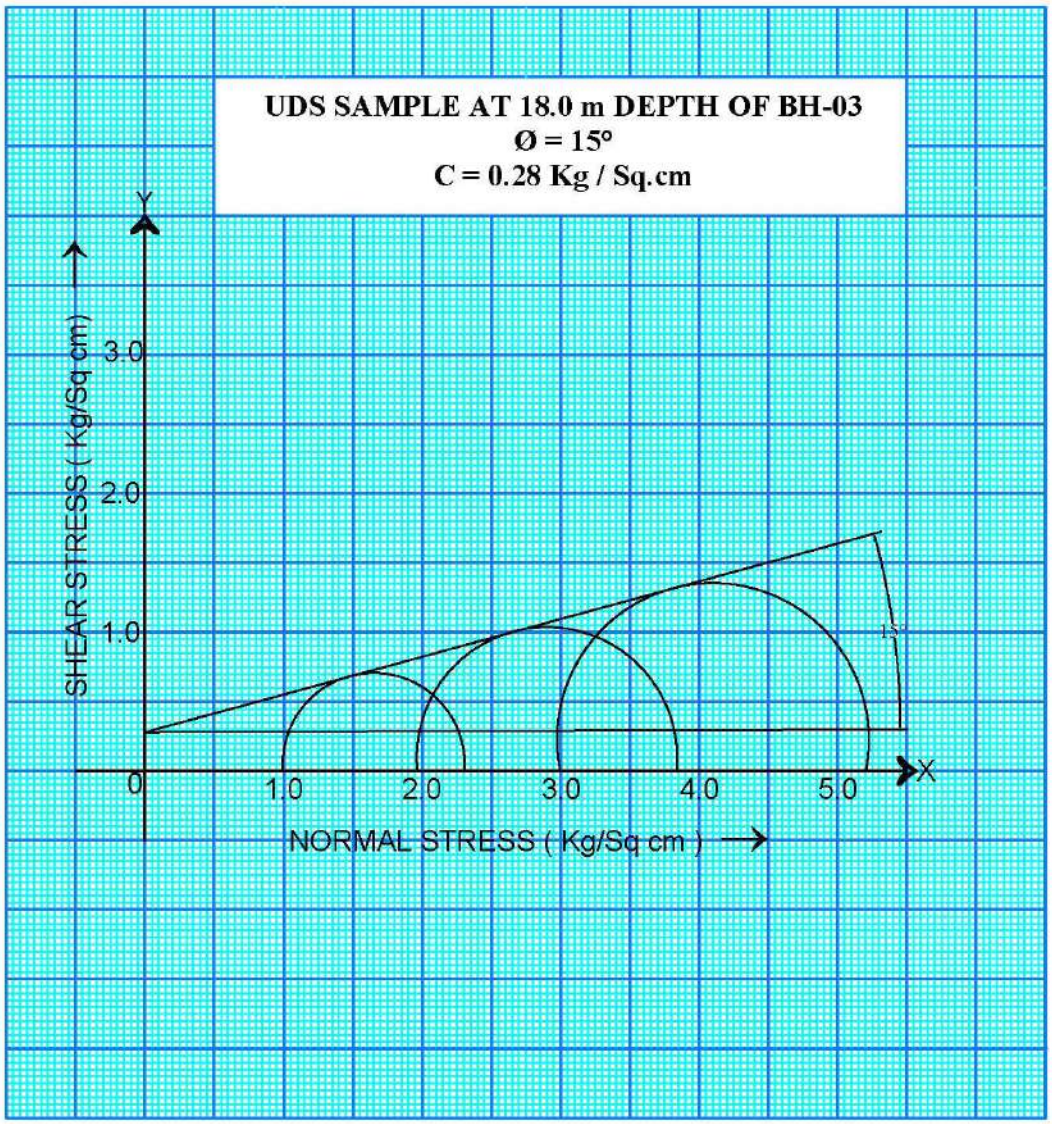
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



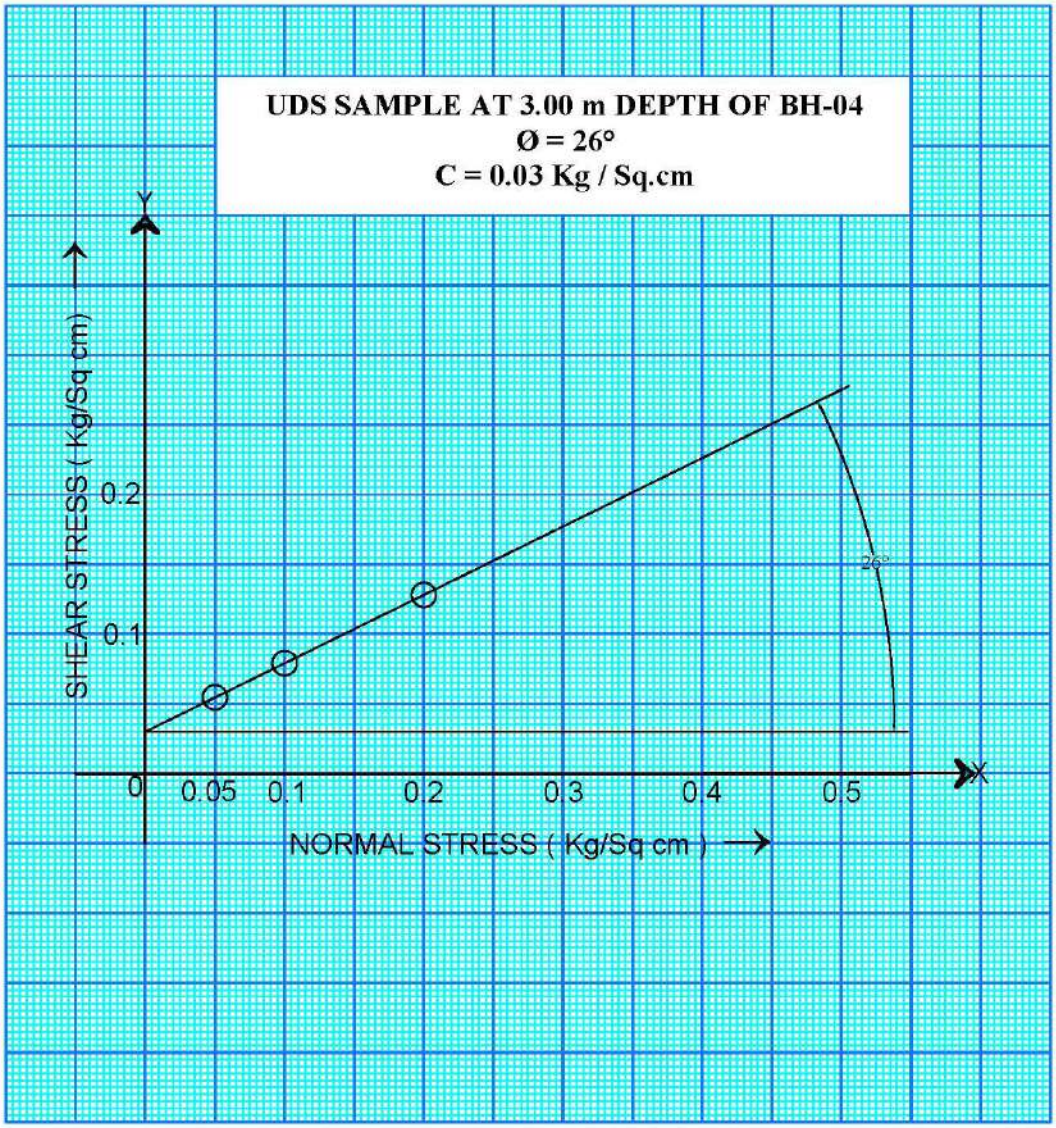
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



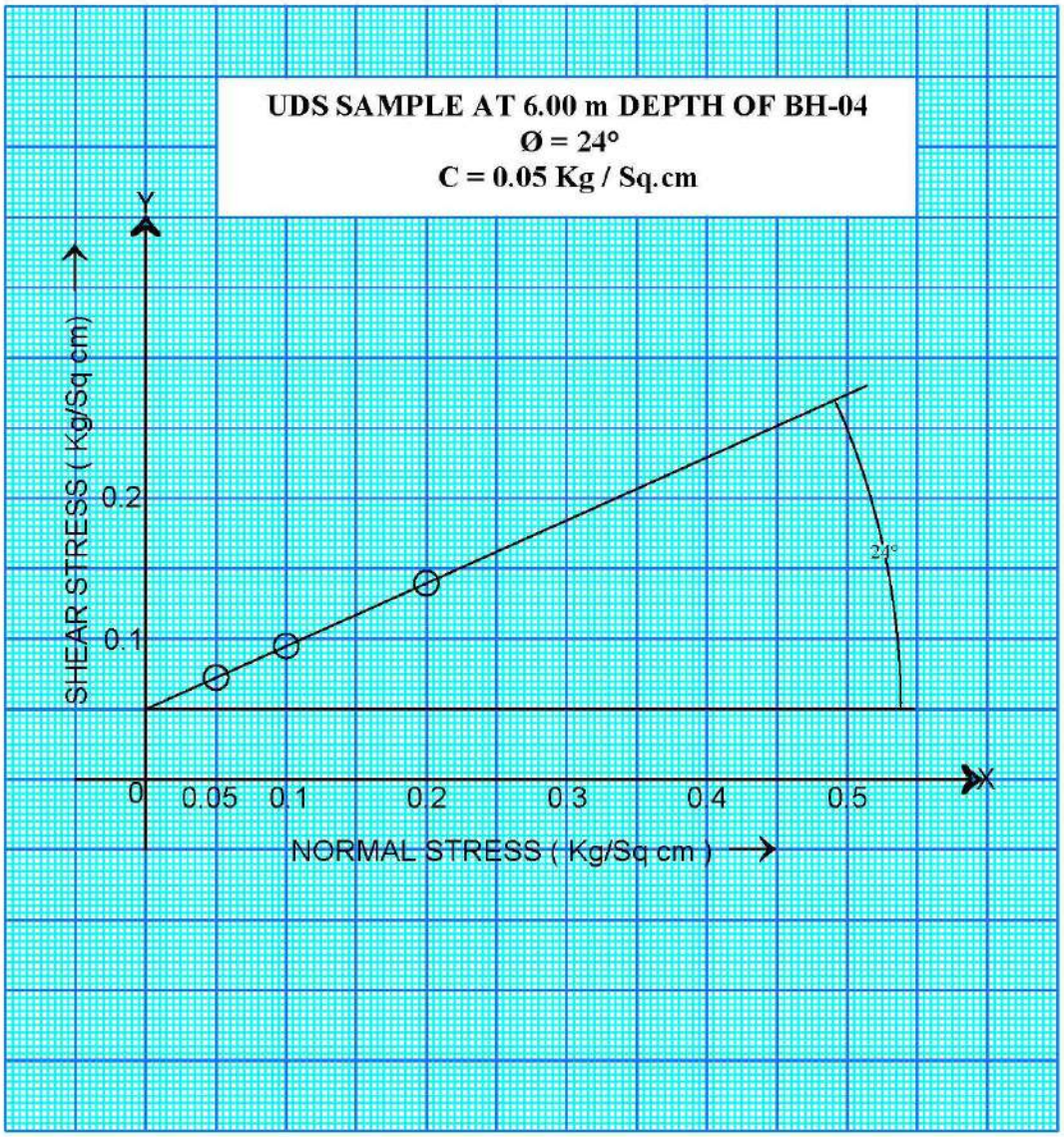
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



Name of Project:	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:	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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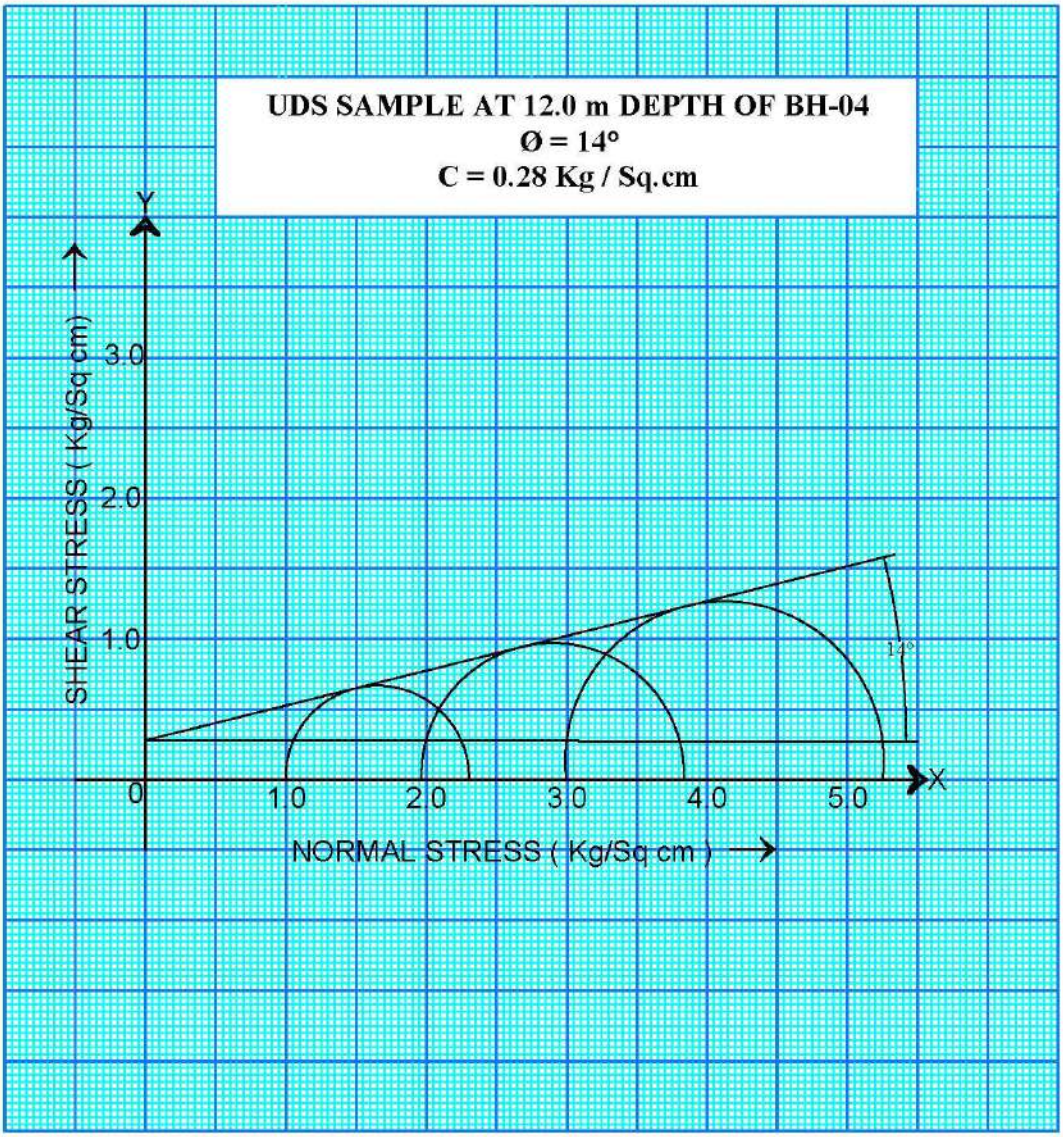
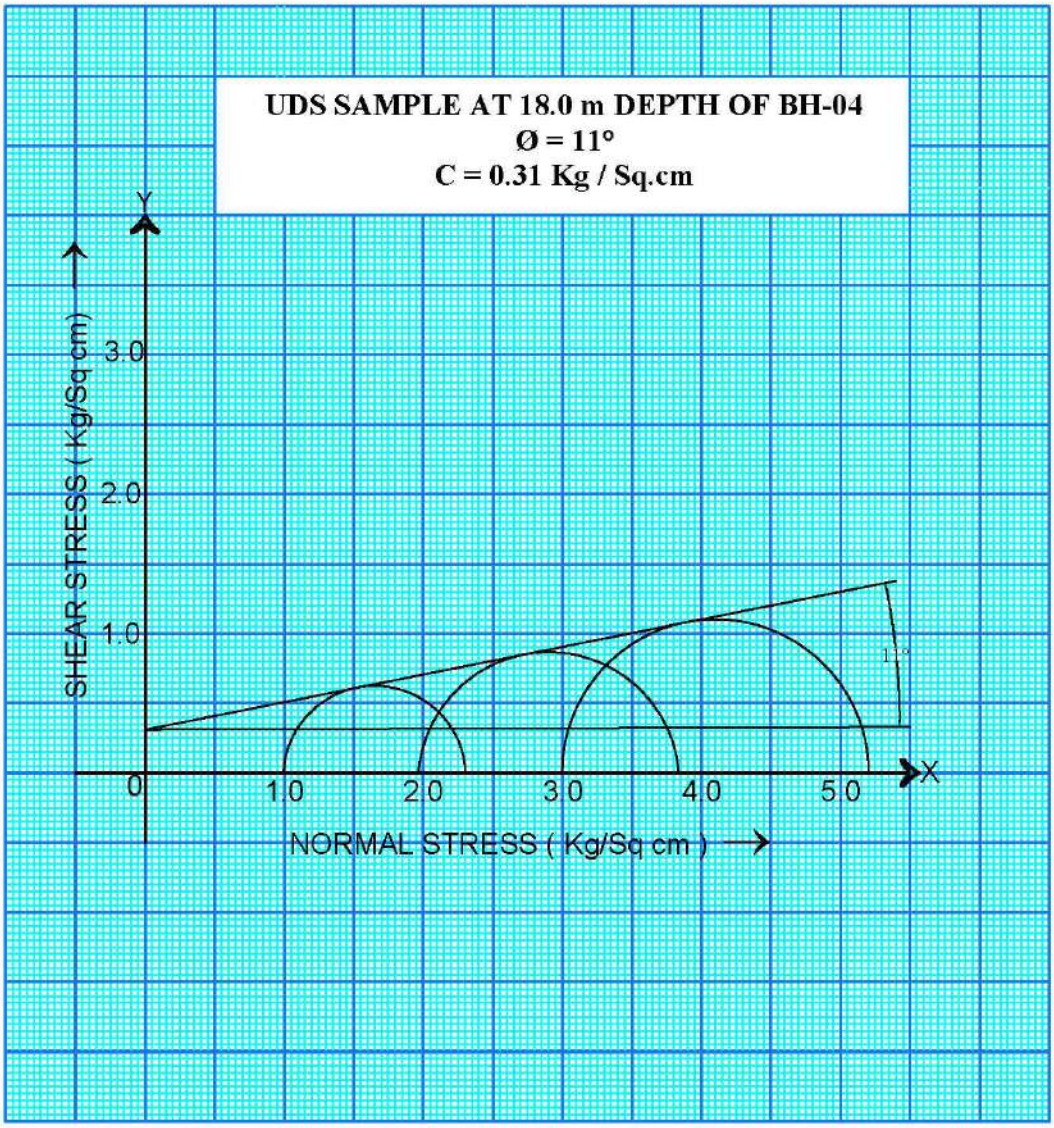
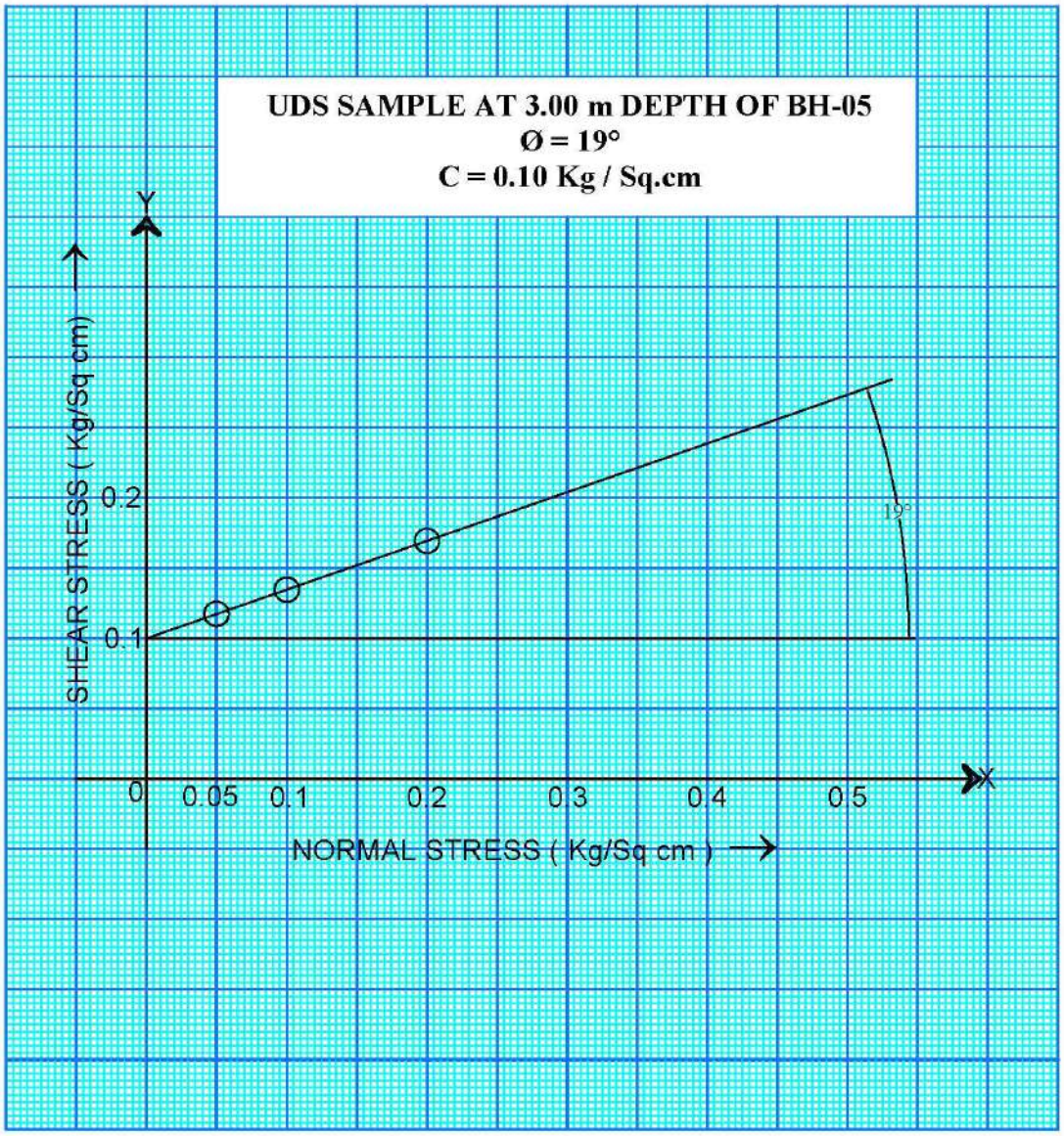


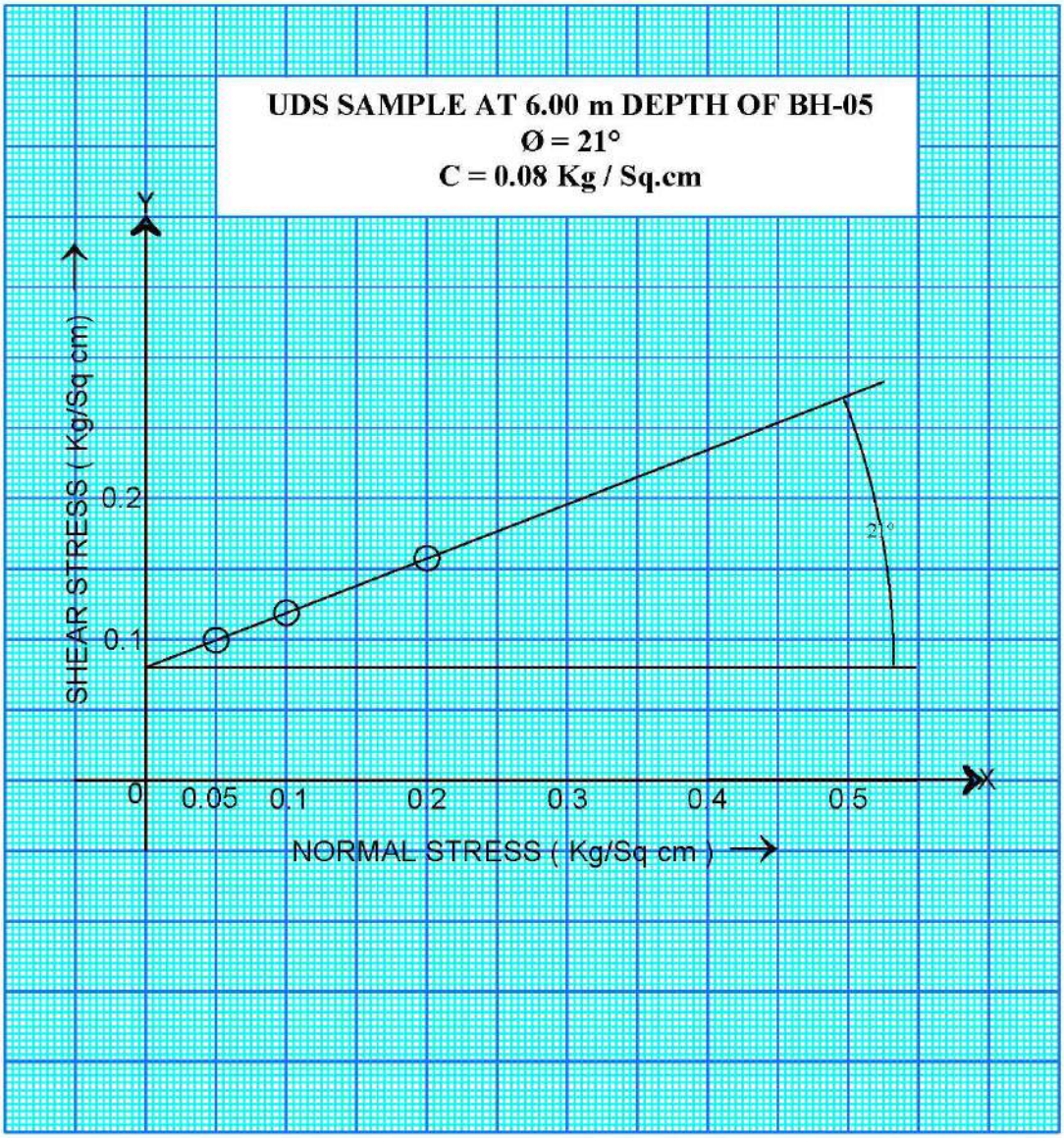
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

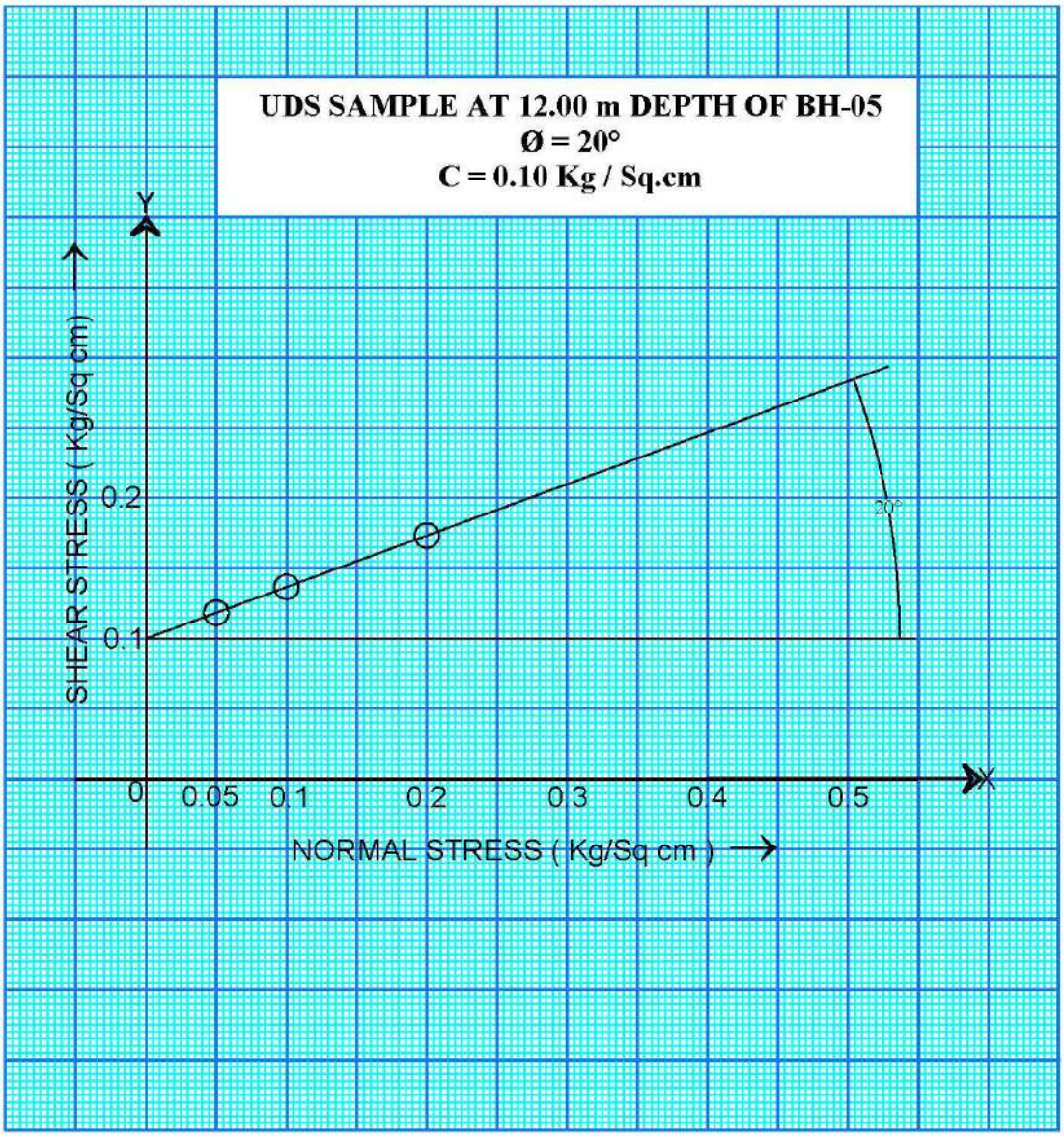


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

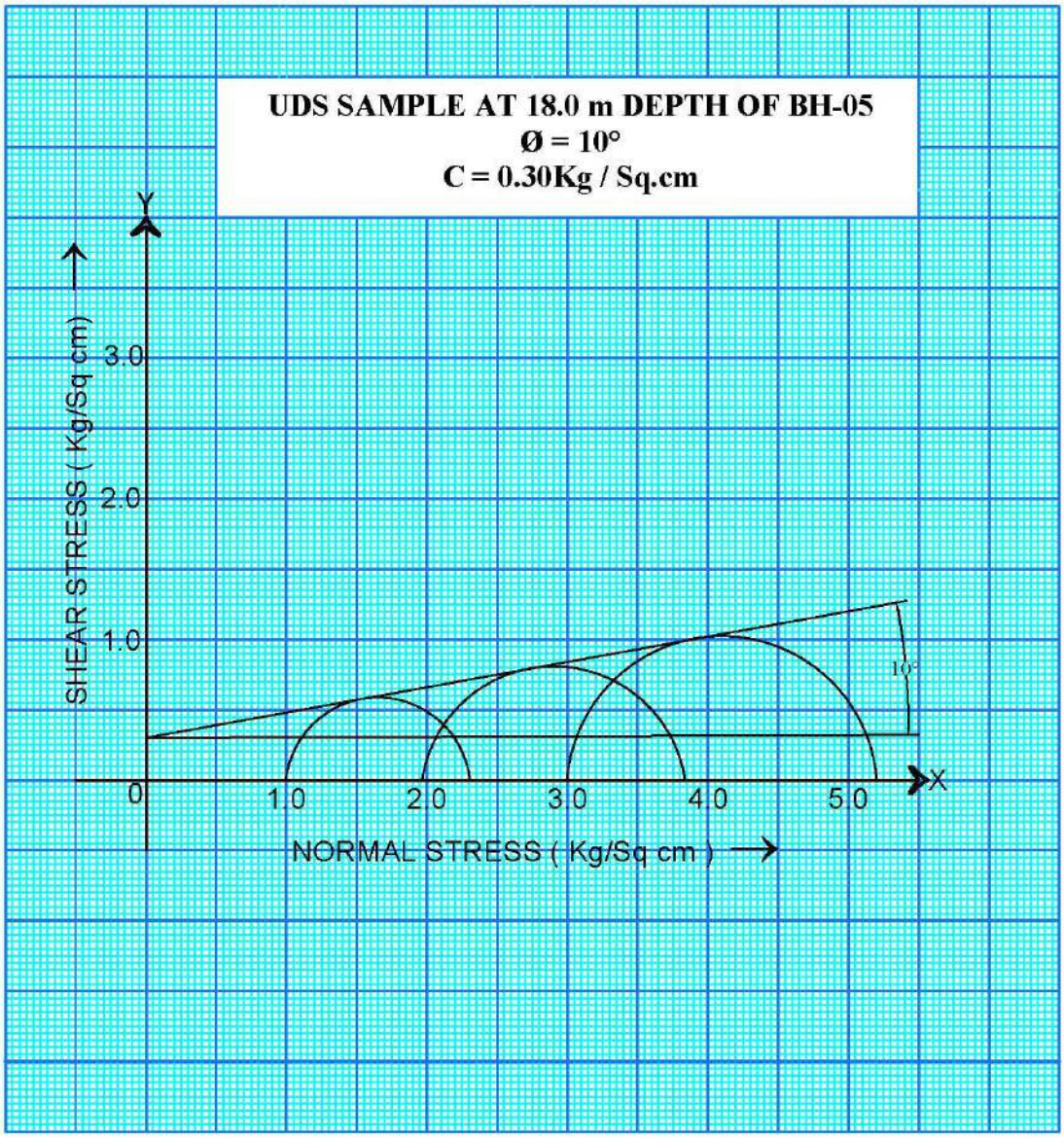


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

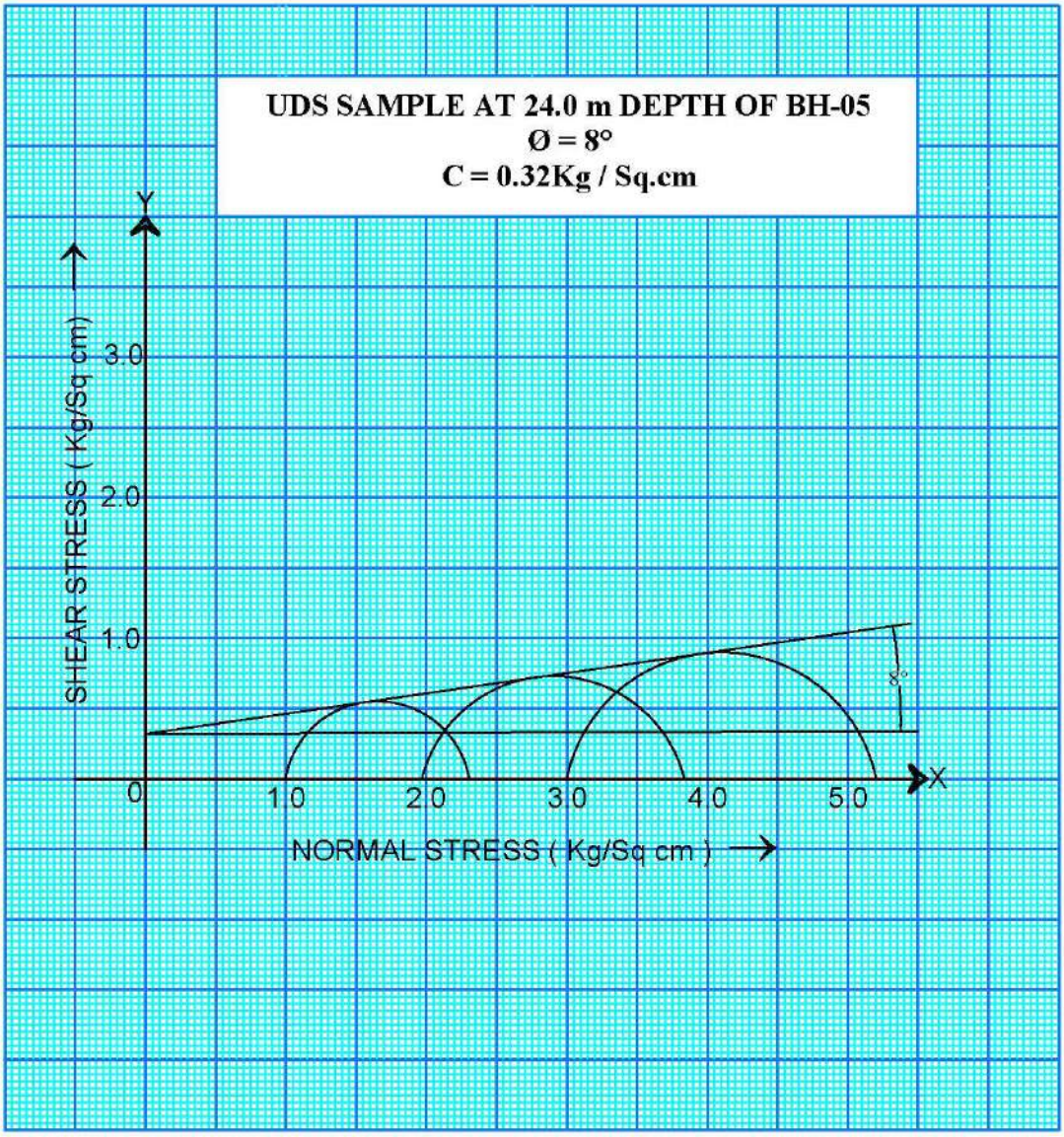

UDS SAMPLE AT 6.00 m DEPTH OF BH-05
Ø = 21°
C = 0.08 Kg / Sq.cm
Y
SHEAR STRESS (Kg/Sq cm)
0.2
0.1
21°
0
0.05
0.1
0.2
0.3
0.4
0.5
X
NORMAL STRESS (Kg/Sq cm)

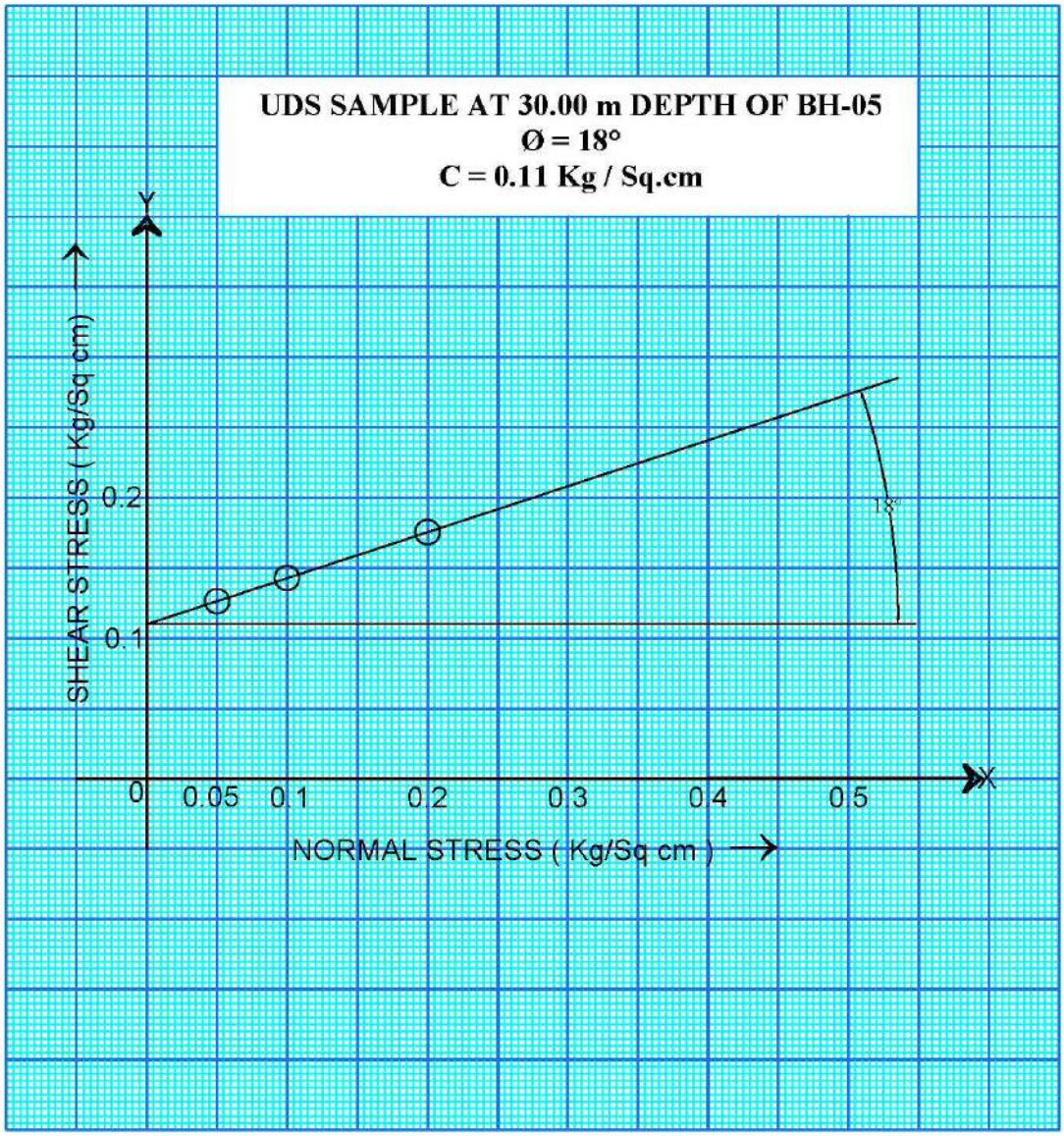


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

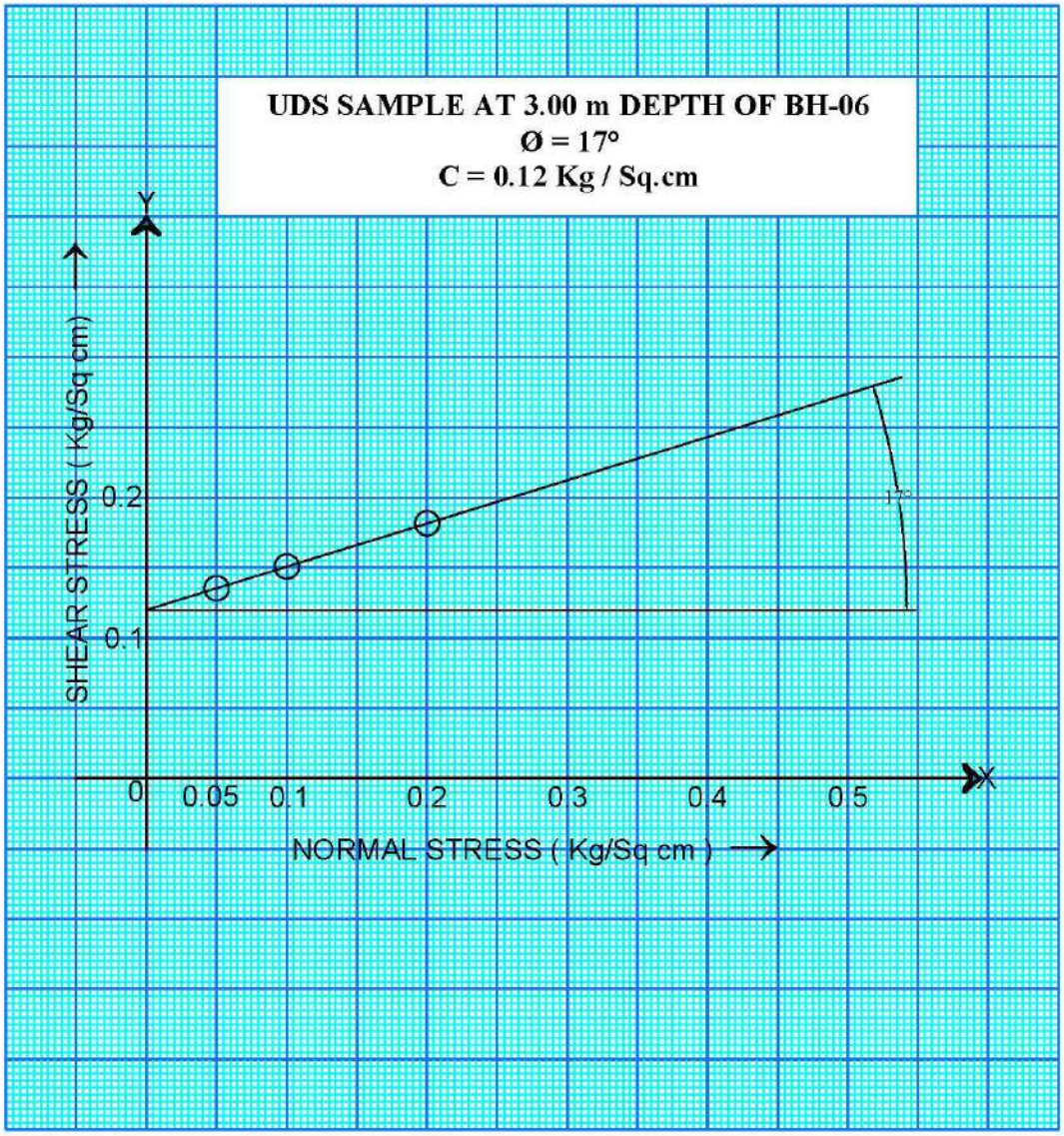


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

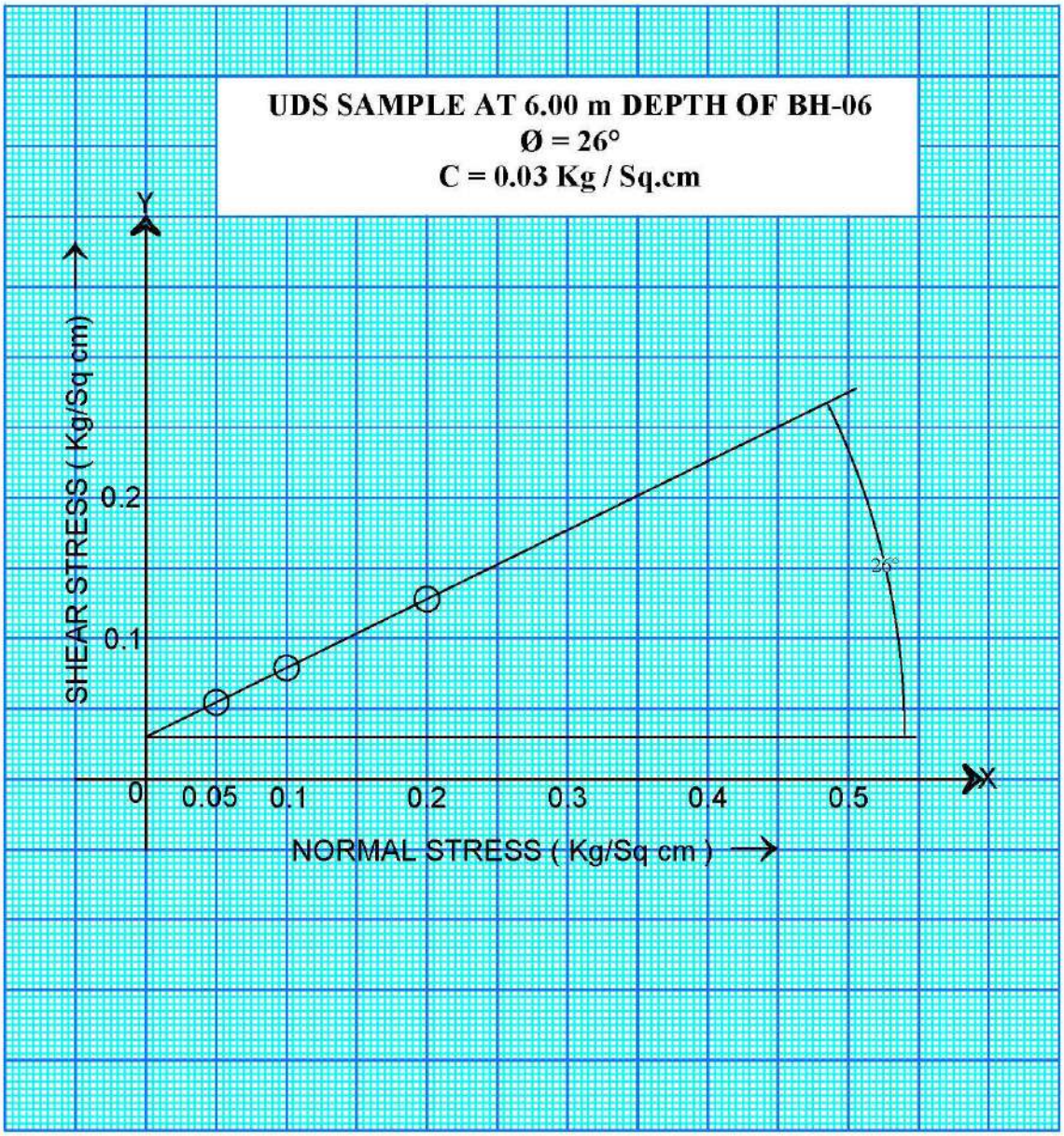

UDS SAMPLE AT 24.0 m DEPTH OF BH-05
Ø = 8°
C = 0.32Kg / Sq.cm
Y
SHEAR STRESS (Kg/Sq cm)
3.0
2.0
1.0
0
1.0
2.0
3.0
4.0
5.0
X
NORMAL STRESS (Kg/Sq cm)
8°



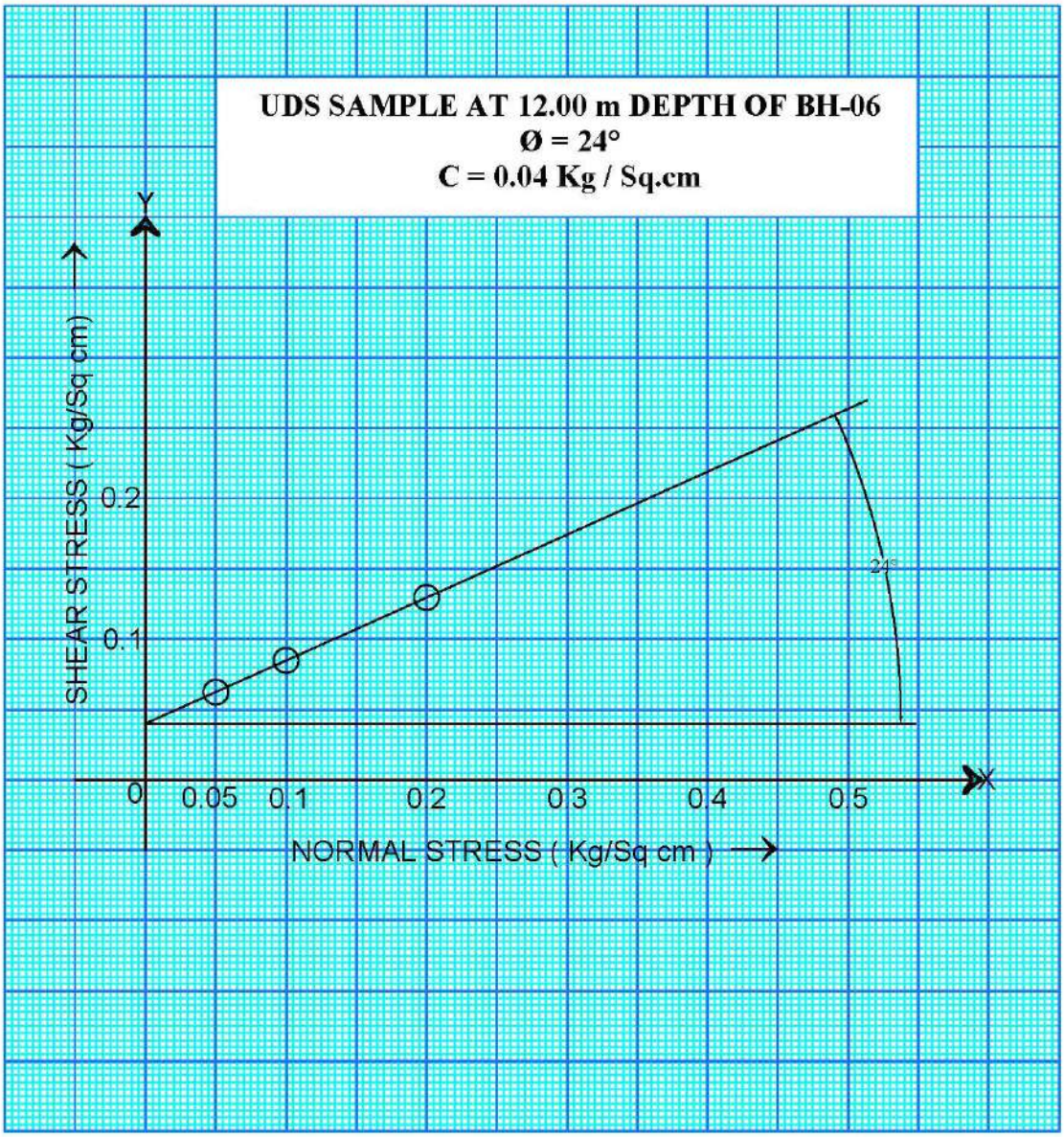
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



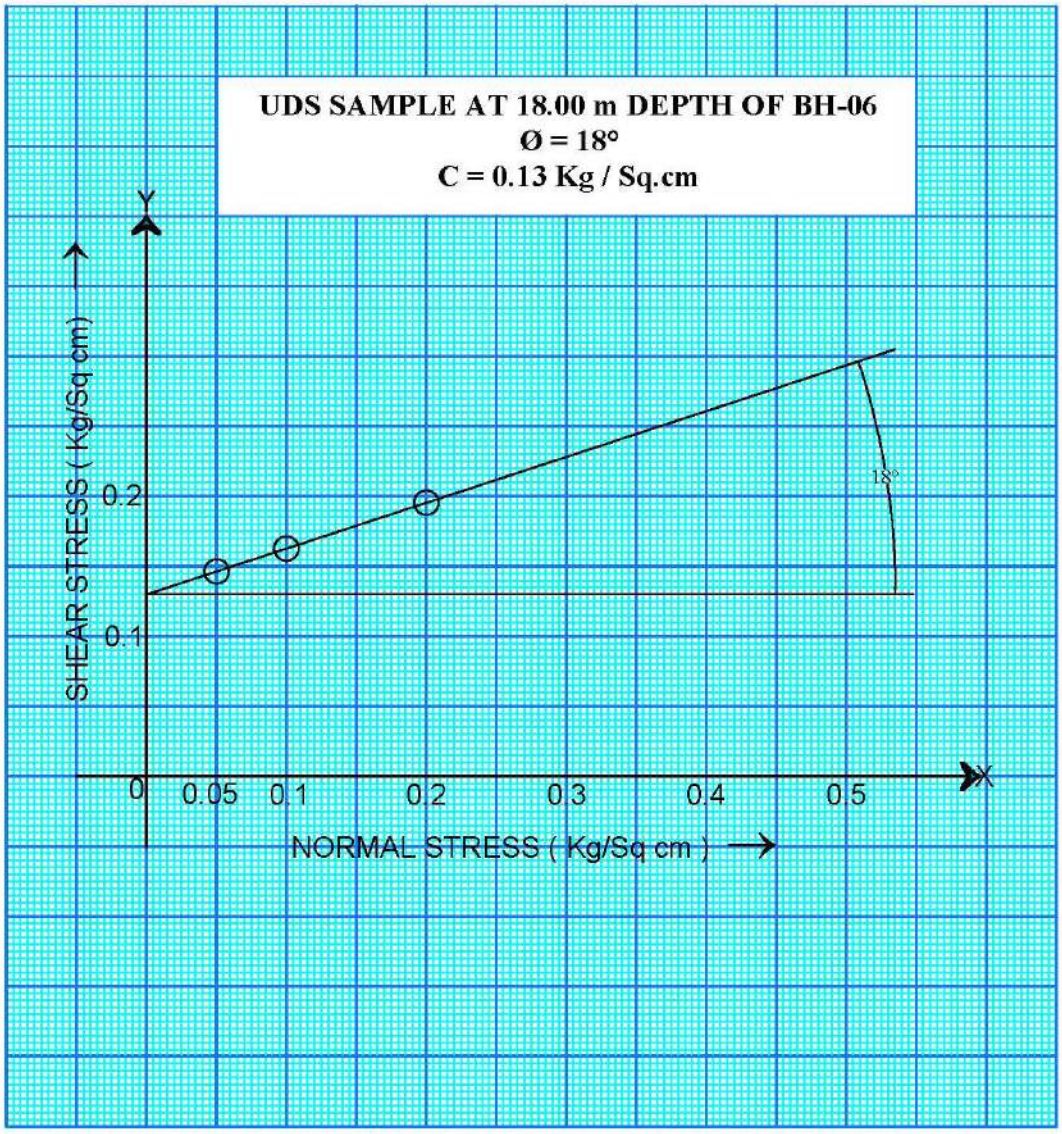
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



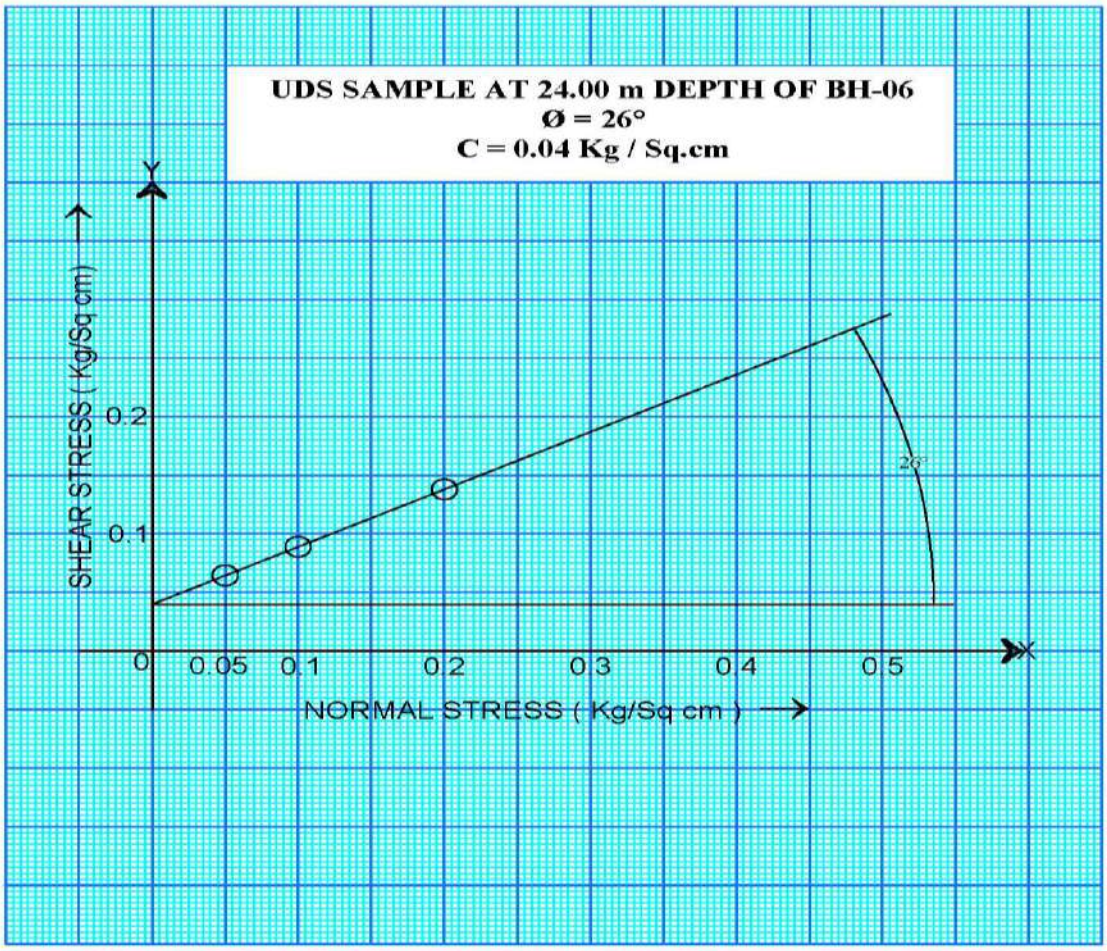
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

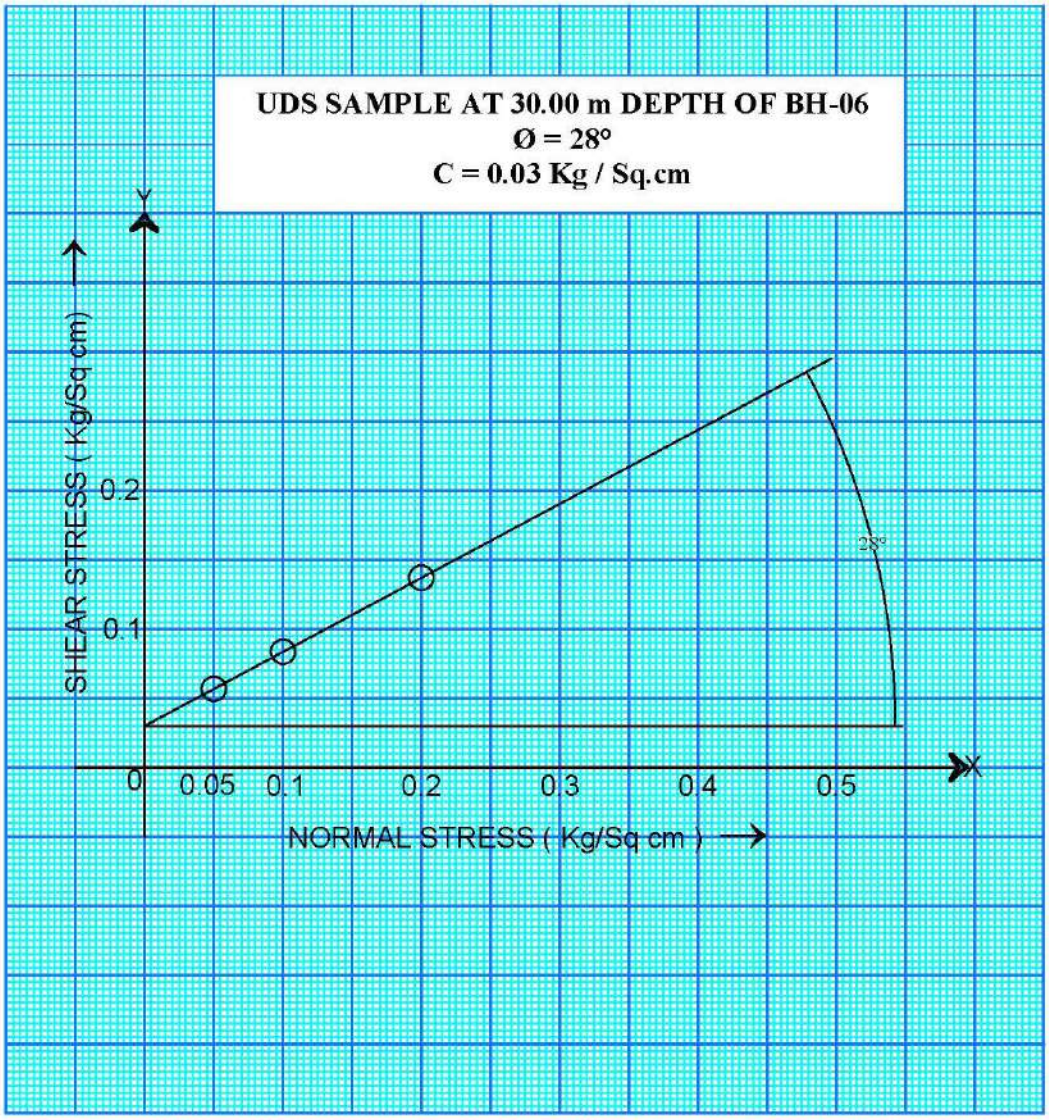


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

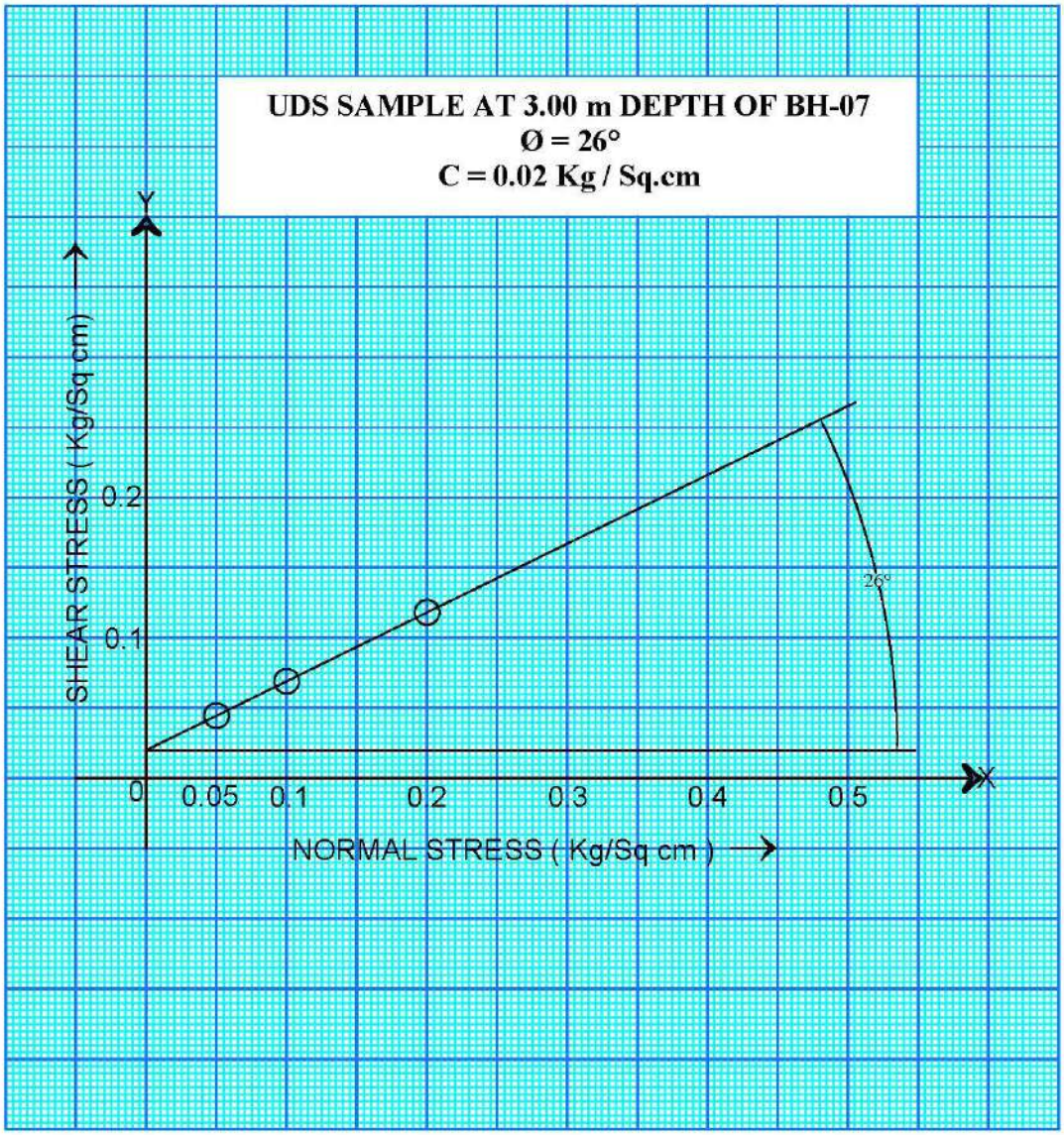


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.


UDS SAMPLE AT 24.00 m DEPTH OF BH-06
Ø = 26°
C = 0.04 Kg / Sq.cm
SHEAR STRESS (Kg/Sq cm)
0.2
0.1
0
0.05
0.1
0.2
0.3
0.4
0.5
NORMAL STRESS (Kg/Sq cm)
26°



Name of Project:	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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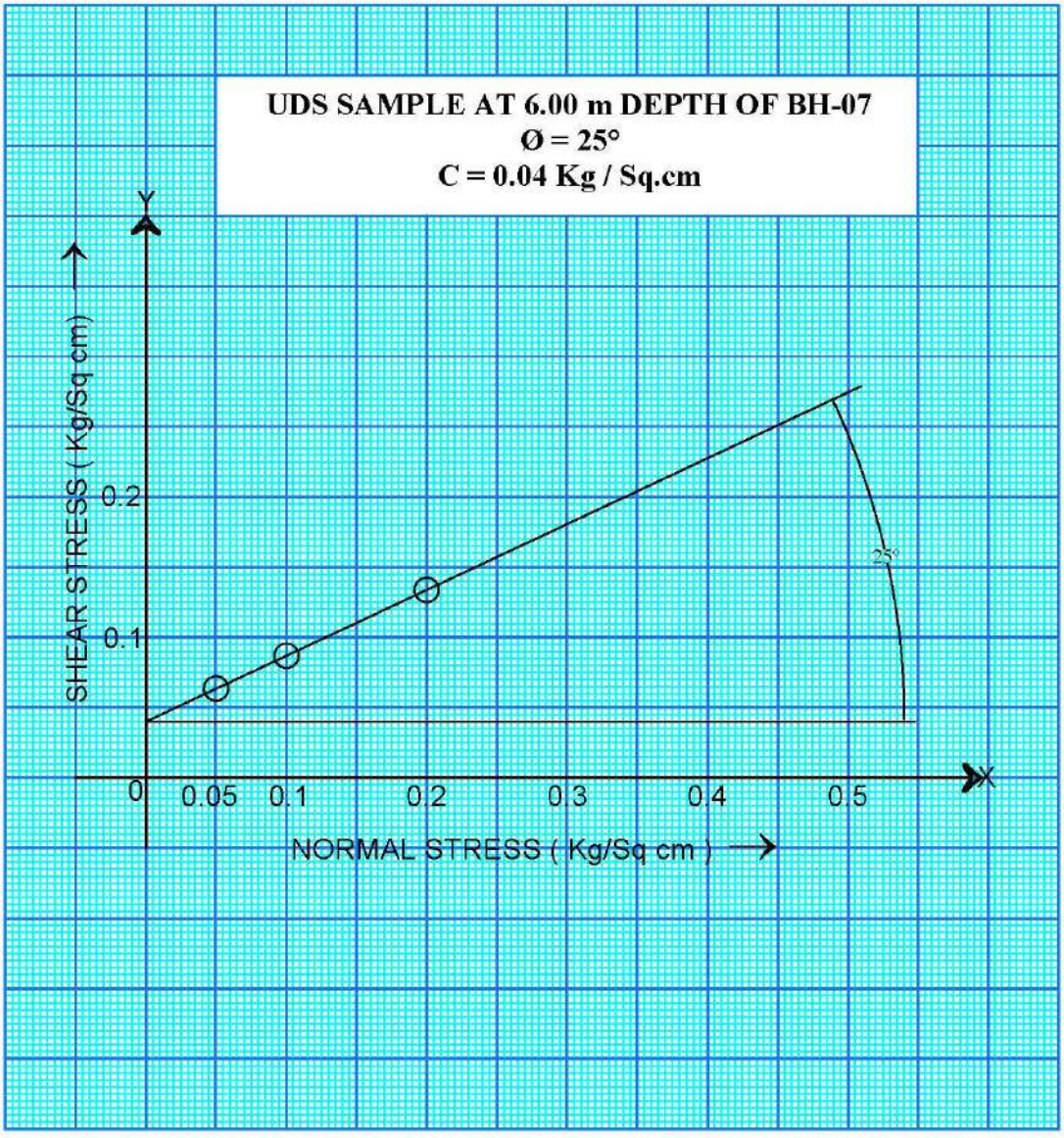
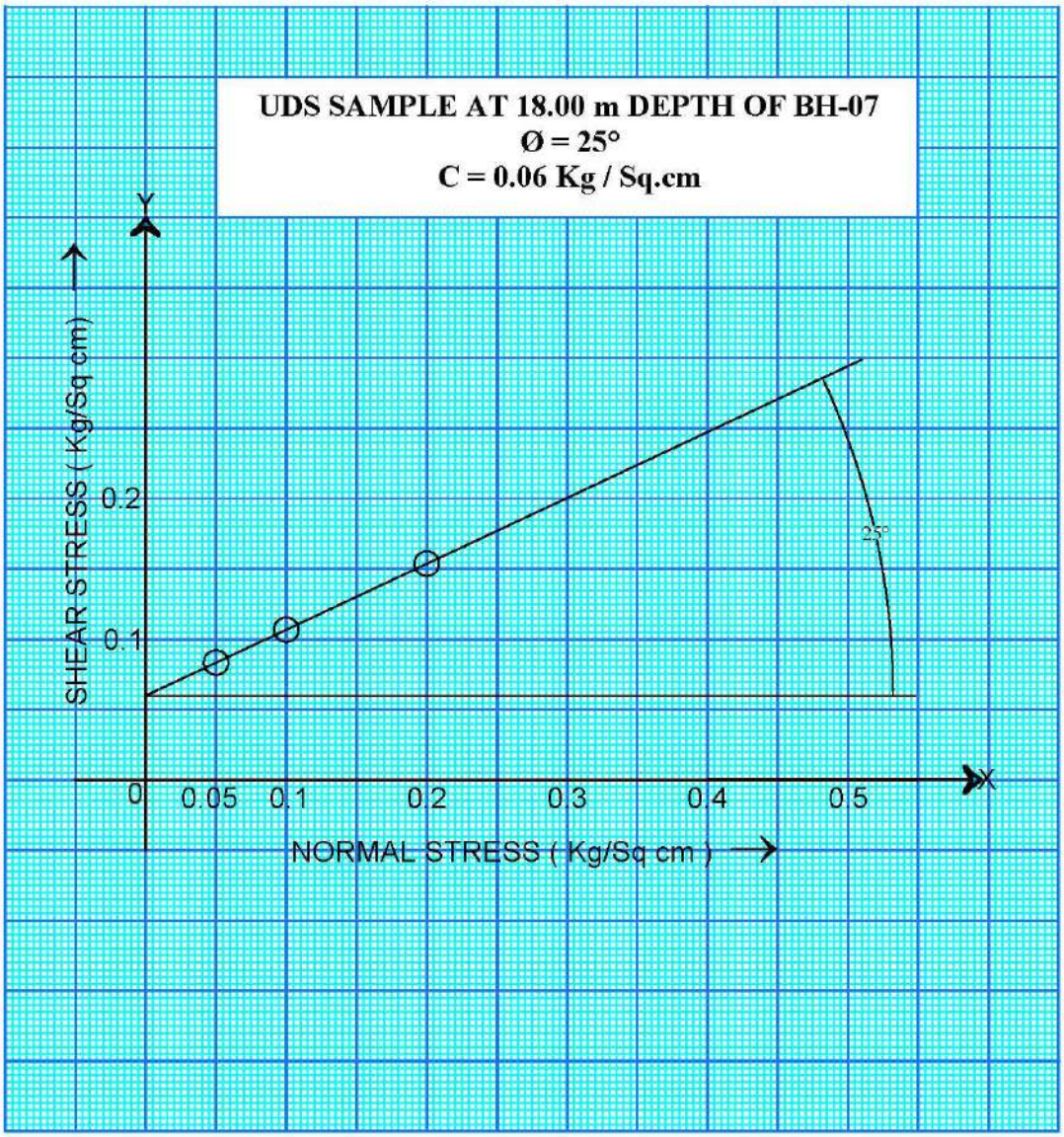
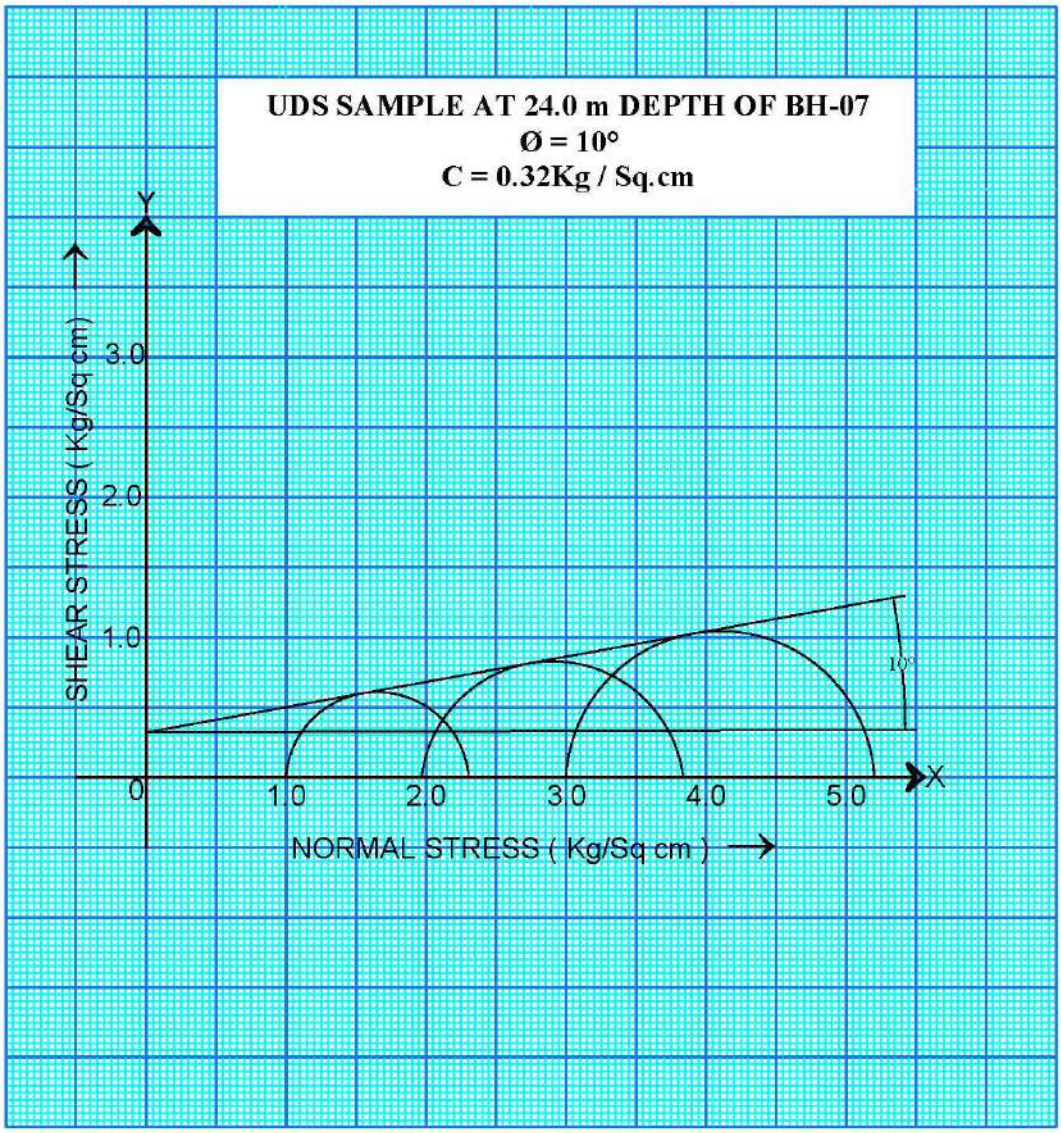


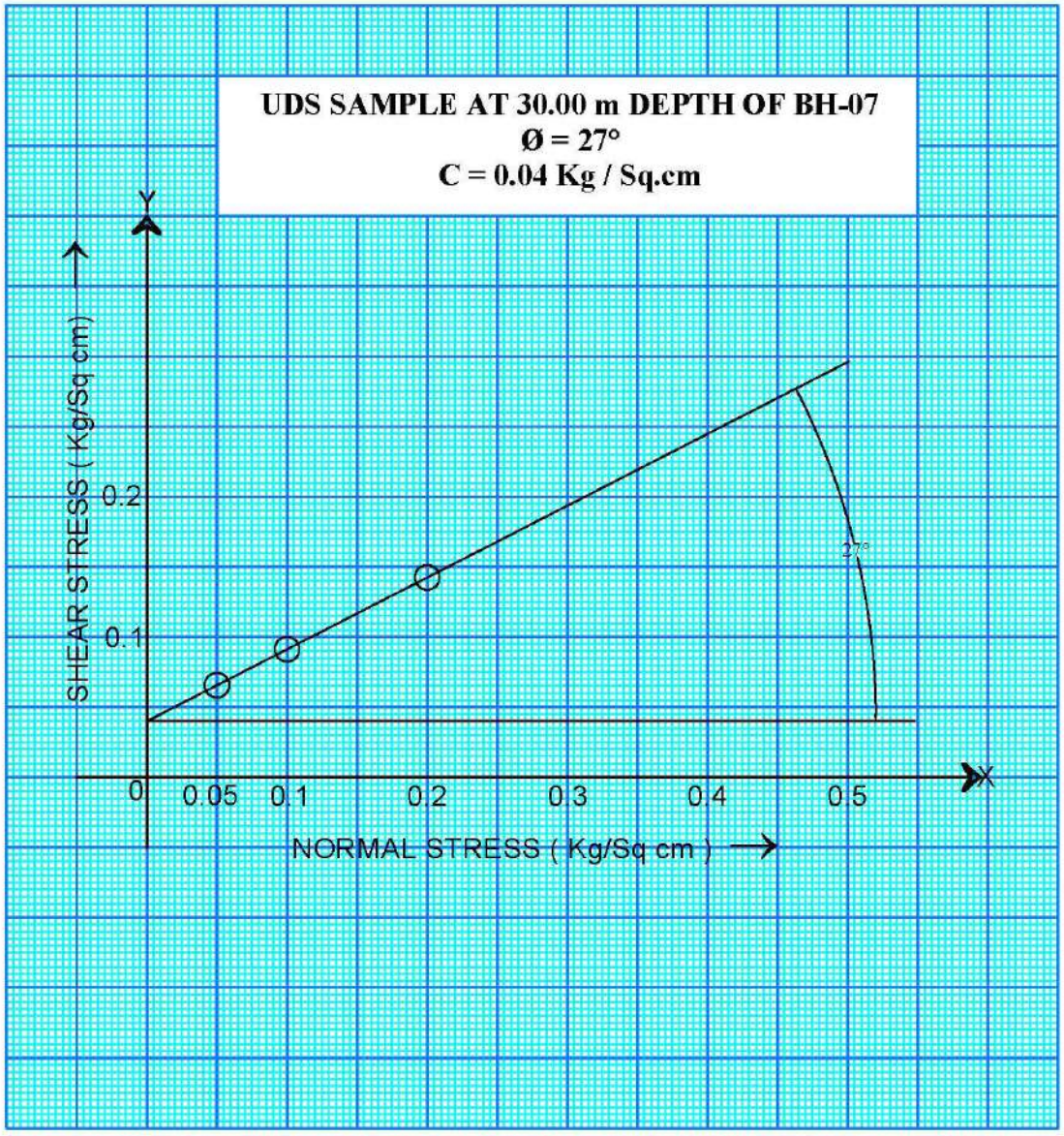
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

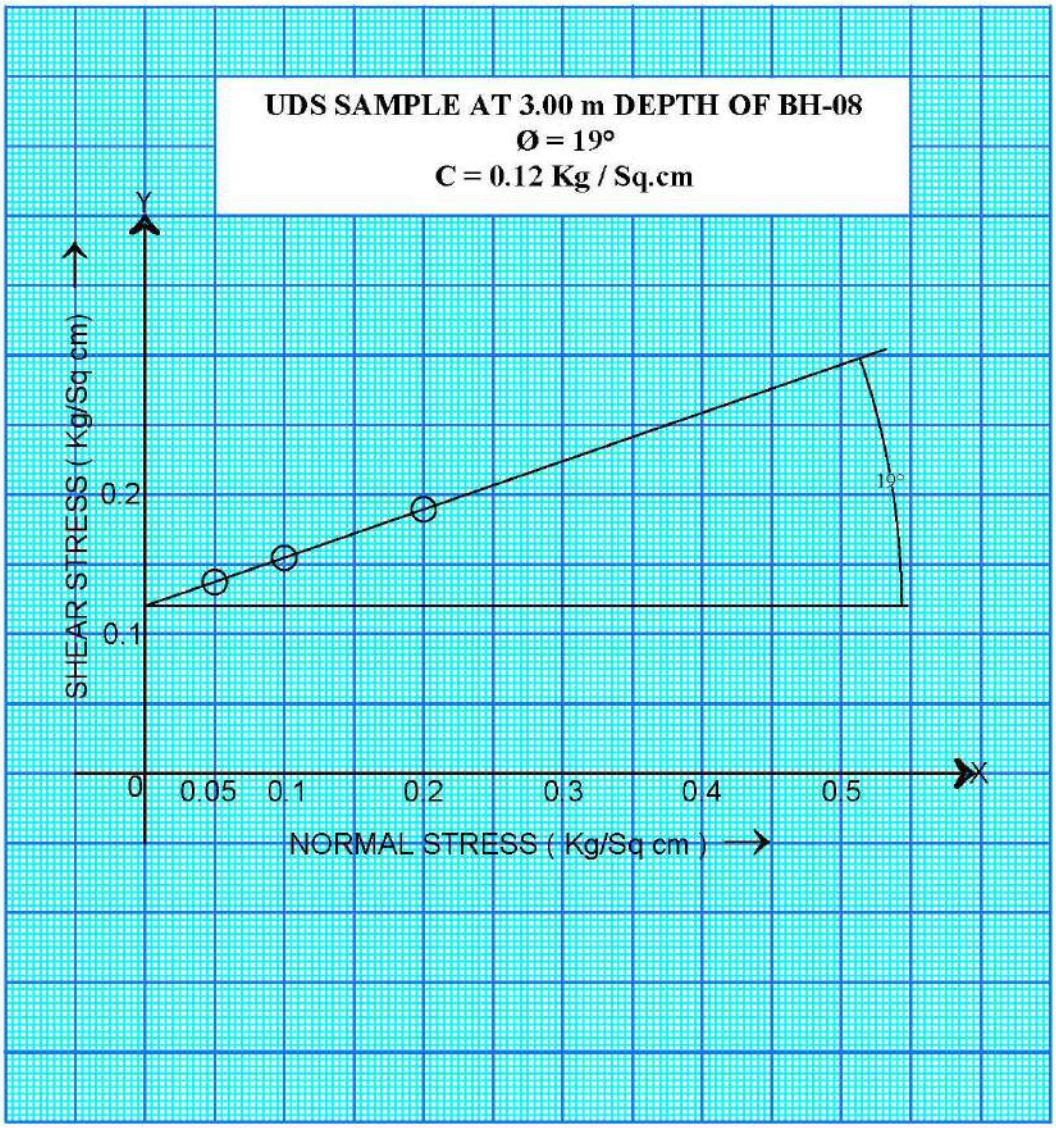


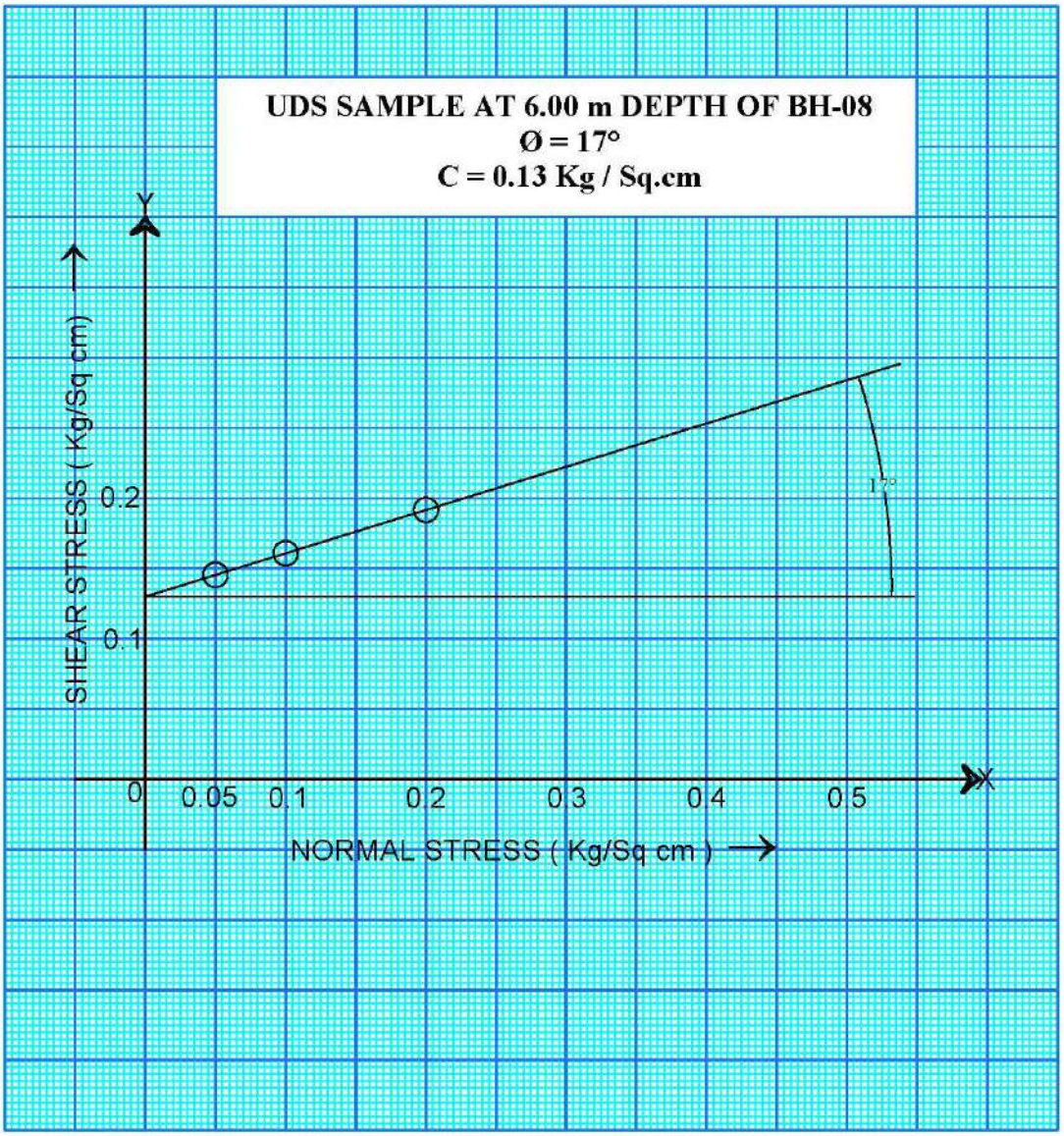
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

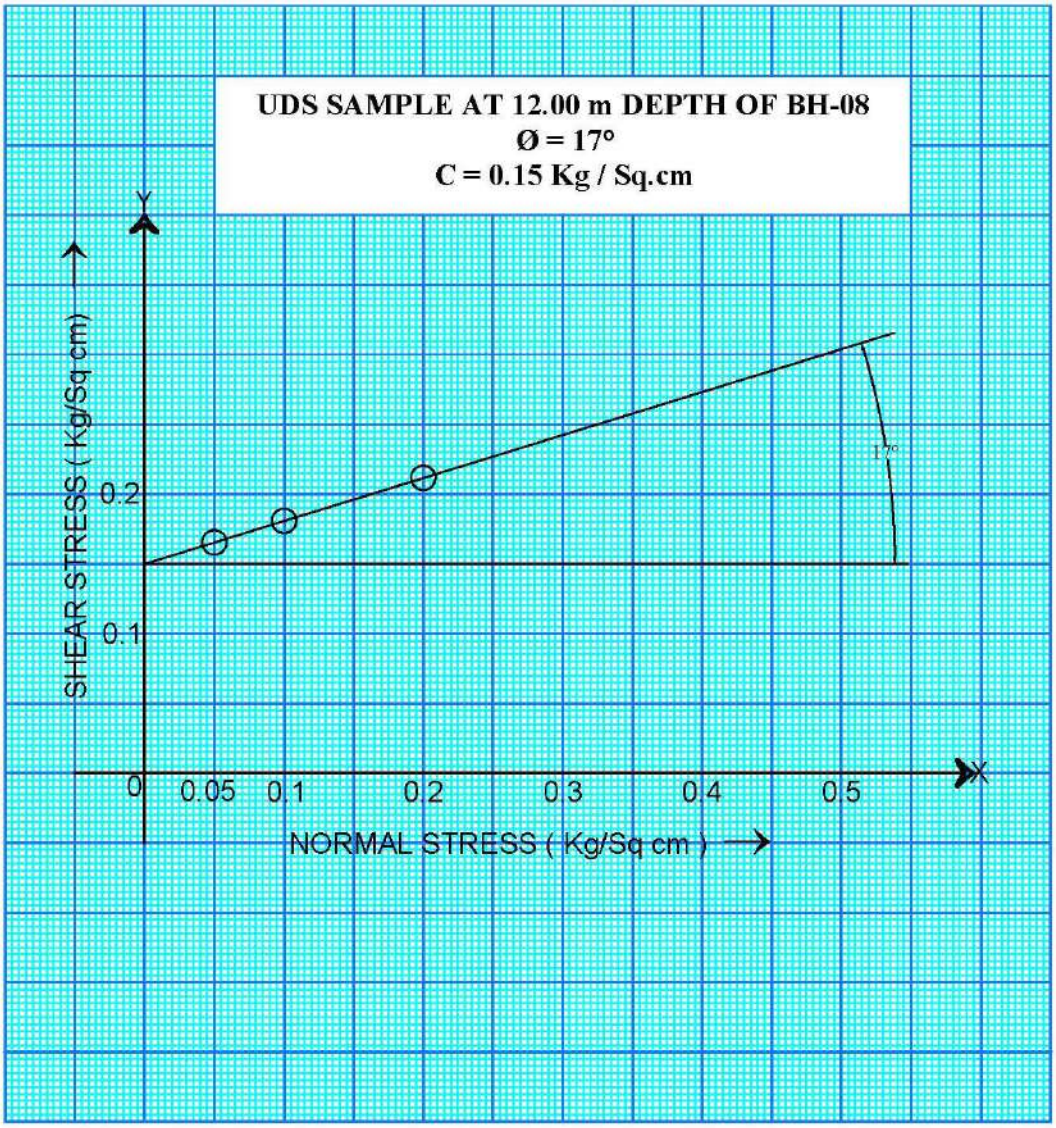


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

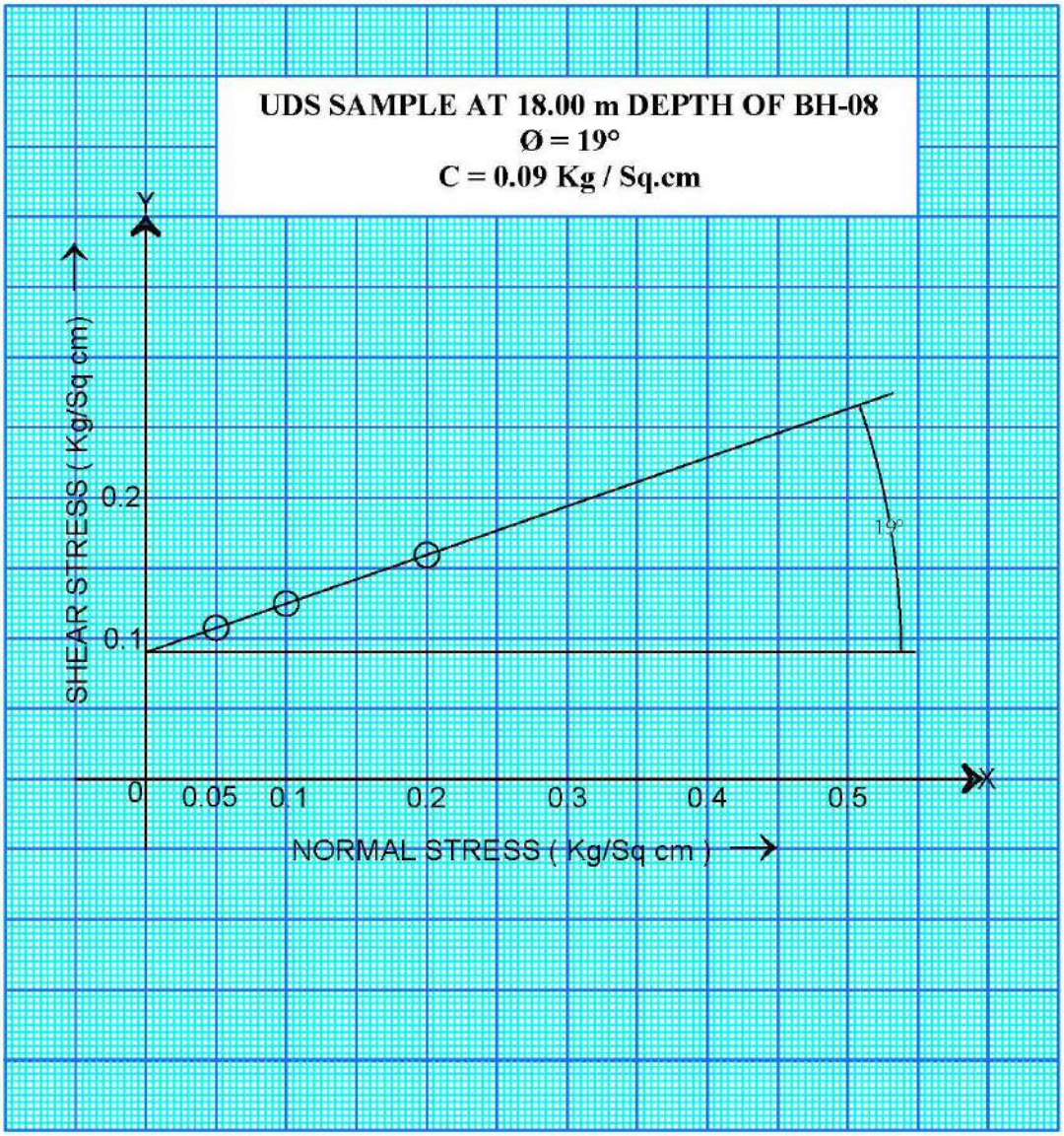

UDS SAMPLE AT 30.00 m DEPTH OF BH-07
Ø = 27°
C = 0.04 Kg / Sq.cm
Y
SHEAR STRESS (Kg/Sq cm)
0.2
0.1
27°
0
0.05
0.1
0.2
0.3
0.4
0.5
X
NORMAL STRESS (Kg/Sq cm)

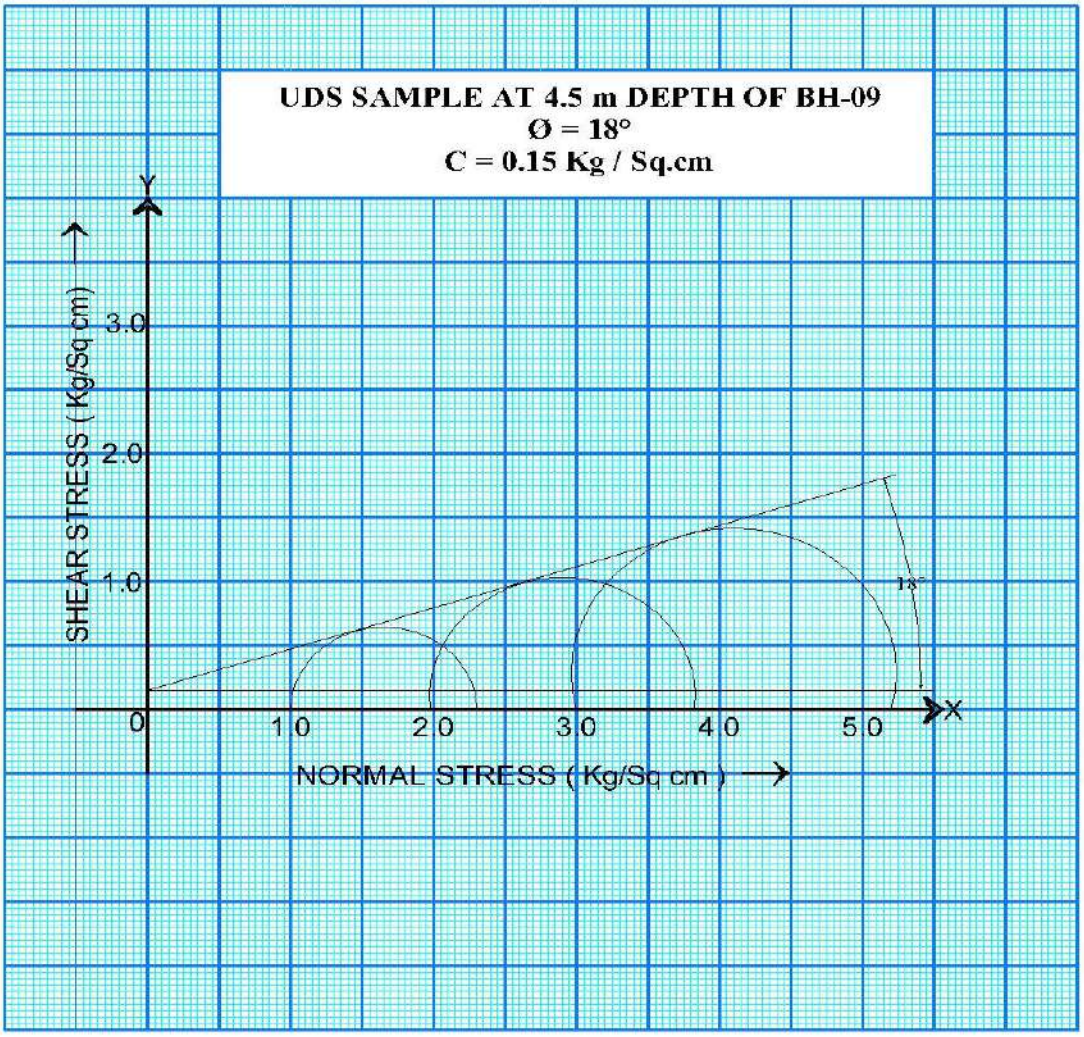

UDS SAMPLE AT 3.00 m DEPTH OF BH-08
Ø = 19°
C = 0.12 Kg / Sq.cm
Y
SHEAR STRESS (Kg/Sq cm)
0.2
0.1
19°
0
0.05
0.1
0.2
0.3
0.4
0.5
X
NORMAL STRESS (Kg/Sq cm)


UDS SAMPLE AT 6.00 m DEPTH OF BH-08
Ø = 17°
C = 0.13 Kg / Sq.cm
SHEAR STRESS (Kg/Sq cm)
0.2
0.1
0
0.05
0.1
0.2
0.3
0.4
0.5
NORMAL STRESS (Kg/Sq cm)
17°

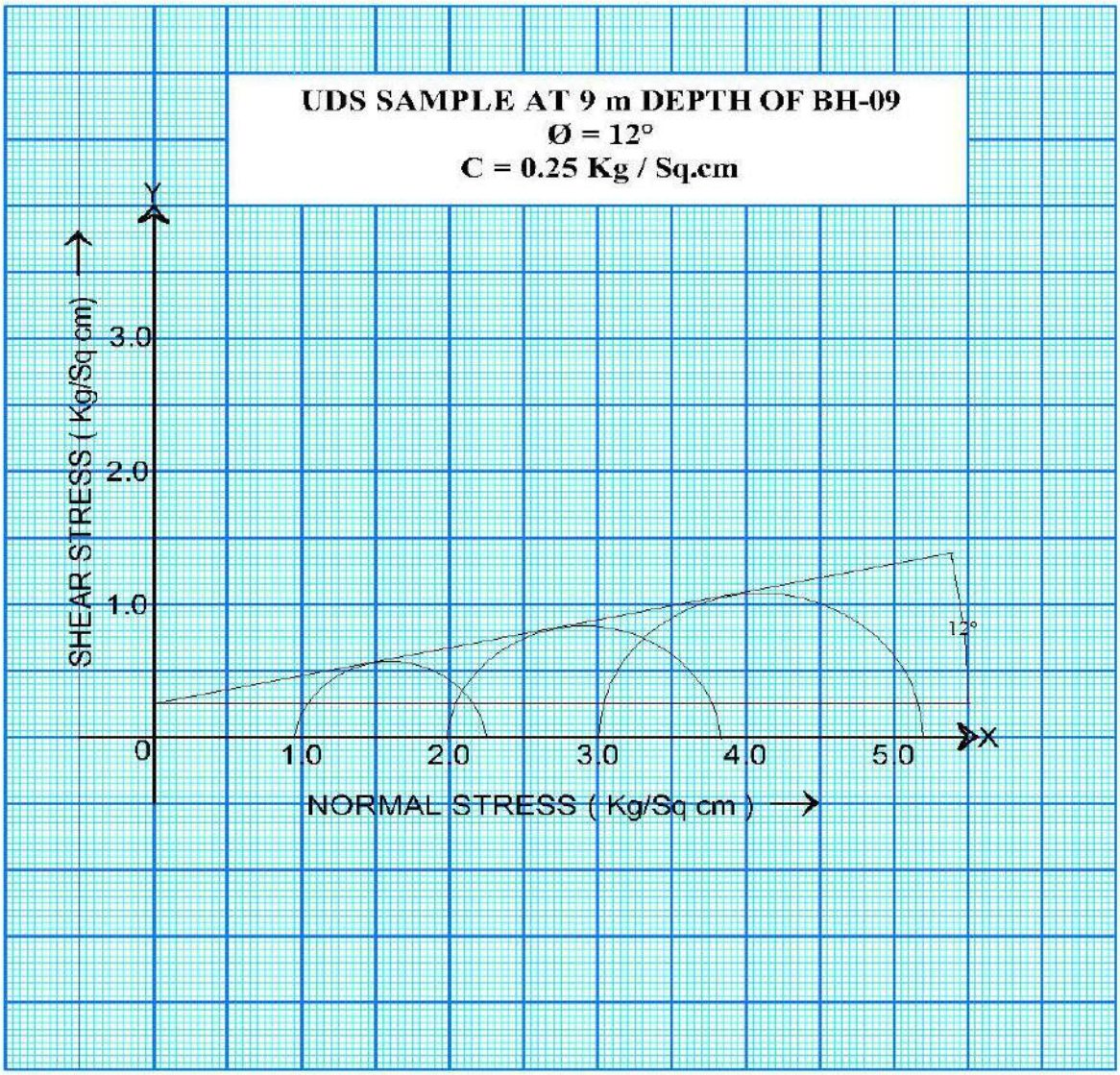


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

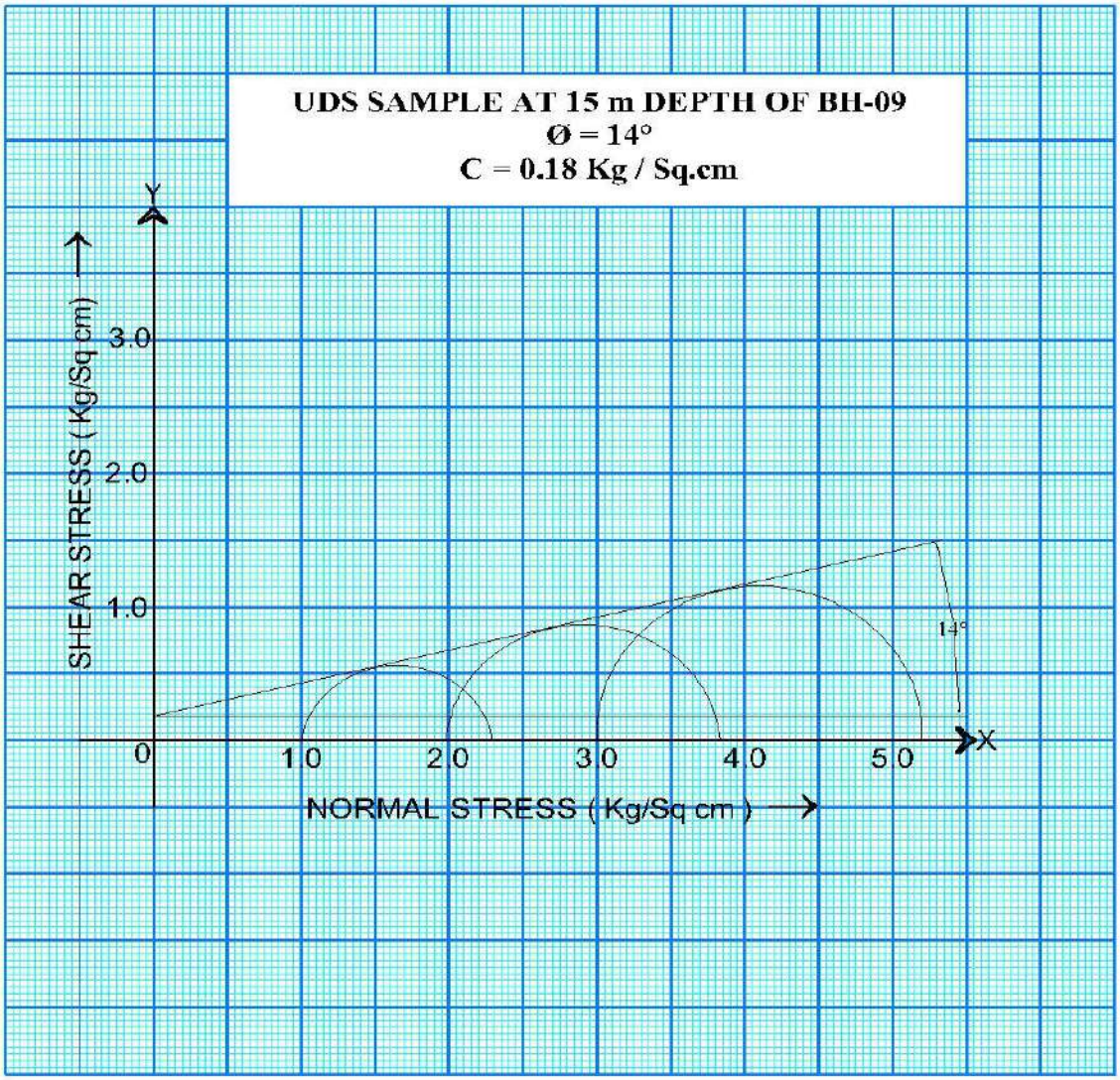

UDS SAMPLE AT 18.00 m DEPTH OF BH-08
Ø = 19°
C = 0.09 Kg / Sq.cm
Y
SHEAR STRESS (Kg/Sq cm)
0.2
0.1
19°
0
0.05
0.1
0.2
0.3
0.4
0.5
X
NORMAL STRESS (Kg/Sq cm)



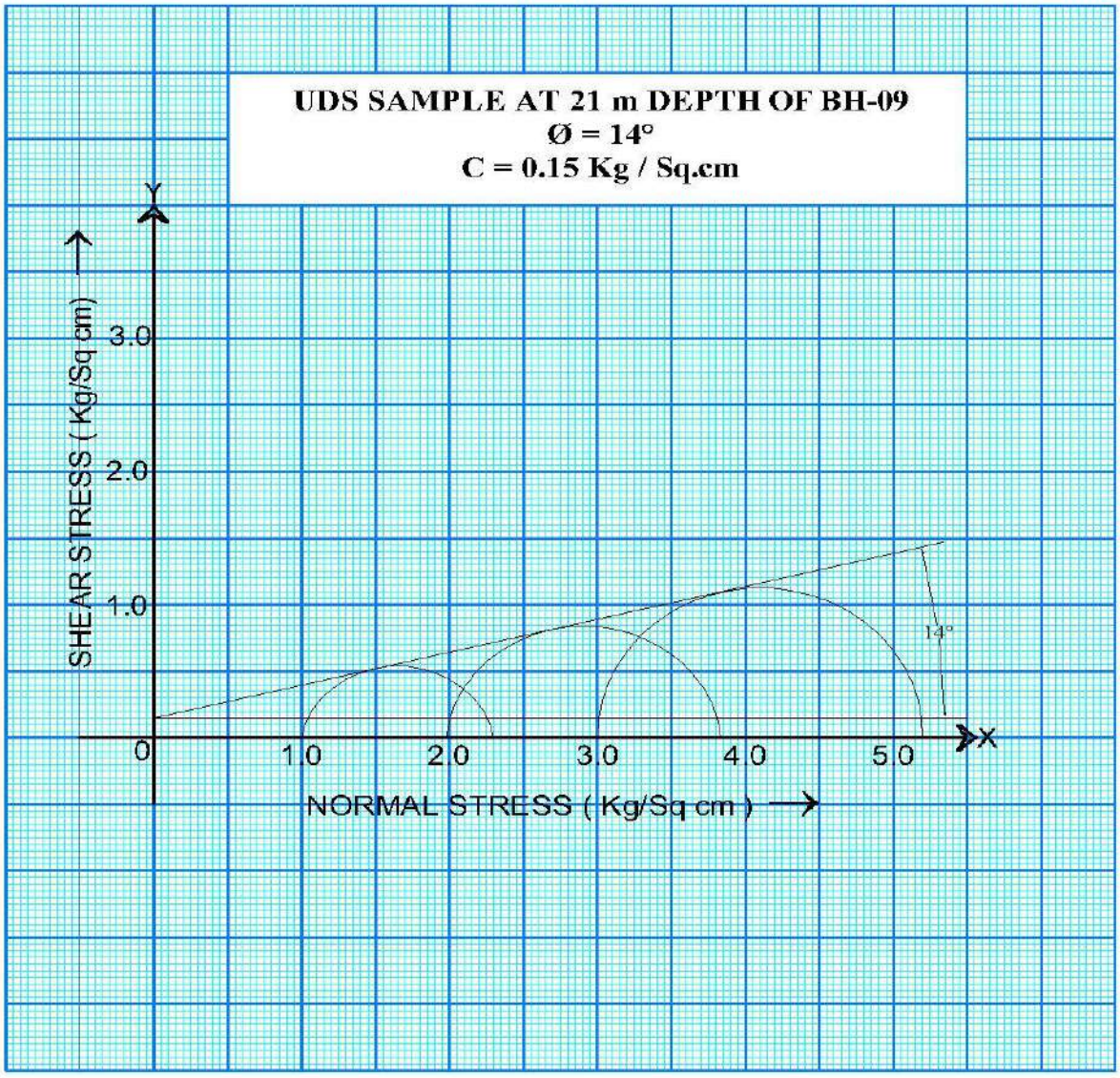
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



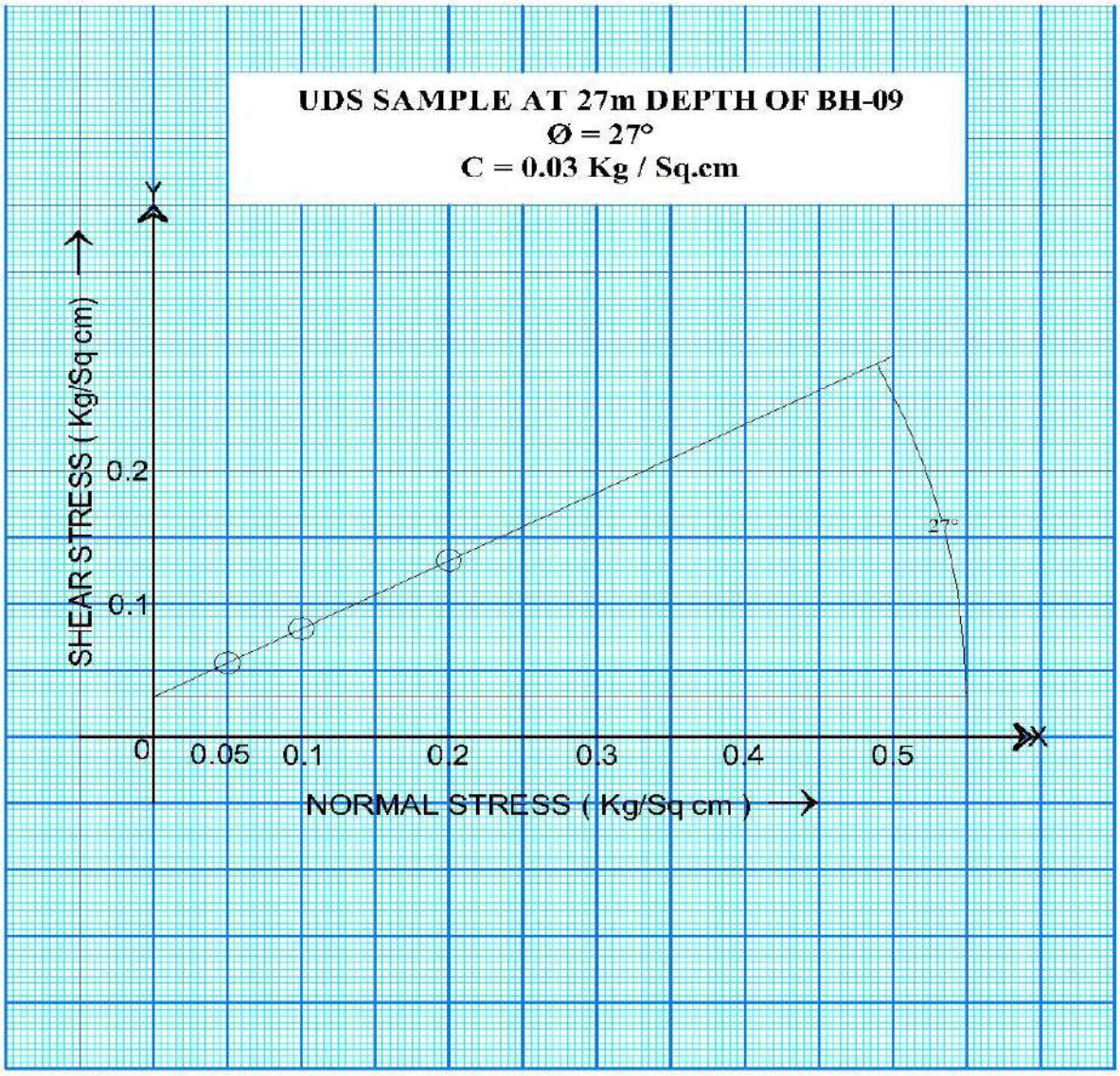
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



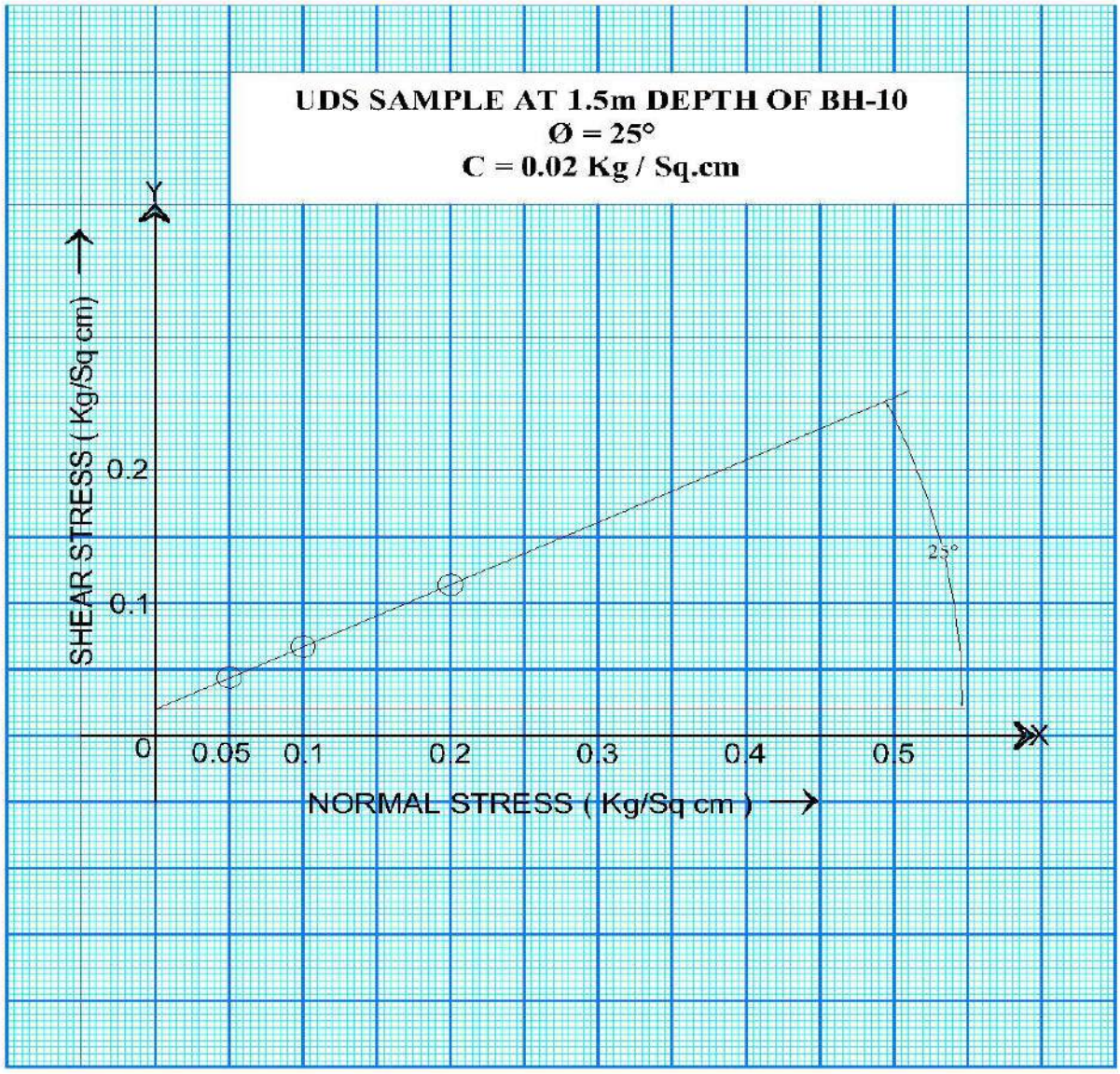
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



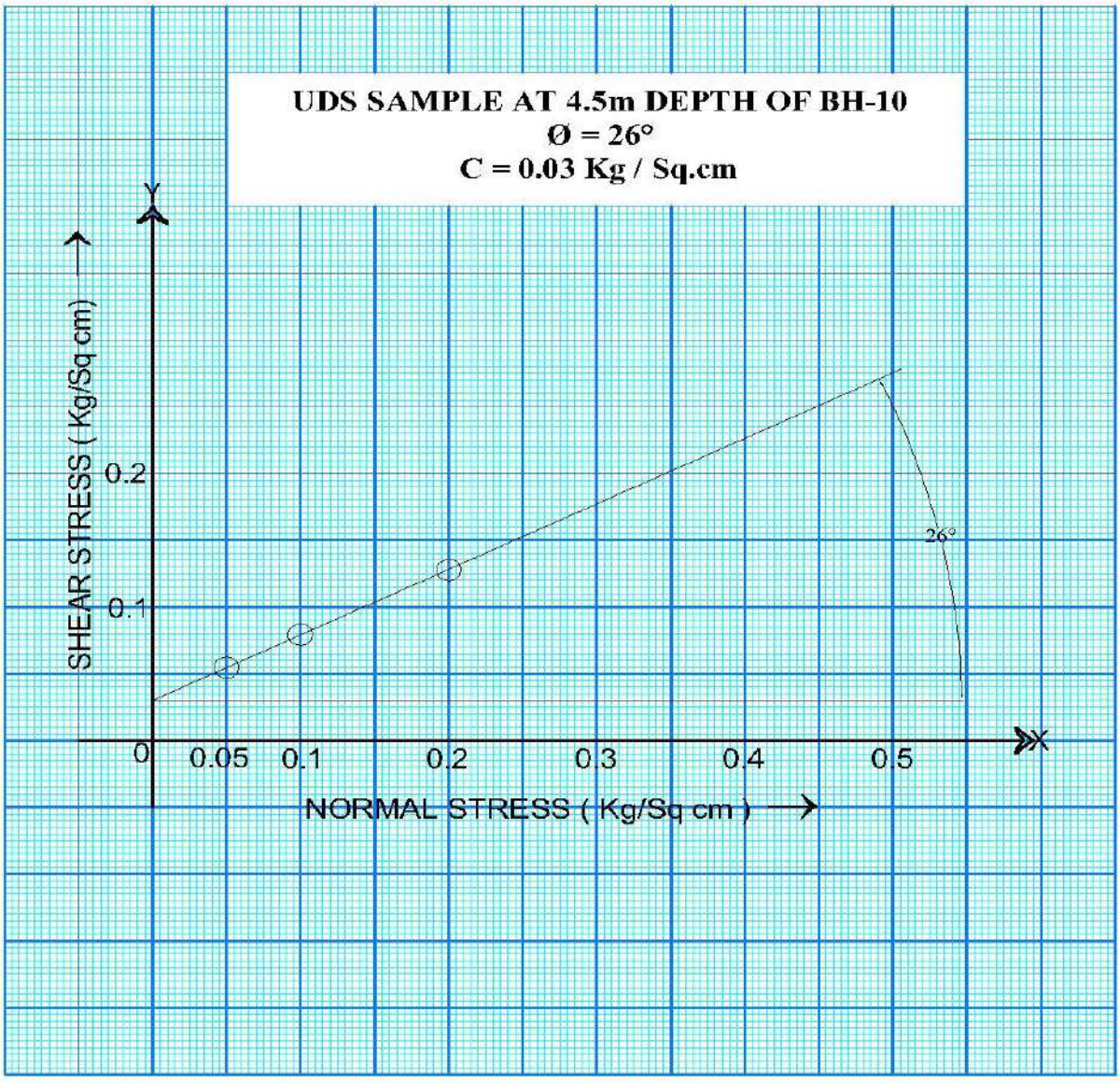
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



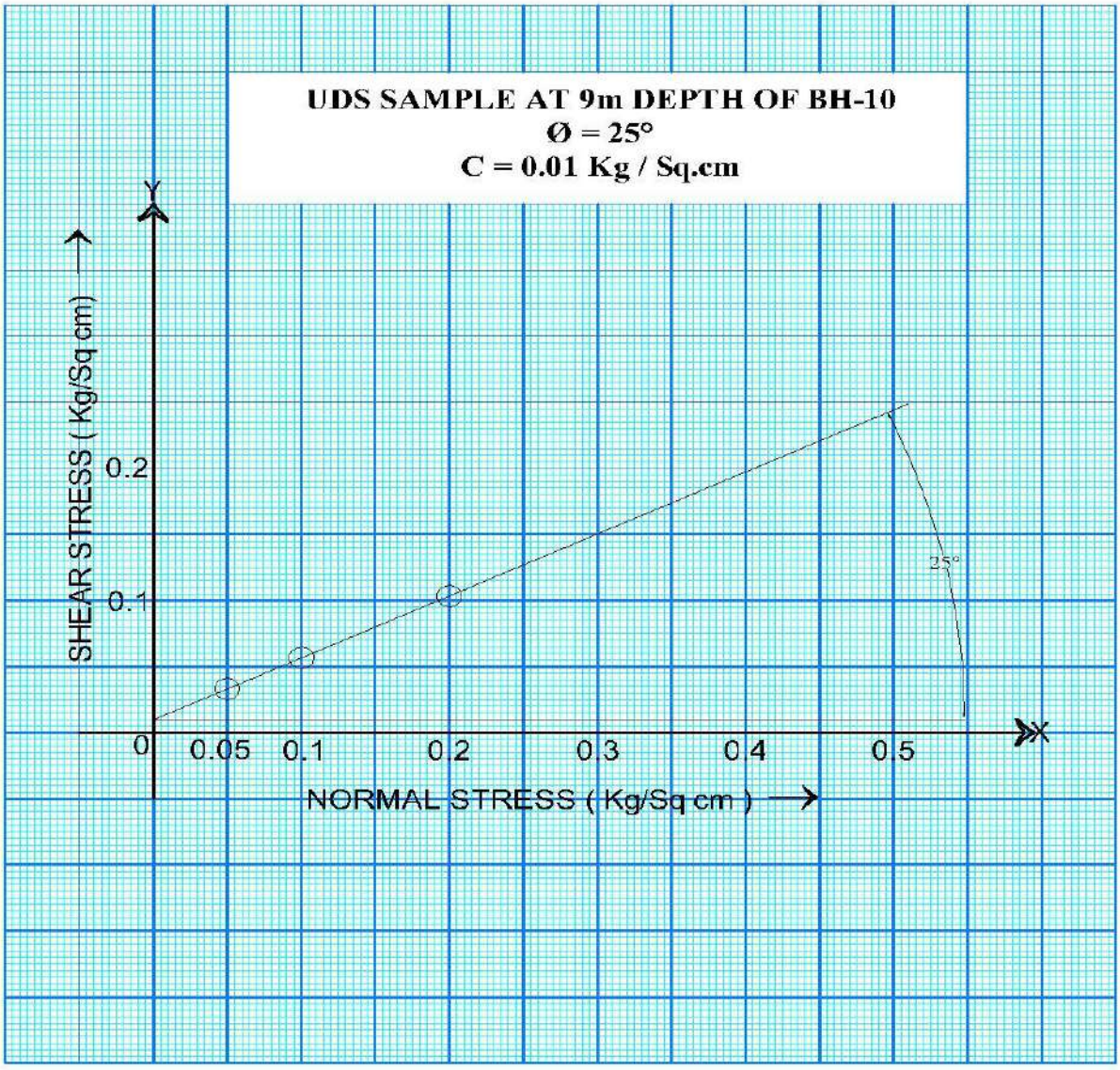
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



Name of Project:	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:	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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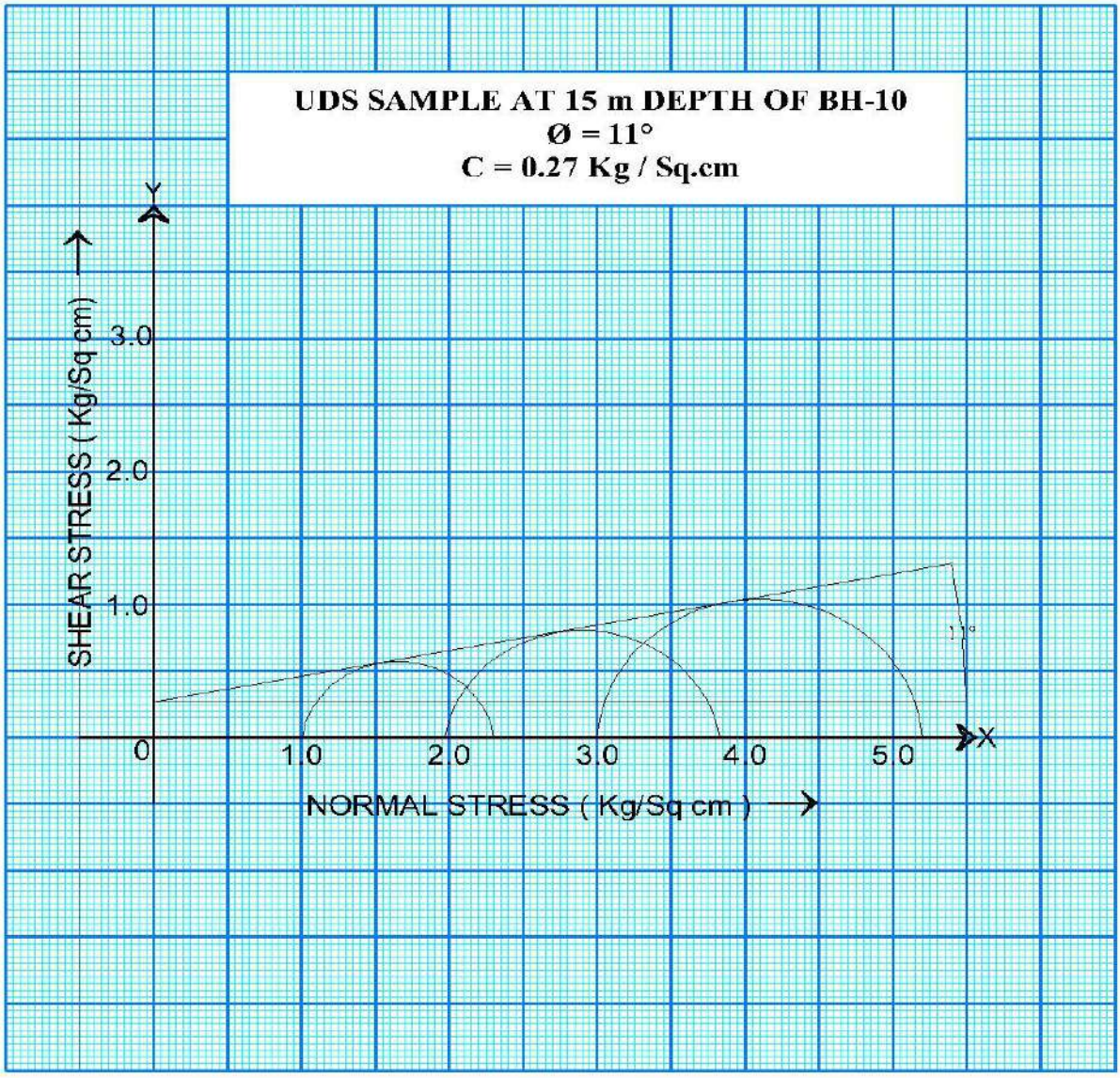
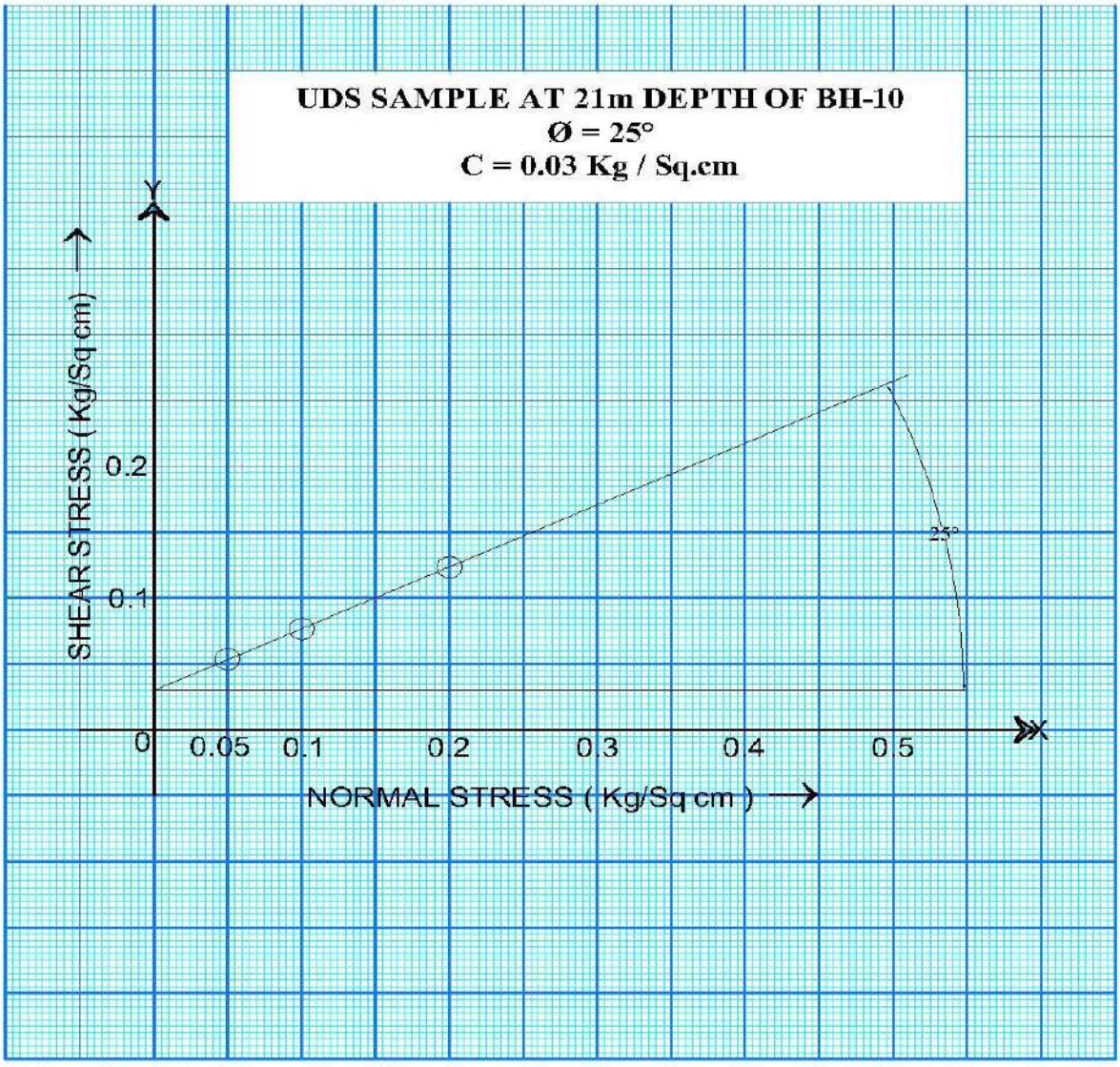
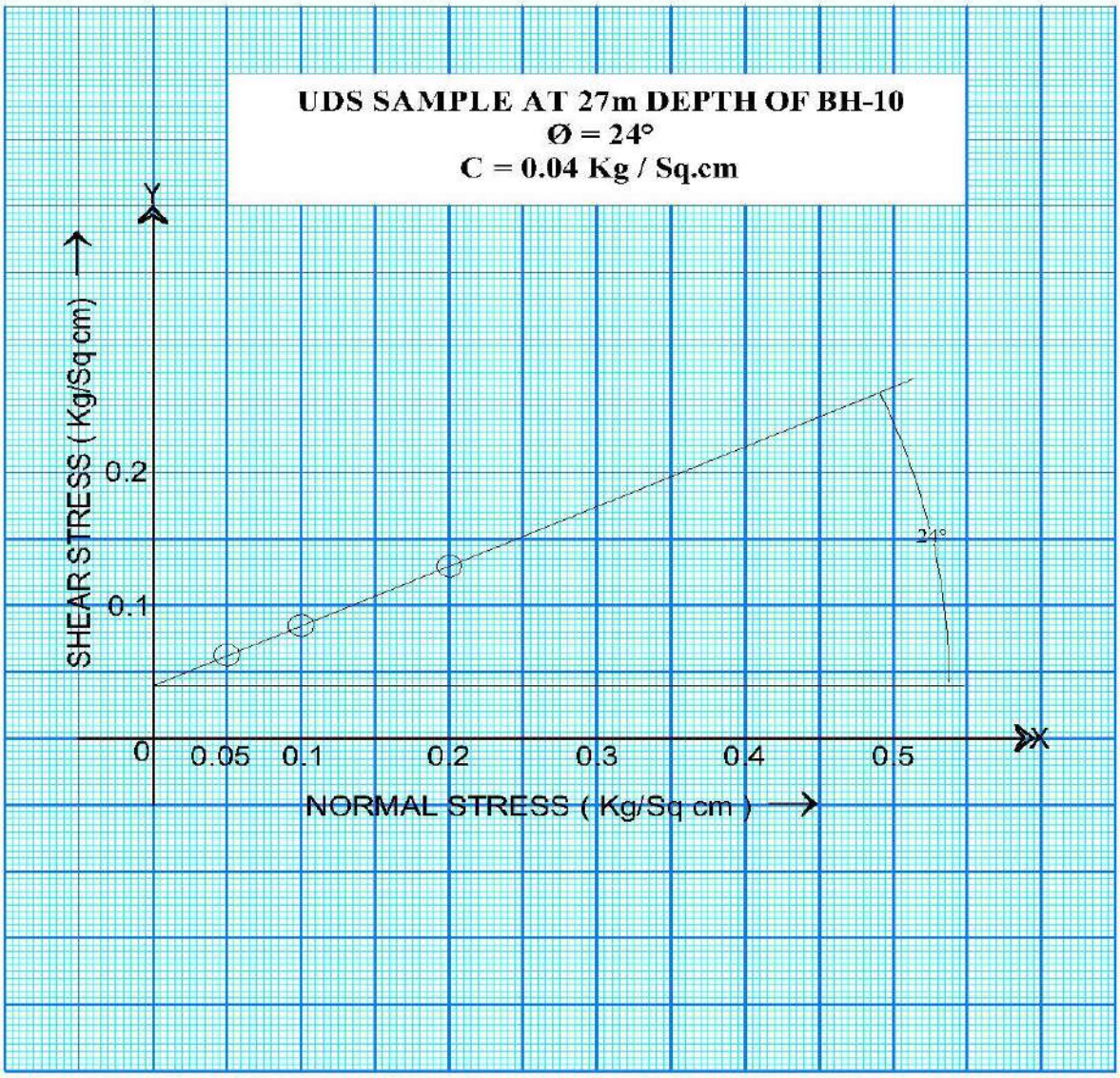


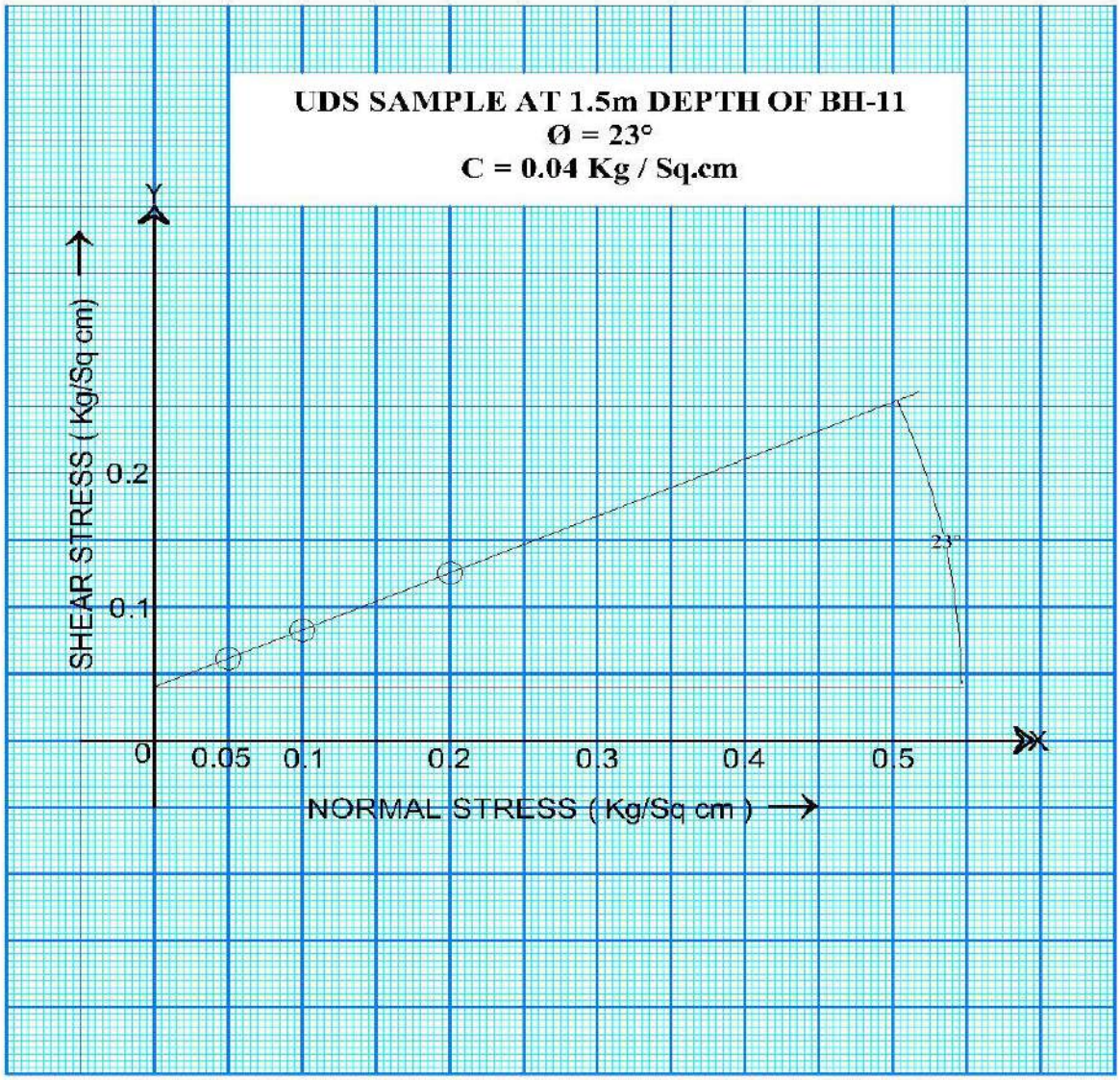
Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



Name of Project:	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:	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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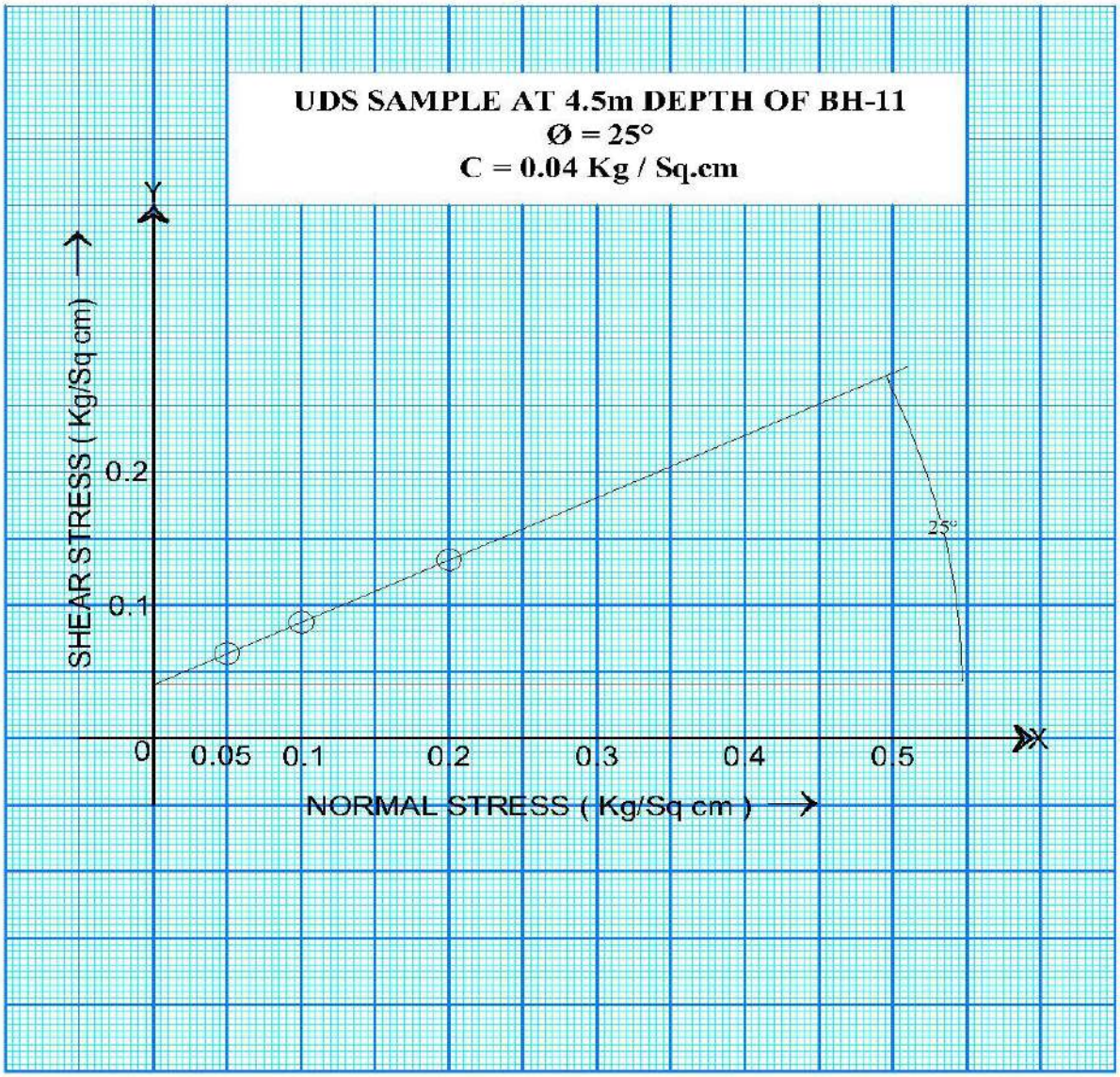

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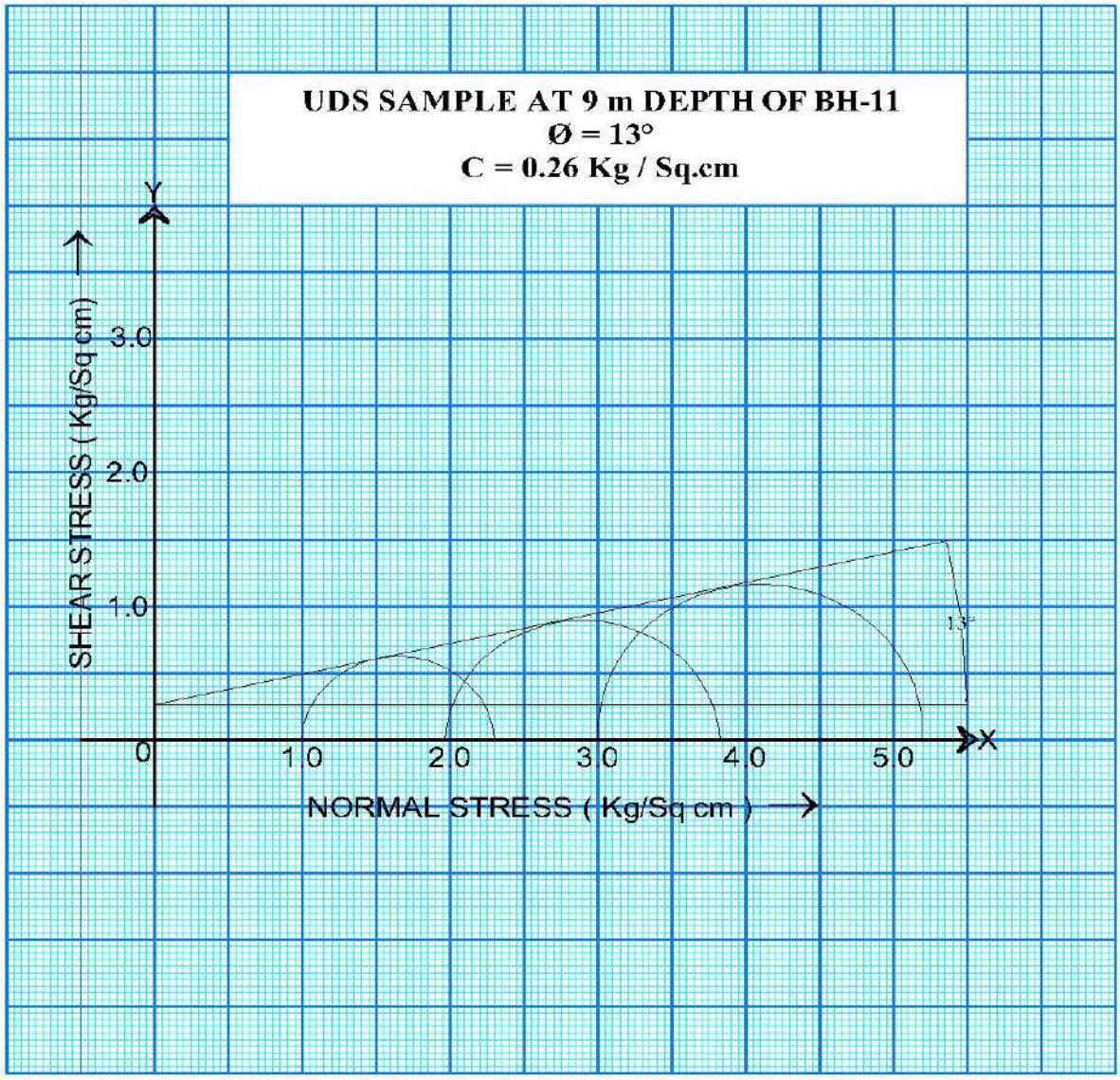

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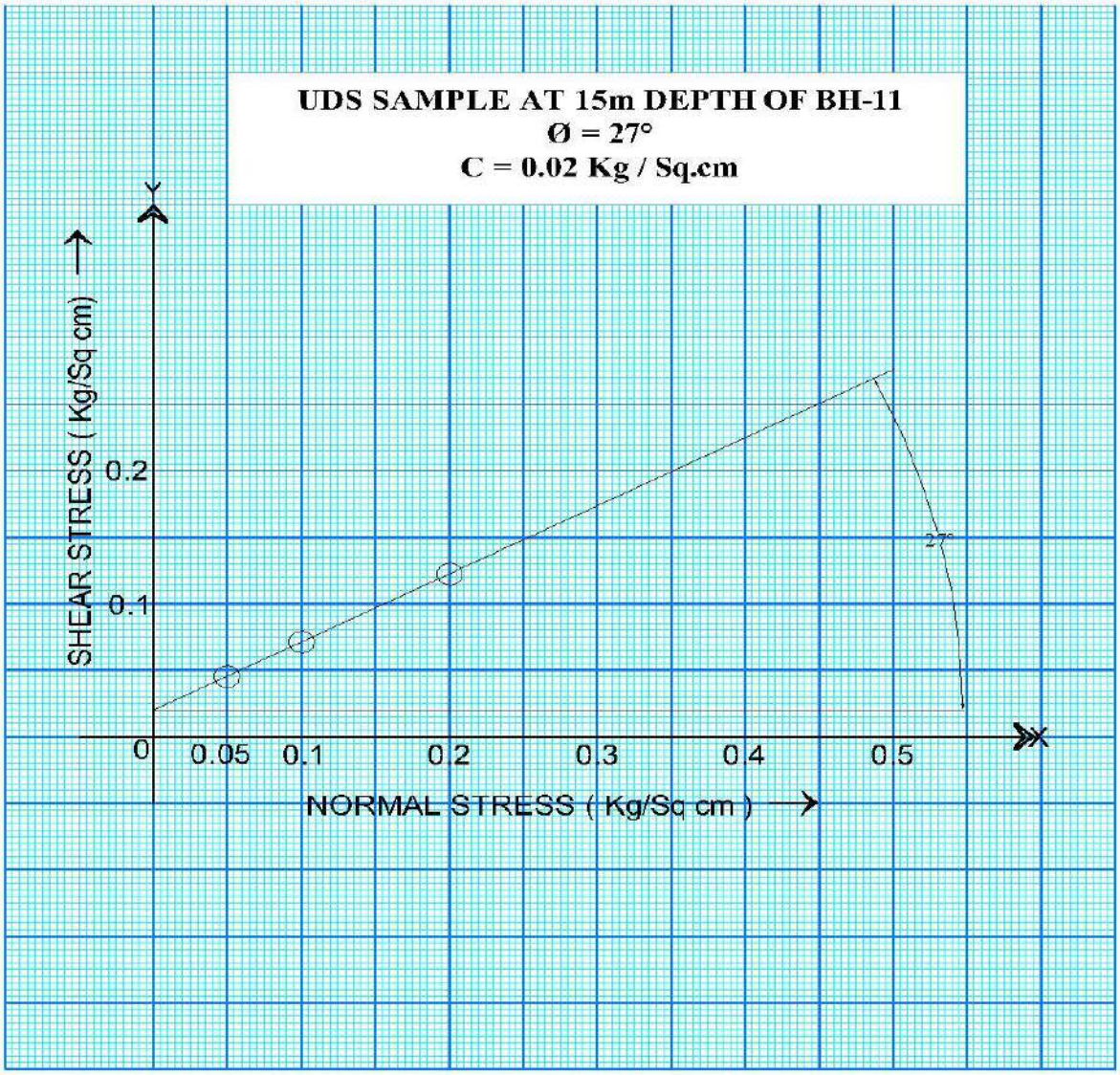
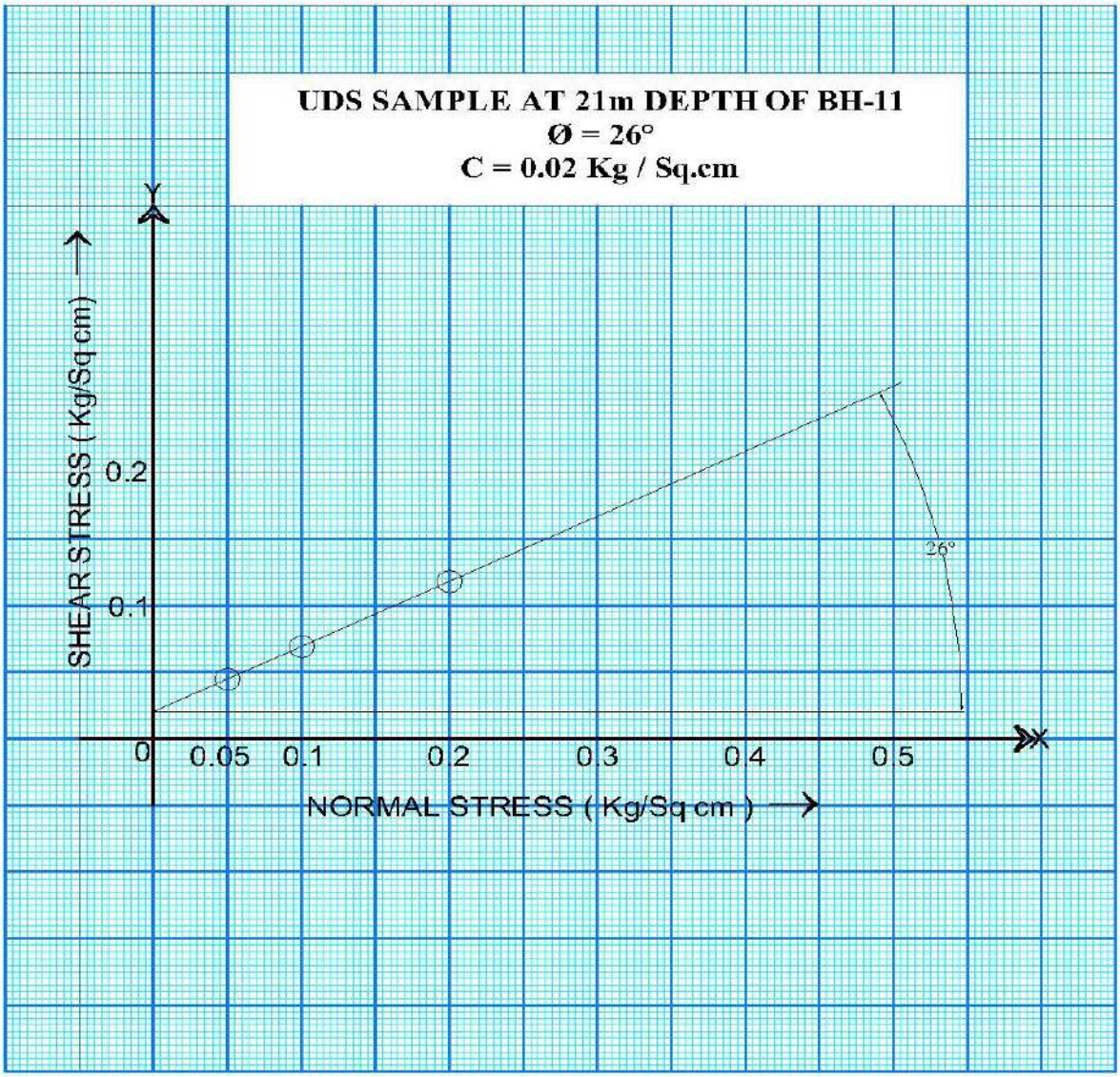

UDS SAMPLE AT 15m DEPTH OF BH-11
Ø = 27°
C = 0.02 Kg / Sq.cm
SHEAR STRESS (Kg/Sq cm)
0.2
0.1
0
0.05
0.1
0.2
0.3
0.4
0.5
NORMAL STRESS (Kg/Sq cm)
27°



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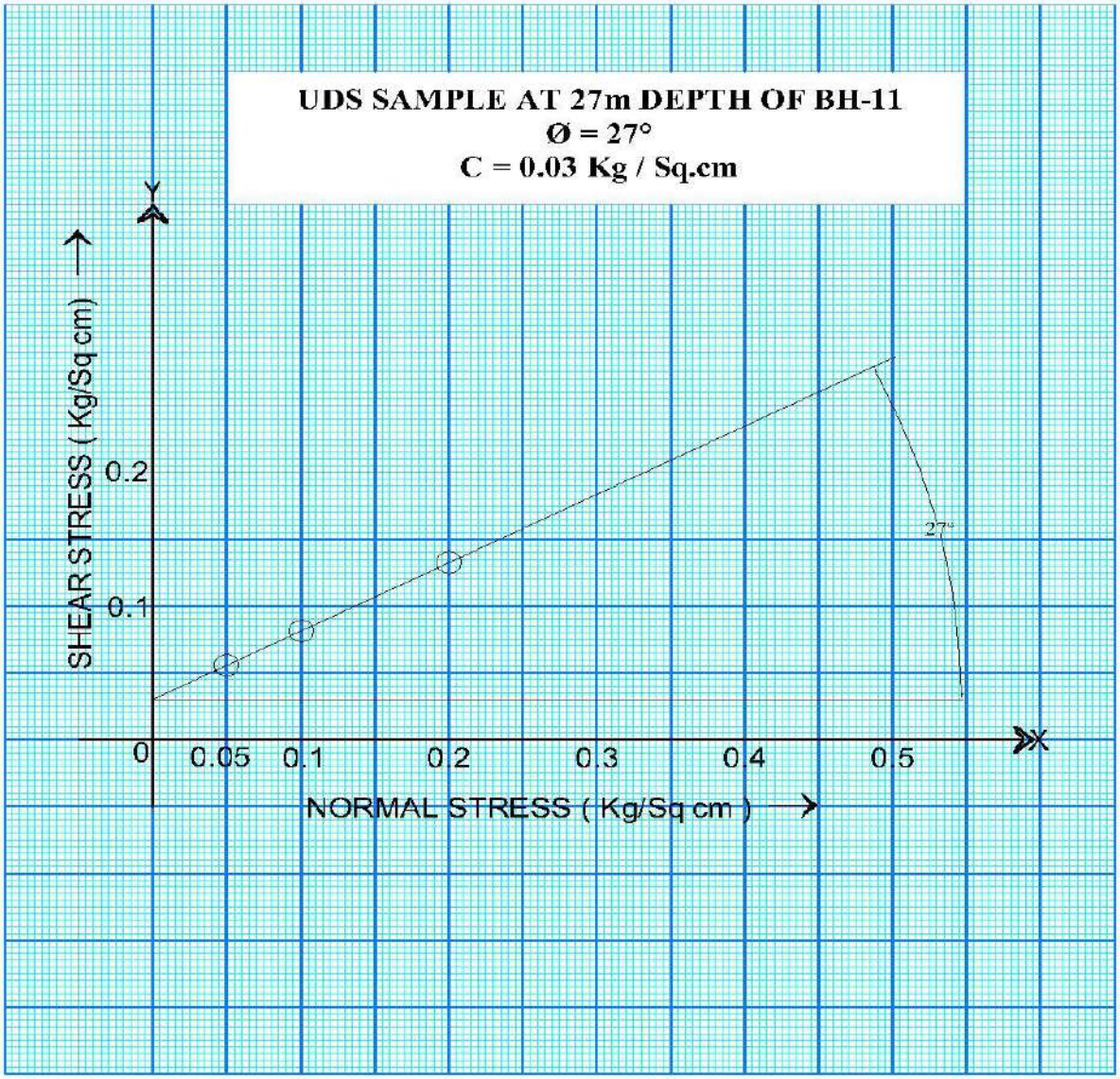
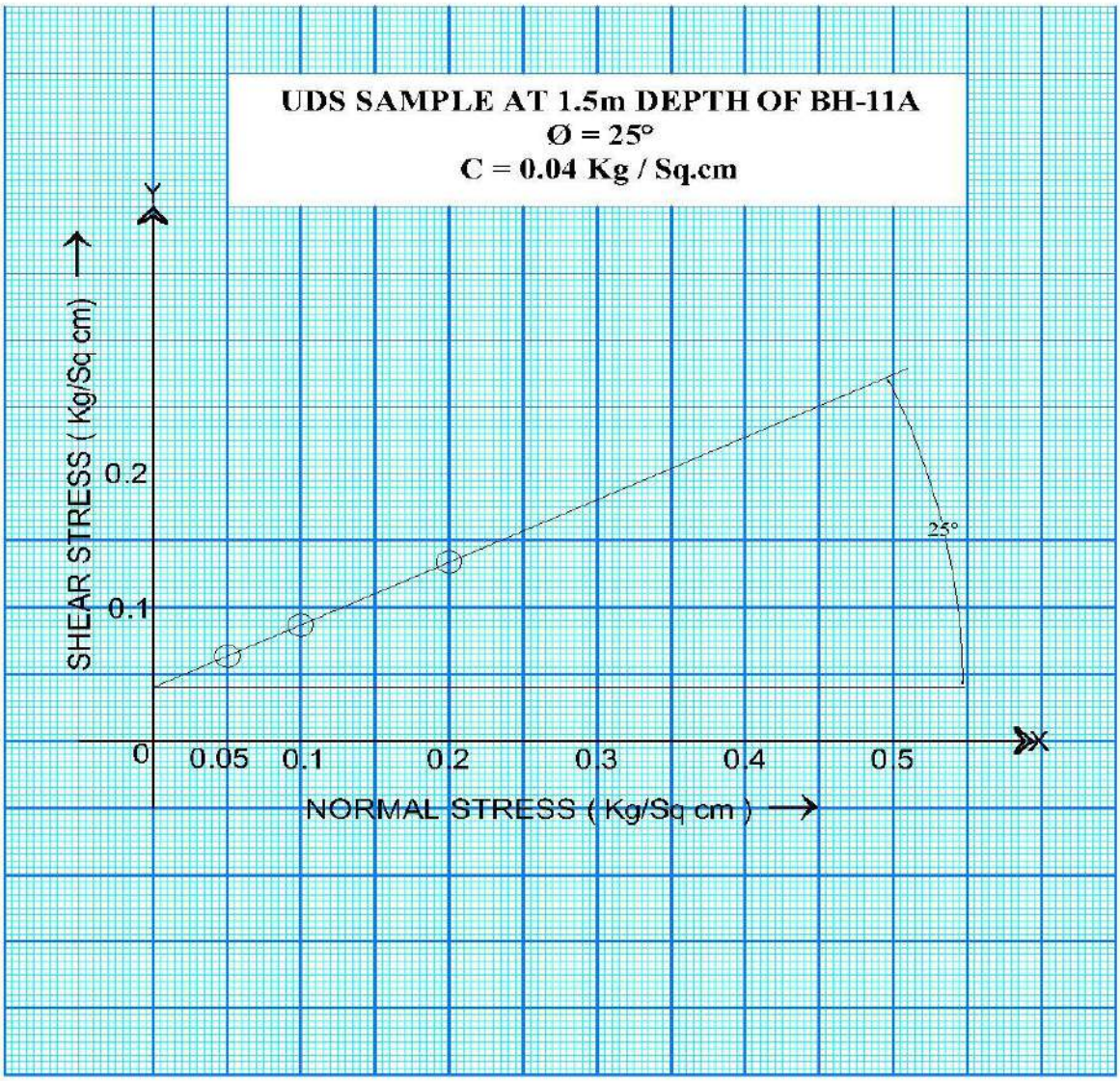

UDS SAMPLE AT 27m DEPTH OF BH-11
Ø = 27°
C = 0.03 Kg / Sq.cm
SHEAR STRESS (Kg/Sq cm)
0.2
0.1
0
0.05
0.1
0.2
0.3
0.4
0.5
NORMAL STRESS (Kg/Sq cm)
27°



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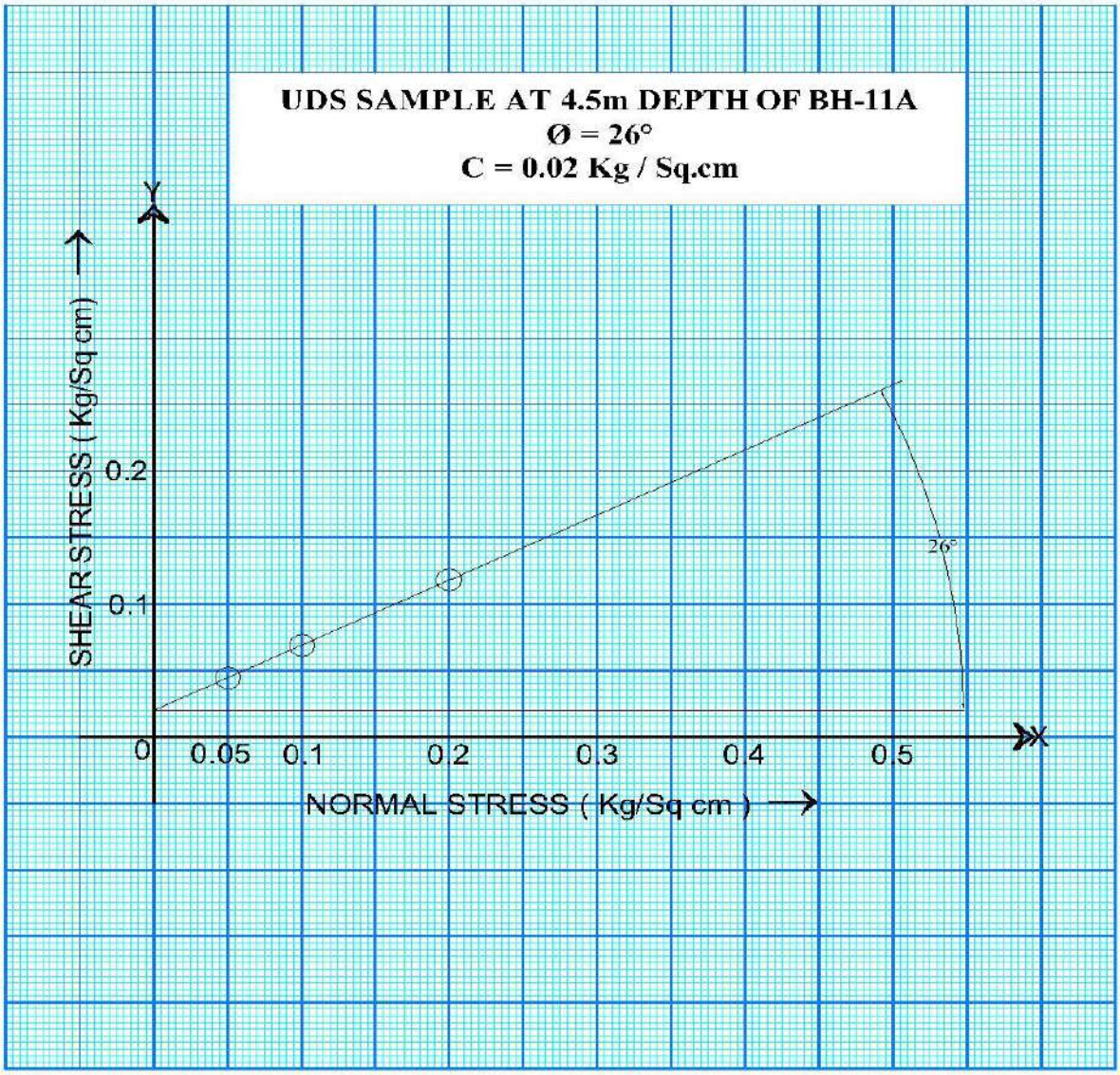
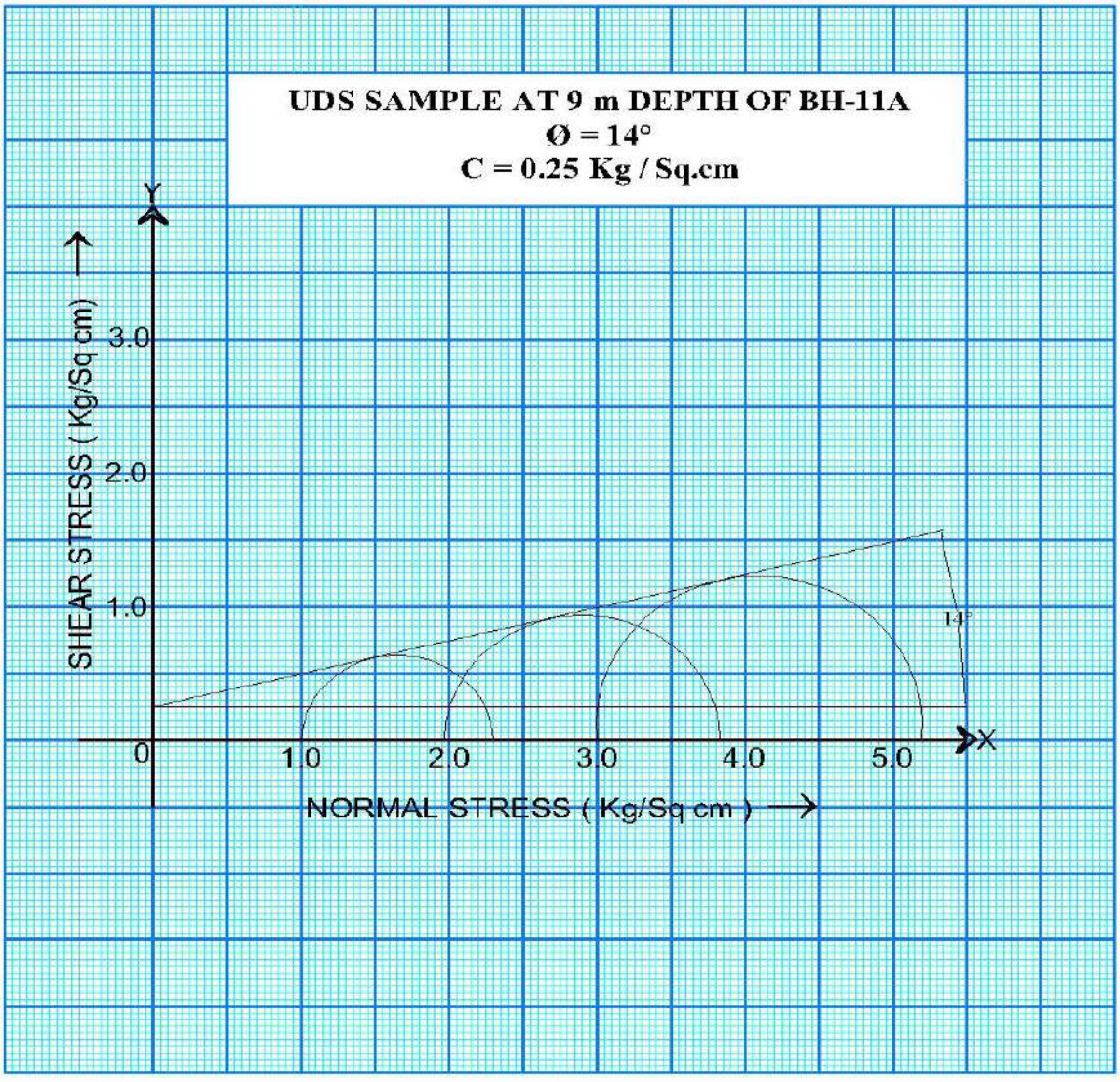
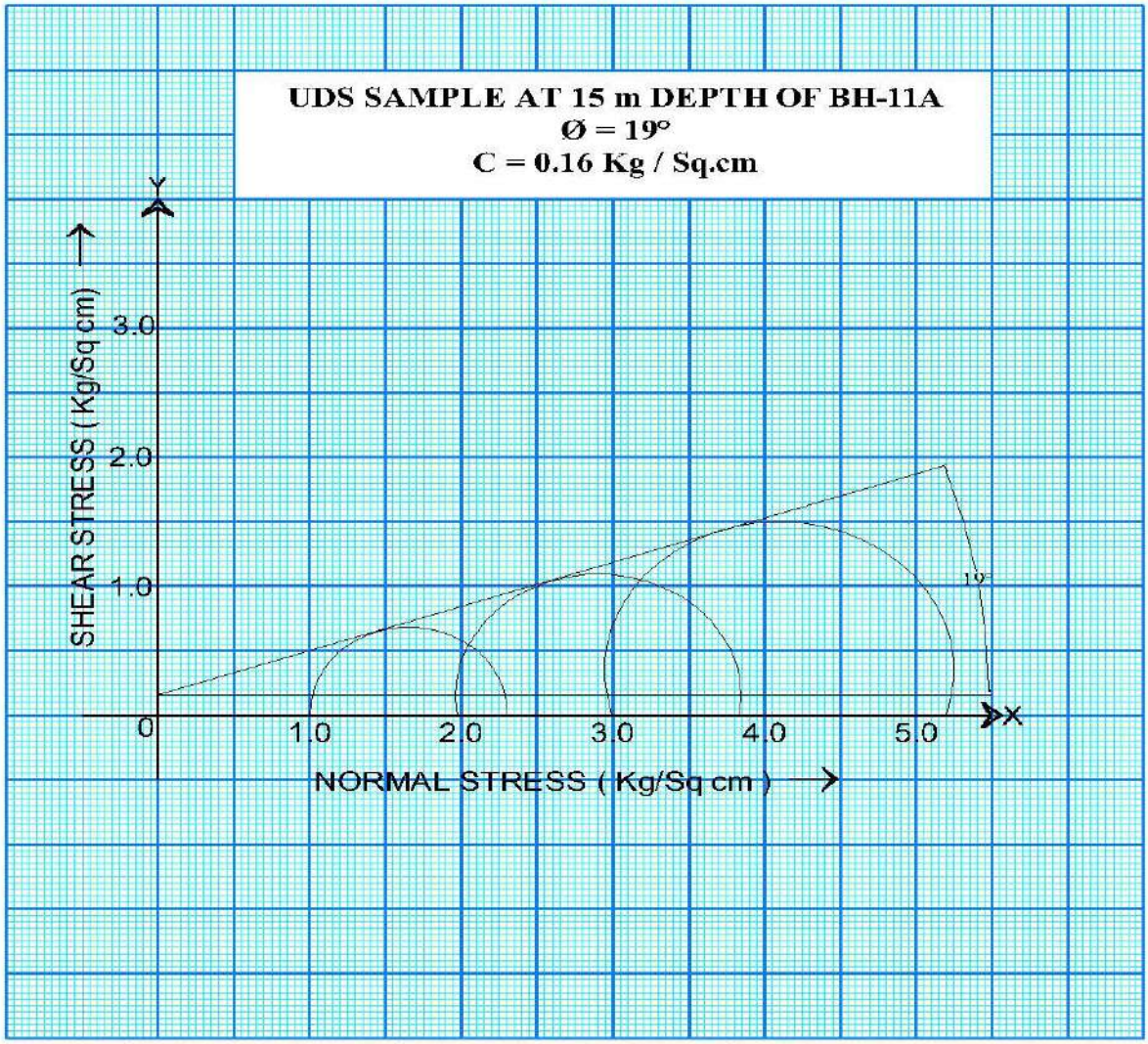


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.



Name of Project:	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.

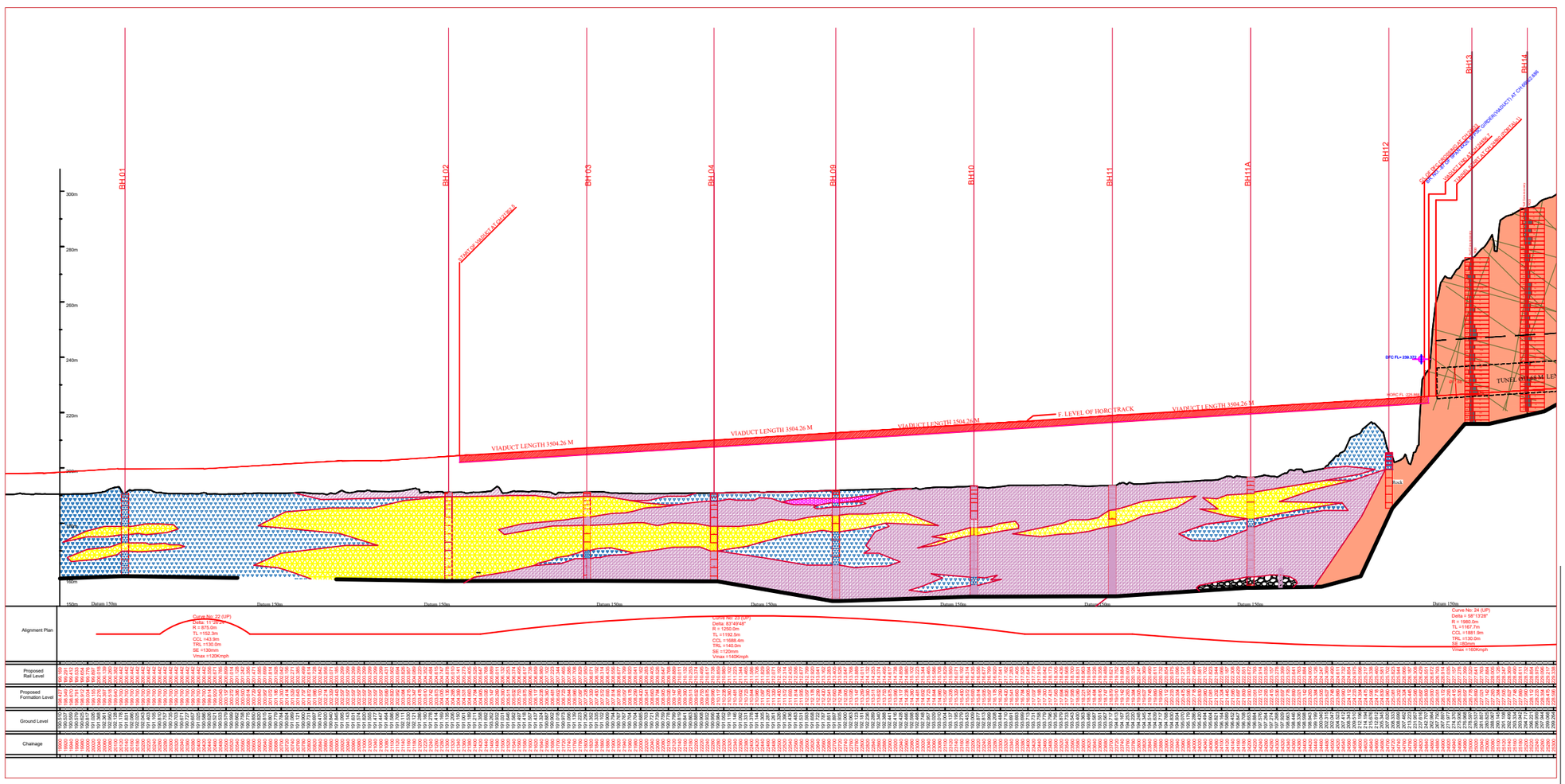


Name of Project:	Exploring alternate alignments, final location survey, geological mapping,geo-technical investigation, detail design of tunnel & its approaches including Viaduct if any and other ancillary work in Sohna-Manesar Section of HORC project.

ANNEXURE -J
LOCATION MAP

Name of Project:	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.

ANNEXURE -K
LITHOLOGICAL SECTION



ABSTRACT OF SAFE BEARING PRESSURE OF SOIL

Location	Depth in m.	Net Safe Bearing Capacity in T/m²	Settlement in mm	Safe Bearing Pressure in T/m² 25 mm settlement	Safe Bearing Pressure in T/m² 50 mm settlement
A-1 (BH-02)	2.0	9	102	2	4
	3.0	10	96	3	5
	4.0	11	91	3	6
P-1 (BH-03)	2.0	12	109	3	6
	3.0	13	100	3	7
	4.0	14	91	4	8
P-2 (BH-04)	2.0	13	42	8	13
	3.0	15	47	8	15
	4.0	16	52	8	15
P-3 (BH-05)	2.0	10	27	9	10
	3.0	12	30	10	12
	4.0	14	29	12	14
P-4 (BH-06)	2.0	9	19	9	9
	3.0	11	18	11	11
	4.0	13	18	13	13
P-5 (BH-07)	2.0	13	38	9	13
	3.0	17	39	11	17
	4.0	22	51	11	22
P-6 (BH-08)	2.0	11	10	11	11
	3.0	12	11	12	12
	4.0	14	14	14	14
P-7 (BH-09)	3.0	13	70	5	9
	4.0	14	79	4	9
P-9 (BH-11)	2.0	11	63	4	9
	3.0	14	84	4	8
	4.0	18	107	4	8
P-10 (BH-11A)	2.0	12	312	1	3
	3.0	14	354	1	2
	4.0	16	395	1	2
P-11 (BH-12)	2.0	79	120	16	33
	3.0	230	261	22	44
	4.0	281	305	23	46

Legend

- Phyllite
- Quarzite
- Joints
- Tunnel Line
- Inorganic Silty Soil (ML)
- Inorganic Clay rich Soil (CL)
- Silty Sand (SM)
- Kanker
- Clayey Sand (SC)
- Inorganic Silty Clayey Soil (ML-CL)

Rock Weathering & Fracturing Index

HW & HF	MW & HF	SW & HF
HW & MF	MW & MF	SW & MF
HW & SF	MW & SF	SW & SF

HW : Highly Weathered
MW: Moderately Weathered
SW: Slightly Weathered

HF: Highly Fractured
MF: Moderately Fractured
SF: Slightly Fractured

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAYATEY KAM PD		SHIV OM DWIVEDI CE/HRIDC	
SUDHIR AGRAWAL CE/GC/W		RAJU SOLANKI DGM/GVA-SOUTH	
AJAY VIJAYVARGIYA DGM/ST		DGM/S&T	
KRISHAN CHAND SAINSI CE/GC/W		DGM/Elect.	
AMARNATH SINGH CSE/S&T			

NORTHERN RAILWAY
DELHI DIVISION

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

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

SIGN
GC/HORC DRG. NO.-

DRAWING NAME: LITHOLOGICAL SECTION OF VIDUCT
N.R.H.Q.E.(P) PLAN NO:
DIVISION PLAN NO :
SCALE: Horizontal 1000, Vertical 100
SMC DRG. NO.- SMC/HORC/TUNNEL/02

CONSULTANT: S.M. CONSULTANTS
An ISO 9001 Company
Ahmedabad / Bhilwara / Secunderabad / South Andaman / New Delhi
Web : www.smcindia.com, E-Mail : kapil@smcindia.com

DESIGN | DRAWN | CHECKED: G.Bhatia-Sanjay | APPROVED: A.K.VERMA PROJECT INCHARGE

RELEASED FOR: PRELIMINARY FOR APPROVAL | TENDER | CONSTRUCTION

7.2 Report No : SR No.544_21-22

Geotechnical Investigation Report

PACKAGE-C5

PART-A (Connecting Line)	Old Ch. (-)2+514 to Old Ch. (-)0+934 [New Ch. (-)1+838 to (-)0+248]
PART-B (Main Line)	Old Ch. 17+625 to Old Ch. 20+300 (New Ch: 18+310 to 20+985)

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)

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

B-11(G), Malviya Industrial Area, Jaipur-302017
Tel. : 91-141-4046599, Fax : 91-141-2751806
E-mail : info@cegtesthouse.com., www.cegtesthouse.com

V
V
V
V
V
V

PART-A (Connecting Line)
Old Ch. (-)2+514 to Old Ch. (-)0+934
[New Ch. (-)1+838 to (-)0+248]

Geotechnical Investigation Report

PACKAGE-C5

New Ch. 0+000 to Old Ch. 10+859 (New Ch: 11+543) &
Old Ch. 17+625 to Old Ch. 20+300 (New Ch: 18+310 to 20+985) &
Connecting Line from Prithala to New Prithla

PART-A

Connecting Line from Prithala to New Prithla
Old Ch. (-)2+514 to Old Ch. (-)0+934 [New Ch. (-)1+838 to (-)0+248]

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
FEBRUARY - 2023

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CEGTH/HRIDCL/SR-544/2022-23/1625 Date:- 17.03.2023

To,

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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 08 boreholes carried out at Connecting Line from Prithala to New Prithla [Old Ch. (-)2+514 to Old Ch. (-)0+934 {New Ch. (-)1+838 to (-)0+248}] 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.

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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 Connecting Line from Prithala to New Prithla **[**Old Ch. (-)2+514 to Old Ch. (-)0+934 **{**New Ch (-)1+838 to (-)0+248**}**] based on soil sample collected from the locations of 08 boreholes.

2.0 SITE LOCATION & GENERAL GEOLOGICAL HISTORY:

The details of the site & test locations for the proposed project are shown in location plan attached vide **Appendix A-1**. The site of proposed project is located from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV (Zone factor=0.24) of India.

Soil of the Haryana Sub-Region have been classified and described under the following major soil types as shown below:-

- Typic Ustochrepts : Soil of old alluvial plains
- Typic Ustipsamments : Soil of Aravali plains
- Typic Ustifluvents : Soil of recent alluvial plains and flood plains
- Typic Torripsamments : Soil of Aeofluvial plains
- Rocky Outcrops : Aravali rocky hills

The district wise details of soil characteristics are described below:-

Panipat: The soils are well drained, Sandy loam to clay loam/silty clay loam in plains and loam to clay loam/ silty/ loose clay loam in relic channels/depressions/basins.

Sonipat: The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. Recent flood plains occur along the Yamuna River and clearly show fluvial features. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Rohtak: The district mainly comprises of old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface. Old meander plains are almost flat with loamy sand to silty clay loam soils. Oldest among all the land forms are old alluvial plains, which cover major areas in the district. These soils are sand to loamy sand/sandy loam (surface) to silt loam/silty clay loam (sub-surface).

Jhajjar: The district mainly comprises of old alluvial plains and some parts of the district also have soil belonging to Aravali plains.

Rewari: The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand.

Gurgaon: The district comprises of sand dunes, sandy plains, alluvial plains, salt affected areas,

low lands, lakes, hills and pediments. The soil varies from sand to loamy sand in sand dunes and sandy plain areas, sandy loam to clay loam / silty clay loam in alluvial plains, calcareous, loamy sand to loam in salt affected plains, silty loam to loam in low lands and calcareous, loamy sand to loam in hills.

Mewat: The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The upper hills are mostly barren.

Faridabad and Palwal: The district comprises of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam

(surface), clay loam/silty clay (sub-surface) in low lying plains and depressions.

3.0 SCOPE OF WORK:

The stipulated scope of work involved carrying out the following operations:-

a) Mobilisation of necessary plant equipment, men and materials for the complete Geotechnical investigation work as per specifications, drawings and instructions of the Engineer and to complete the same within the stipulated time schedule and demobilisation after completion of field work.

b) Shifting of Equipments from one structure location to another including Ereaction, installation of rigs at site and dismantling of the same after completion of field work. Shifting of setup for each borehole location and associated preparation for borehole under water

c) Making 150 mm nominal diameter boreholes at various locations in all types of soils except hard rock and large boulders using suitable approved method of boring including chiselling, cleaning, providing casing pipe as required; performing Standard Penetration Test at every 3.0m interval and at change of strata; collection of water samples and disturbed soil samples, observation such as ground water, etc., collection of undisturbed soil samples at every 3.0 m interval and at change of strata; transportation of all the collected samples to the laboratory and back filling of boreholes on completion of the same, complete as per specification and instructions of the Engineer, for depths below natural ground level.

d) Conducting Electrical resistivity tests at various locations all complete as per specification and directions of the Engineer.

e) Conducting plate load test at various locations, all complete as per specification and directions of the Engineer.

f) Drilling of Nx size boreholes (75mm dia.) in all types of hard rock, collection of core samples, maintaining continuous record of core recovery/ RQD, keeping the cores in wooden core boxes, transporting to laboratory, backfilling on completion of the same, all complete as per specification and instructions of the EIC.

g) Conducting various laboratory tests on soil samples at an approved laboratory including preparation of soil samples to determine the following properties of soil, all complete as per specification.

<u>On soil Samples</u>

- Dry density test
- Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- Liquid Limit and Plastic Limit
- Specific gravity
- Shrinkage Limit
- Free Swell Index
- Direct Shear Test
- Triaxial Shear Test
- One Dimensional consolidation test
- Chemical Analysis of soil samples (pH, chloride, Sulphate)

h) Conducting laboratory tests on rock samples including preparation of the samples to determine the following properties, all complete as per specification

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.

4.0 FIELD INVESTIGATION IN SOIL STRATA:

The investigation was planned to obtain the subsurface stratification in the proposed project site and collect soil / rock core samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum.

For geotechnical investigation work, required equipements along with rotary drilling rigs and manpower were mobilized at site to carry out various field activities as per the scope of work. These were shifted from one test location to another location during execution of field work and were demobilized on satisfactory completion of field work.

For conducting the field investigations the following practices were followed at site:

- The locations of 08 boreholes carried out at Connecting Line from Prithala to New Prithla **[**Old Ch. (-)2+514 to Old Ch. (-)0+934 **{**New Ch. (-)1+838 to (-)0+248**}**] were marked at site at specified locations. These locations are shown in **Appendix-A1** attached subsequently.

The details of various boreholes along with their coordinates are provided herein below:

Table 1.1: Details of Borehole Locations

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
1.	(-)2+514	(-)1+838	BH-CL	MNB	7.15	10.00	722701.988	3126414.281	195.721
2.	(-)1+969	(-)1+291	BH-CL	MNB	7.50	10.00	722173.198	3126541.073	195.326
3.	(-)1+500	(-)0+821	BH-A1	MJB	5.10	35.00	721737.910	3126432.416	195.309
4.			BH-A2	MJB	5.20	35.00	721703.826	3126418.378	195.429
5.	(-)1+269	(-)0+592	BH-A1	MJB	6.10	30.00	721528.877	3126336.130	194.566
6.			BH-A2	MJB	6.55	30.00	721508.138	3126327.463	195.172
7.	(-)1+241	(-)0+567	BH-CL	MNB	6.50	10.00	721494.114	3126321.741	194.789
8.	(-)0+934	(-)0+248	BH-CL	MNB	8.10	10.00	721203.669	3126250.134	196.343

***NE=Not Encountered**

- 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 5.10m to 8.10m below EGL. The detailed procedure adopted for conducting various field tests is given here in below:

(i) Standard Penetration Test:

The Standard Penetration Test was conducted in boreholes as per IS 2131. The test was carried out using the standard split spoon sampler to measure the number of blows 'N'.

Standard split spoon sampler was attached to an 'A' rod. It was driven from borehole bottom to a distance of 45 cm using a standard hammer of 63.5 kg falling freely from a height of 75 cm to the required depth. While driving, the number of blows required to penetrate every 15 cm are recorded. The total number of blows required for the last 30 cm is taken as 'N' value at that particular depth of the borehole. Wherever the total penetration was less than 45cm, the no. of blows & the depth penetrated is recorded in the respective borelog.

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:-

Table 1.2: Soil compactness as per SPT N values (cl. 9.7, table 9.3 & 9.4, page 330_text book of V.N.S. Murthy)

Correlation for Clay / Plastic silt		Correlation for Sand / Non-Plastic silt	
Consistency	**SPT "N" Value**	**Compactness**	**SPT "N" Value**
Very Soft	0 - 2	Very Loose	0 - 4
Soft	2 - 4	Loose	4 - 10
Medium	4 - 8	Medium	10 - 30
Stiff	8 - 15	Dense	30 - 50
Very Stiff	15 - 30	Very Dense	> 50
Hard	> 30		

The field SPT N values obtained were further corrected as per the guidelines given in IS: 2131 as follows:

(a) For overburden: - The N value for cohesionless soil is corrected with the help of fig. 1 given in IS-2131.

(b) Due to dilatancy :- Wherever N values observed below water table in fine sand, silty sand or silt was greater than 15, then corrected N values were corrected as under:

$$N' = 15 + \tfrac{1}{2}(N-15)$$

(ii) Undisturbed Sampling (Soil) in boreholes:

Undisturbed samples were collected using MS tubes of suitable diameter and length with Area ratio as per clause 4.1.1 (c) of IS: 1892 (latest) fitted to an adopter with ball and socket arrangement. Before taking any sample, sampling tube was properly greased. Immediately after taking on undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the sample were trimmed off any wet disturbed soil. The ends were coated alternately with four layers of just molten wax. More molten wax was added to give a total thickness of min. 25 mm. The samples were carefully labeled and transported to the laboratory for testing. Undisturbed samples wherever slipped during lifting were duly marked in the field logs as well as in the soil profile.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

Table 1.3: Description of Tests

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)	√	-

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)	√	-
Atterberg Limits • Liquid Limit • Plastic Limit	 IS: 2720 (Part - 5) IS: 2720 (Part - 5)	 √ √	 √ √
Specific Gravity	IS : 2720 (Part – 3)	√	-
Direct Shear Test	IS : 2720 (Part – 13)	√	-
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)	√	-
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)	√	-

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

5.1.1 Dry density and Bulk density

For determination of bulk density and dry density, a sample of known volume 'V' was extracted from the undisturbed sampling tube and it's bulk weight 'W' was noted down.Moisture content 'Wn' was determined by oven drying method.

The bulk density and dry density were determined by following equation-

Bulk density (γ_b) = W/V

Dry density (γ_d) = γ_b/ (1+Wn)

5.1.2 Natural water content

For this test, the soil sample of known quantity (Wm) was taken in a container.The container with soil sample was placed into an oven for drying at 105-110°c temperature for 16-24 hours. After drying, the dry sample was again weighted to determine the dry weight of sample (Wd).

The natural water content was computed by the following equation-

Wn = (Wm-Wd)*100/Wd

5.1.3 Grain Size Analysis (IS: 2720- Part-4)

Wet sieve analysis:

For determination of particle sizes finer than 75 micron, wet sieve analysis test was conducted. For this test, oven dried sample of known quantity was taken in a container and soaked with dispersing agent. The soaked soil sample was washed thoroughly over 75 micron IS sieve until the water passing sieve was substantially clean.

Fraction retained on 75 micron IS sieve was carefully collected in a container without any loss in material and placed into oven for drying.

Dry sieve analysis:

For this test, the oven dried soil sample after wet sieving was sieved through the set of IS sieves 20 mm, 10 mm, 4.75 mm, 2.0 mm, 1.0 m , 425 micron , 300 micron, 150 micron and 75micron. The amounts of soil retained on each sieve were noted down. The % retained, cumulative % retained and % passing were computed accordingly. Wherever the soil sample % passing 75 micron sieve was significant, Hydrometer method was used to find the percentage of silt and clay fraction.

Grain size analysis for the fraction passing 75 micron IS Sieve (Hydrometer method)

Calibration of Hydrometer

Hydrometer was calibrated to determine a relationship (an equation) between the effective depth H_R and corresponding hydrometer reading R_h (obtained during test).

50 to 100 gm of soil sample passing through 75 micron IS Sieve was taken. It was mixed with 100 ml of sodium hexametaphesphate solution and the mixture was warmed for about 10 minutes. It was then transferred to the cup of the mechanical mixer and the soil suspension was stirred for 15 minutes. The soil suspension was transferred into 1000 ml measuring cylinder and distilled water was added to make 1000ml solution. This solution was mixed vigorously. The measuring cylinder was then allowed to stand and the stopwatch was started. Hydrometer was immersed in the solution and reading were taken after half, one, two and four minutes. The hydrometer was then removed slowly and kept in distilled water at the same temperature as the soil suspension. Readings were taken after the periods of 8, 15 and 30 minutes, and one, two and four hours. Hydrometer was removed, rinsed and placed in the distilled water after each reading. After 4 hours reading was taken once or twice within 24 hours. Finally a reading was taken at the end of 24 hours. The temperature of the suspension was observed and recorded.

Calculations

Diameter of the particles (D):

$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = M\sqrt{\frac{H_R}{t}}$$

Where,

D = diameter of particle in suspension, in mm;

μ = co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;

G = specific gravity of the soil fraction used in the sedimentations analysis;

H_R = effective depth corresponding to R_n, in cm.

t = time elapsed between the beginning of sedimentation and taking of hydrometer reading in minutes

$M = \sqrt{\frac{30\mu}{980(G-1)}}$ = a constant factor for given values of μ and G at the temperature of the suspension.

Percentage finer than diameter D:

The percentage by mass (w) of particles smaller than corresponding equivalent particle diameters (D) was calculated from the formula:

$$w = \frac{100G_s}{W_b(G_s-1)} \times R_h$$

Where

w = percentage finer

G_s = specific gravity of soil particle

W_b = weight of soil

R_h = Hydrometer reading

5.1.4 Specific Gravity (IS: 2720-Part-3 Sec-1)

The specific gravity of soil sample was determined by density bottle method. For this test 5-10g oven dried and cooled soil sample was taken in 50ml capacity density bottle and its weight was noted down as W_2 .The soil was covered with distilled water and left for sufficient period for suitable soaking. The entrapped air was removed by vacuum. The bottle with soil was filled fully with water and its weight was noted down (W_3). The mass of empty bottle and bottle filled with distilled water were noted down as W_1 and W_4 respectively.

The Specific Gravity was determined by using following equation :

$G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$

5.1.5 Liquid Limit (IS: 2720- Part-5)

By Cone Penetrometer Method

The 'Cone Penetrometer Apparatus' is a variant of the fall-cone and consists of a cone with a smooth polished surface and angle of 30° ± 1/2°. The weight of the cone, together with its associated shaft is 80g ± 0.5g. A support assembly with an automatic cone release mechanism and cone height adjustment mechanism used to hold the cone vertically. The angle and weight of the cone were calibrated at regular intervals, and the sharpness of the cone tip was checked daily.

Distilled water was added and thoroughly mixed with the soil sample to produce a homogeneous paste. The paste was then placed in a cup with a diameter of at least 55mm and a depth of at least 40mm. The surface of the soil was smoothed off level and parallel to the base. The support assembly was used to position the tip of the cone so that it was just touching the top surface of the soil, and the automatic tripping mechanism was released. The cone was allowed to penetrate into the soil for a period of 5 (± 1) s, then the cone was locked off to stop further movement and the penetration was recorded. The cup was refilled and the test was repeated. The two recorded penetrations need to be within 0.5mm of each other, otherwise a third test is performed. when the three test vary by more than 1mm the test was repeated.

Further tests were conducted, at varying water contents, in order to produce a series of cone penetrations (usually 4) in the range 15mm to 25mm. The resulting cone penetrations were plotted verses the water content of the test specimens. The Liquid Limit (W_L) was read off the graph, being the water content at which the line of best fit through the test points crosses 20mm penetration.

5.1.6 Plastic Limit (IS: 2720-Part-5)

For this test, soil sample was prepared in the same way as for liquid limit test. A ball of soil sample weighed about 5 gm was formed. The ball was rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm was reached, soil was again remolded into a ball. The process of rolling and remolding was repeated until the thread started just crumbing at a diameter of 3 mm. The crumbled thread was immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content has been termed as plastic limit. (W_P)

5.1.7 Plasticity Index (IS: 2720-Part-5)

The plasticity index Ip was given by

$I_p = W_L - W_P$ (in percent)

5.1.8 Direct Shear Test (IS:2720-Part-13):

For this test shear box test apparatus was used. The prepared specimen from remolded/undisturbed sample was placed carefully in the box. The plain grid was kept on top of the specimen with its directions at right angles to the direction of shear. The upper porous stone was placed on the grid and loading pad on the stone. The box with specimen was gently placed in the container (water jacket). The specimen was submerged with water. The container was mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box was so adjusted that it

touchéd the proving ring. The jack was brought forward to bear up against the box container. The proving ring dial gauge was set to read zero.

The steel ball was placed in the recess of the loading pad. The loading yoke was set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load was applied and any change in thickness of specimen was recorded. Shear displacement dial gauge was also set to read zero. The locking screw was now removed and two parts of the shear box were separated by advancing the spacing screws.

The specimen was sheared at constant rate of strain. The readings of the proving ring dial gauge were noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge were also recorded at the same time interval. The test was continued until the specimen fails. The specimen was assumed to fail when the proving ring dial gauge started receding or at shear displacement of approximately 15% of the length took place.

The soil was removed from the box and test was repeated on the identical specimen under increased normal load.

The rate of strain for conducting Direct Shear Test is kept as 0.25 mm/min as per codal/literature provision based on strata.

5.1.9 Triaxial Shear Test_UUT (IS: 2720-Part-11)

For this test, Triaxial Shear Test apparatus was used. The plain disc was placed on the pedestal of the triaxial cell. The specimen was placed centrally on the disc. A correct size rubber membrane was fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum was applied to stretch the membrane to the inside surface of the stretcher which was carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane was released. Its bottom part was rolled down into the pedestal. plain disc was placed on the top of the specimen and then loading pad was placed. The top part of membrane was rolled on to the loading pad. Then the stretcher was removed and ends were sealed with ‘O’ rings. With the properly sealed specimen placed centrally on the pedestal, the cell was assembled, keeping the loading piston initially clear of the loading pad of the specimen, the assembly was placed in the loading frame.

For unconsolidated undrained test, the bottom drainage value (BDV) and top drainage value (TDV) of cell, was closed and air release valve (ARV) was opened. The cell was filled with water through the cell water value CWV. ARV was closed when water begins to escape through it. The cell pressure was raised to the desired value and kept constant till the end of the test.

When the cell pressure was applied, the load piston rises upward, the loading machine was operated at the anticipated rate to bring the load piston slightly above the loading pad of the specimen and the load measuring dial gauge on proving ring was set to zero.

The piston was brought just in contact with loading pad by hand operation of the machine. The

axial compression dial gauge was mounted and set to read zero.

The axial loading was started at 1.25 mm/min rate of strain. Simultaneous readings on the load and compression dial gauges were noted down. The test was continued until a recession of the axial load is observed or 20% of strain.

After failure, the specimen was unloaded by reversing the loading machine, cell pressure was reduced and cell water was drained out through BRV. The cell was dismantled and the specimen was taken out, rubber membrane was removed and weight of the failed sample and its water content was determined. The test was repeated on two more identical specimens with increasing cell pressure.

The rate of strain for conducting UUT is kept as 1.25 mm/min as per codal/literature provision based on strata.

5.1.10 Chemical Testing

Chemical Testing was generally performed in accordance with IS: 2720, but the different parts of method as described below:

a) Total Sulphate Content Of Soil

Samples were tested according to IS 2720 (Part 27). The dried soil was extracted with a 10% solution of hydrochloric acid. The extract was adjusted to slightly alkaline pH with ammonia, and then barium chloride solution was added to precipitate the sulphate. The barium sulphate precipitate was collected by filtration, and it was washed, dried and weighed. The mass of barium sulphate recovered was used to calculate the sulphate content of the original soil.

b) pH Value

Samples were tested according to IS: 2720 (Part 26). The soil sample (30 ± 0.1g) was extracted with 75 ml of distilled water and the pH of the resulting suspension was measured with a calibrated (by means of Standard buffer solution) pH meter.

c) Chloride Content

For the water soluble content, soil samples were extracted with a volume of water equal to twice the mass of the soil. The extract was filtered and acidified with a small amount of nitric acid. Standardized silver nitrate solution was then added to precipitate the chloride as its silver salt. The amount of precipitated silver remaining in solution was then determined by titration.

An acid-soluble version of the test was also available, with the initial extraction being with nitric acid instead of water.

CHAPTER 2 ANALYSIS OF TEST RESULTS AND INTERPRETATION

6.0 STRATIFICATION

From the study of the borehole carried out at Connecting Line from Prithala to New Prithla [Old Ch. (-)2+514 to Old Ch. (-)0+934 {New Ch (-)1+838 to (-)0+248}], it is revealed that the substrata of all boreholes mainly consisit of Silty Clay of low plasticity (CL), sandy silt of low plasticity (ML-CL), Silty Sand with Clay (SM-SC), Silty Sand (SM).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table was met at depths of from 5.10m to 8.10m below EGL as given in Table 1.1, 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 :-

Summary of chemical analysis of soil samples

Chemical Property	Findings (Min. to Max.)	Remarks (Required limits as per IS 456-2000)
pH	6.95 to 8.17	> 6.0
Sulphite as SO_3^{2-} (%)	0.0021 (%) to 0.0029 (%)	< 0.2% (Class I)
Chlorides as Cl^- (%)	0.0062 (%) to 0.0088 (%)	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

6.3 COMPUTATION OF LIQUEFACTION POTENTIAL

Liquefaction is the sudden loss of shear strength of the sub soil strata due to earthquake-induced vibration under saturated conditions.

Assessment of liquefaction potential of foundation strata is made by simplified approach proposed as per IS: 1893 (Part-1)-2016, from the SPT data and peak ground acceleration likely to occur at the site. In this method, cyclic shear stress likely to be induced in the foundation strata by Design Basis Earthquake (DBE) is first evaluated.

Next threshold cyclic shear stress, which is good enough to cause liquefaction, is determined from SPT data and the empirical relations. Finally, comparison of these two stresses is used in the estimation of liquefaction susceptibility of the foundation strata.

Unsaturated soils are not subjected to liquefaction because vibratory forces from earthquakes do not cause any increase in pore water pressure in such soils.

The area of site from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV of India as per IS: 1893. Further as per the provisions of IS: 1893 in soil deposits consisting of submerged loose sands & soils falling under classification of SP with standard penetration N value less than 15, the shaking caused by earthquake ground motion may cause liquefaction or excessive total and differential settlements.

For the analysis of liquefaction potential, following constant parameters are considered:

EQ Zone	IV
Earthquake Magnitude (Mw)	7.0
Peak Horizontal Ground Acceleration (amax /g)	0.24

The Ground Water Table was met at depths of from 5.10m to 8.10m below EGL as given in Table 1.1. For the analysis of liquefaction potential, the water table is generally considered to rise by about 2.0m to 3.0m at the location of all boreholes. The strata in the boreholes are not likely to liquefy as mentioned above and the same is tabulated below:-

Table 2.1: Liquefaction Analysis

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Water table depth Considered for Liquefaction Analysis	Liquefiable Depth (m)
1.	(-)2+514	(-)1+838	MNB	BH-CL	7.15	3.15	Non Liquefiable
2.	(-)1+969	(-)1+291	MNB	BH-CL	7.50	4.50	Non Liquefiable
3.	(-)1+500	(-)0+821	MJB	BH-A1	5.10	2.00	Non Liquefiable
4.			MJB	BH-A2	5.20	2.00	Non Liquefiable
5.	(-)1+269	(-)0+592	MJB	BH-A1	6.10	3.00	Non Liquefiable
6.			MJB	BH-A2	6.55	3.00	Non Liquefiable
7.	(-)1+241	(-)0+567	MNB	BH-CL	6.50	3.00	Non Liquefiable
8.	(-)0+934	(-)0+248	MNB	BH-CL	8.10	5.10	Non Liquefiable

6.4 INTERPRETATION OF LAB TEST RESULTS

Grain Size Analysis

1. **Clay content:** It generally varies from 4 to 11%.
2. **Silt content:** It generally varies from 20 to 66%.
3. **Sand content:** It generally varies from 22 to 85%.
4. **Gravel content:** It generally varies from 1 to 10%.

Atterberg's Limit

5. **Liquid limit:** The test results of liquid limit of the soil samples reveal that it generally varies from 24 to 28% in ML-CL type of soil, 32 to 33% in CL type of soil.
6. **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.
7. **Plasticity index*:*** The plasticity index of the soil samples generally varies from 5 to 6% in ML-CL type of soil, 9 to 11% in CL type of soil whereas ML-CL and SM/ SM-SC/ SC type of soil are non-plastic.

Natural moisture content & Bulk density

The bulk density of soil samples generally varies from 1.84 gm/cc to 1.97gm/cc whereas natural moisture content varies from 10% to 21%.

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 28^o to 32^o, whereas cohesion varies from 0.00 kg/cm^2 to 0.11 kg/cm^2.

For Silty strata (ML-CL), the value of angle of internal friction varies from 24^o to 27^o, whereas cohesion varies from 0.11 kg/cm^2 to 0.22 kg/cm^2.

Triaxial shear tests:

Triaxial shear test under undrained condition have been conducted in silty clay (CL) type of soil.

For silty clay (CL) strata, the value of angle of internal friction varies from 4^o to 5^o, whereas cohesion varies from 1.41kg/cm^2 to 2.22 kg/cm^2.

CHAPTER 3 TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS

7.0 TYPE & DEPTH OF FOUNDATION:

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

Table 3.1 : Shallow Foundation

Type of foundation	Depth of Foundation below E.G.L. (m)	Size of Foundation (m x m)
Shallow Foundation	1.0, 2.0, 3.0	4.8 x 4.8
	2.0, 3.0, 4.0	7.2 x 7.2
	1.0, 1.5, 2.0	8.0 x 8.0

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+Ø/2) (where B = Width of the Foundation, Ø = Angle of internal friction) is used in the analysis. A factor of safety of 2.5 to estimate the net safe bearing capacity from ultimate net bearing capacity.

For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria.

The ultimate net bearing capacity in case of general shear failure is given by following expression,

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

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,

$$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\ (D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure = $\tan^{-1}(0.67 \tan\phi)$

7.1.2 From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure.

The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B below the base to account for the effects of energy ratio, adopted bearing pressure, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure.

Further for settlement Calculation in cohesive soil the following equation has been used.

$S_t = \Delta P\ M_v\ H$

Where,

M_v = Coefficient of volume compressibility, cm^2/kg

ΔP = Pressure increment, kg/cm^2

H = Thickness of layers

Note: - Value of Coefficient of volume compressibility (Mv) has been calculated by using the following co-relation [Ref. Stroud and Butler, 1975] :-

Coefficient of Volume Compressibility derived from SPT N-Value (after Stroud and Butler, 1975)

Plasticity Index (%)	Conversion Factor (f_2)	m_v (10^{-3} kPa^{-1}) based on N-Value: $m_v = 1/(f_2 N)$				
		N=10	N=20	N=30	N=40	N=50
10	800	0.12	0.06	0.04	0.03	0.02
20	525	0.19	0.09	0.06	0.05	0.04
30	475	0.21	0.10	0.07	0.05	0.04
40	450	0.22	0.11	0.07	0.06	0.04

$Mv = 1/(f_2 N_{corr.})$

Where f_2 = factor based on $N_{corr.}$ Value & plasticity index of soil

$N_{corr.}$ = corrected SPT 'N' value

For analysis of shallow foundation the total permissible settlement has been considered as 25mm, & 50mm as per IS 1904.

Zone of influence below foundation has been considered up to 1.5 times the width of the foundation.

For the determination of the SBC from settlement criteria, the corrected SPT N values within the influence zone are given in the table below.

NOTE:-

- Lower of the two values obtained from settlement and shear criteria is used in arriving at allowable bearing capacity of the soil.
- Structural foundations are designed based on the minimum of Safe Bearing Capacity obtained from Shear Failure Criteria and Allowable Bearing Pressure corresponding to the permissible settlement. The permissible Settlement that can be allowed for the foundation depends on the strata at the location and type of foundation (whether Isolated or Raft).

  Settlement occurs with the application of loads on foundations. It has two components, Immediate Settlement and Long Term Settlement. The immediate settlement takes place immediately as the loading is imposed on the structure and long term settlement arises due to the consolidation of the sub-soil with time under the load. Hence, the total settlement allowed for a foundation is the sum of the immediate and consolidation settlement that is expected to occur. The cohesionless strata (predominantly sandy) is primarily subjected to immediate settlement and cohesive strata (clayey) undergoes settlement in long time with the compression of the strata due to consolidation. Settlement of the foundation is determined from the relation provided in Indian standards (IS: 8009 (part-1) &/or various literatures (Bowles, BM Das, etc.).

  From the Geotechnical investigation conducted on our site along with subsequent laboratory tests on soil samples, it is observed that predominantly the strata is silty with sand (SM/SC/SM-SC/ML-CL i.e. predominantly cohesionless) with the presence of small patches of silty clay of low plasticity (CL). Since the Settlement that takes place in cohesionless strata is mostly immediate, it takes place immediately after the imposing of load, initially during construction with the application of Dead Load and further during Live Load. The live load usually is many times lesser than the dead load, and correspondingly the post construction settlement is very less for live loads. As an example, if dead load is three times that of live load, then the settlement corresponding to live load (i.e. the post construction settlement) will be one-third of the settlement due to dead load which is comparatively lesser than 25mm for permissible settlement of 50mm.

  According to the IS 1904, the permissible settlement for concrete structure having raft foundation is allowed upto 75mm, and the permissible settlement is 25mm post construction as per IRS code (Code of Practice for The Design of Sub-Structures and Foundations of Bridges). As discussed

above, the settlement post construction is directly proportional to the allowable settlement. Therefore, given the importance of structure to be constructed and considering mostly cohesionless strata encountered at site, it is recommended that the maximum permissible settlement shall be restricted to 50mm for the design purpose on conservative side so that the post construction settlement can be constraint to lesser than 25mm.

As per IS- 8009 part 1 clause 9.2.2.1, If the clay layer is sandwitched between cohesionless soil layers, the immediate settlement is zero. Hence, even though the immediate settlement has been calculated during analysis, however it is ignored in the calculation of total settlement.

The sample calculations for computation of allowable bearing capacity of sub-strata for shallow foundation vide **Appendix – C-2.**

7.2 ANALYSIS OF PILE FOUNDATION

(A) DEEP FOUNDATION

The safe Load Carrying Capacity of normal bored cast in-situ RCC pile is determined in compression, uplift and lateral as per IS: 2911 (Part-1/sec-2) – 2010. The axial capacity of a pile depends upon the soil skin friction along the shaft and end bearing at it's tip.

Thus Axial load = Skin Friction + End-bearing

a) For piles in granular soils (using the static formula)

$$\mathbf{Q_u = (0.5*D*\gamma*N_\gamma + P_D*N_q)*A_p + (\Sigma K_i*P_{Di}*\tan\delta_i)*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

D = dia. of pile shaft in m

γ = effective unit weight of the soil at pile tip in kN/m^3

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction Φ at pile tip (N_γ from IS 6403 for general shear failure case & N_q from Fig. 1, IS 2911)

P_D = effective overburden pressure at pile tip in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

K_i = coefficient of earth pressure applicable for the i^{th} layer

P_{Di} = effective overburden pressure for the i^{th} layer in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

δ_i = angle of wall friction between pile and soil for i^{th} layer, and

A_{si} = surface area of pile shaft in the i^{th} layer in m^2

b) For piles in cohesive soils (using the static formula)

$$Q_u = cp*Nc*A_p + \Sigma\alpha_i*c_i*A_{si}$$

Where,

Q_u = Ultimate load capacity of pile in KN

A_p = cross-sectional area of pile tip in m^2

N_c = bearing capacity factor (= 9)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

α_i = adhesion factor for the i^{th} 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 i^{th} layer in m^2

c) For computation of safe load carrying capacity of pile in lateral, the following equation has been used:

i. <u>Fixed Head Condition</u>

$$Q = (12 * E * I * Y) / (L_1 + L_f)^3$$

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 20.0m to 30.0m were selected.

For the analysis of the pile foundations the soil parameters used for computation of safe load carrying capacity of pile is tabulated below:-

Table 3.3 : Design Soil Parameter

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	AngleofinternalFriction(Φ)(°)
			From	To			Observed	Corrected			
(-)2+514	(-)1+838	BH-CL	0.00	4.00	4.00	SandySilt	13	17	1.73	0.21	24
			4.00	7.00	3.00	SiltySand	28	28	1.80	0.00	29
			7.00	10.00	3.00	SiltySand	46	28	1.83	0.00	30
(-)1+969	(-)1+291	BH-C	0.00	4.00	4.00	SandySilt	9	14	1.70	0.18	26
			4.00	8.50	4.50	SiltyClay	22	22	1.82	0.75	5
			8.50	10.00	1.50	SandySilt	34	22	1.85	0.21	27
(-)1+500	(-)0+821	BH-A1	0.00	4.00	4.00	SandySilt	10	16	1.71	0.22	23
			4.00	8.50	4.50	SiltySand	26	23	1.77	0.00	29
			8.50	11.50	3.00	SiltySand	48	30	1.82	0.00	30
			11.50	19.00	7.50	SiltyClay	35	35	1.99	1.02	5
			19.00	25.00	6.00	SandySilt	96	43	1.95	0.21	27
			25.00	31.00	6.00	SiltyClay	70	70	2.02	2.01	4
			31.00	35.00	4.00	SiltySand	100	38	-	-	-
		BH-A2	0.00	4.00	4.00	SandySilt	13	17	1.78	0.19	24
			4.00	7.00	3.00	SiltyClay	36	36	1.94	1.23	5
			7.00	10.00	3.00	SiltyClay	43	43	2.00	1.35	5
			10.00	13.00	3.00	SiltyClay	36	36	1.99	1.35	5
			13.00	16.00	3.00	SiltyClay	41	41	2.00	1.35	5
			16.00	19.00	3.00	SiltyClay	50	50	2.00	1.64	4
			19.00	22.00	3.00	SandySilt	100	43	1.96	0.21	28
			22.00	25.00	3.00	SandySilt	100	41	1.96	0.21	28
			25.00	29.50	4.50	SiltyClay	50	50	2.01	1.66	4
			29.50	35.00	5.50	SiltySand	100	38	1.95	0.10	30
(-)1+269	(-)0+592	BH-A1	0.00	4.00	4.00	SandySilt	19	24	1.74	0.14	23
			4.00	7.00	3.00	SandySilt	18	18	1.75	0.15	23
			7.00	8.50	1.50	SandySilt	-	-	1.76	0.15	23
			8.50	13.00	4.50	SiltySand	27	20	1.75	0.00	30
			13.00	16.00	3.00	SandySilt	60	32	1.83	0.16	24
			16.00	19.00	3.00	SandySilt	60	31	1.85	0.16	24
			19.00	22.00	3.00	SandySilt	75	35	1.86	0.16	25
			22.00	25.00	3.00	SandySilt	73	33	1.86	0.16	25
			25.00	30.00	5.00	SandySilt	65	29	1.88	0.16	26
		BH-A2	0.00	5.50	5.50	SandySilt	18	24	1.73	0.13	22
			5.50	7.00	1.50	SandySilt	-	-	1.77	0.14	24
			7.00	11.50	4.50	SiltySand	43	28	1.78	0.00	30
			11.50	14.50	3.00	SandySilt	42	25	1.81	0.16	24
			14.50	17.50	3.00	SandySilt	47	26	1.81	0.16	24

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	AngleofinternalFriction(Φ)(°)
			From	To			Observed	Corrected			
(-)1+269	(-)0+592	BH-A2	17.50	19.00	1.50	SandySilt	-	-	1.81	0.16	24
			19.00	23.50	4.50	SiltySand	69	33	1.84	0.00	31
			23.50	26.50	3.00	SiltySand	72	32	1.86	0.00	31
			26.50	30.00	3.50	SiltySand	77	33	1.87	0.00	32
(-)1+241	(-)0+567	BH-CL	0.00	4.00	4.00	SiltySand	10	16	1.71	0.00	29
			4.00	7.00	3.00	SiltySand	23	26	1.80	0.00	30
			7.00	10.00	3.00	SiltySand	41	28	1.85	0.00	31
(-)0+934	(-)0+248	BH-CL	0.00	4.00	4.00	SiltySand	16	21	1.73	0.00	29
			4.00	7.00	3.00	SiltySand	39	39	1.82	0.00	31
			7.00	10.00	3.00	SiltySand	41	26	1.78	0.00	30

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-in-situ RCC pile in compression & uplift are attached vide **Appendix C-3.**

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-4.**

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 4.2.

Table 4.1: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm

Chainage Old (km)	Chainage New (km)	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+514	(-)1+838	BH-CL	8.0 x 8.0	1.0	26.6	16.4	16.4
			8.0 x 8.0	2.0	31.4	16.4	16.4
			8.0 x 8.0	3.0	36.4	16.5	16.5
(-)1+969	(-)1+291	BH-CL	4.8 x 4.8	1.0	17.2	11.7	11.7
			4.8 x 4.8	2.0	21.2	13.9	13.9
			4.8 x 4.8	3.0	25.3	17.0	17.0
(-)1+500	(-)0+821	BH-A1	7.2 x 7.2	2.0	21.0	10.2	10.2
			7.2 x 7.2	3.0	23.3	10.8	10.8
			7.2 x 7.2	4.0	25.4	11.6	11.6
		BH-A2	7.2 x 7.2	2.0	35.6	12.9	12.9
			7.2 x 7.2	3.0	36.8	17.3	17.3
			7.2 x 7.2	4.0	38.0	26.2	26.2
(-)1+269	(-)0+592	BH-A1	7.2 x 7.2	2.0	21.7	14.9	14.9
			7.2 x 7.2	3.0	25.8	26.3	25.8
			7.2 x 7.2	4.0	28.3	27.8	27.8
		BH-A2	7.2 x 7.2	2.0	24.5	15.1	15.1
			7.2 x 7.2	3.0	29.2	26.3	26.3
			7.2 x 7.2	4.0	32.0	27.8	27.8
(-)1+241	(-)0+567	BH-CL	2.7 x 2.7	1.0	14.9	15.1	14.9
			2.7 x 2.7	2.0	22.6	18.7	18.7
			2.7 x 2.7	3.0	30.7	21.7	21.7
(-)0+934	(-)0+248	BH-CL	4.8 x 4.8	1.0	23.3	19.2	19.2
			4.8 x 4.8	2.0	31.7	20.7	20.7
			4.8 x 4.8	3.0	40.6	20.7	20.7

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm

Chainage Old (km)	Chainage New (km)	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+514	(-)1+838	BH-CL	8.0 x 8.0	1.0	26.6	32.8	26.6
			8.0 x 8.0	2.0	31.4	32.8	31.4
			8.0 x 8.0	3.0	36.4	33.0	33.0
(-)1+969	(-)1+291	BH-CL	4.8 x 4.8	1.0	17.2	23.4	17.2
			4.8 x 4.8	2.0	21.2	27.9	21.2
			4.8 x 4.8	3.0	25.3	33.9	25.3
(-)1+500	(-)0+821	BH-A1	7.2 x 7.2	2.0	21.0	20.4	20.4
			7.2 x 7.2	3.0	23.3	21.5	21.5
			7.2 x 7.2	4.0	25.4	23.1	23.1
		BH-A2	7.2 x 7.2	2.0	35.6	25.8	25.8
			7.2 x 7.2	3.0	36.8	34.7	34.7
			7.2 x 7.2	4.0	38.0	52.3	38.0
(-)1+269	(-)0+592	BH-A1	7.2 x 7.2	2.0	21.7	29.7	21.7
			7.2 x 7.2	3.0	25.8	52.6	25.8
			7.2 x 7.2	4.0	28.3	55.5	28.3
		BH-A2	7.2 x 7.2	2.0	24.5	30.1	24.5
			7.2 x 7.2	3.0	29.2	52.6	29.2
			7.2 x 7.2	4.0	32.0	55.5	32.0
(-)1+241	(-)0+567	BH-CL	2.7 x 2.7	1.0	14.9	30.2	14.9
			2.7 x 2.7	2.0	22.6	37.4	22.6
			2.7 x 2.7	3.0	30.7	43.4	30.7
(-)0+934	(-)0+248	BH-CL	4.8 x 4.8	1.0	23.3	38.4	23.3
			4.8 x 4.8	2.0	31.7	41.4	31.7
			4.8 x 4.8	3.0	40.6	41.4	40.6

* 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:-

Table 4.5: Safe Load Carrying Capacity of normal bored cast in-situ RCC Pile in Soil

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
(-)1+500	(-)0+821	BH-A1	1.0	20.0	2.0	222.0	162.0	18.0
				22.0		226.0	185.0	
				24.0		245.0	205.0	
				26.0		259.0	220.0	
				28.0		274.0	237.0	
				30.0		312.0	256.0	
			1.2	20.0		267.0	210.0	25.0
				22.0		300.0	243.0	
				24.0		325.0	270.0	
				26.0		342.0	290.0	
				28.0		361.0	311.0	
				30.0		412.0	336.0	
		BH-A2	1.0	20.0	2.0	210.0	169.0	25.0
				22.0		237.0	196.0	
				24.0		258.0	217.0	
				26.0		272.0	233.0	
				28.0		289.0	251.0	
				30.0		392.0	277.0	
			1.2	20.0		275.0	219.0	33.0
				22.0		313.0	256.0	
				24.0		341.0	285.0	
				26.0		358.0	305.0	
				28.0		381.0	330.0	
				30.0		561.0	367.0	
(-)1+269	(-)0+592	BH-A1	1.0	20.0	2.0	227.0	179.0	18.0
				22.0		249.0	201.0	
				24.0		270.0	223.0	
				26.0		292.0	245.0	
				28.0		314.0	267.0	
				30.0		335.0	289.0	
			1.2	20.0		310.0	233.0	25.0
				22.0		340.0	264.0	
				24.0		370.0	294.0	
				26.0		400.0	325.0	
				28.0		429.0	355.0	
				30.0		459.0	385.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
(-)1+269	(-)0+592	BH-A2	1.0	20.0	2.0	307.0	180.0	21.0
				22.0		330.0	203.0	
				24.0		353.0	226.0	
				26.0		376.0	249.0	
				28.0		399.0	272.0	
				30.0		422.0	295.0	
			1.2	20.0		447.0	235.0	28.0
				22.0		479.0	267.0	
				24.0		511.0	299.0	
				26.0		543.0	332.0	
				28.0		575.0	364.0	
				30.0		607.0	396.0	

Notes : -

1. Permissible lateral deflection has been taken as 5 mm.
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

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2. IS 2911 : Part 4 : 2013 (Reaffirmed Year : 2018) Design and construction of pile foundations - Code of practice : Part 4 Load test on piles .
3. IS 6403 : 1981 (Reaffirmed Year : 2016), Amd. 2 : 2018 Code of practice for determination of bearing capacity of shallow foundations.
4. IS 8009 : Part 1 : 1976 (Reaffirmed Year : 2018) Code of practice for calculation of settlements of foundations: Part 1 Shallow foundations subjected to symmetrical static vertical loads.
5. IS 8009 : Part 2 : 1980 (Reaffirmed Year : 2020) Code of practice for calculation of settlement of foundations: Part 2 Deep foundations subjected to symmetrical static vertical loading.
6. IS 1893 : Part 1 : 2016 (Reaffirmed Year : 2021) Criteria for Earthquake Resistant Design of Structures - Part 1 : General Provisions and Buildings.
7. IS 1904 : 2021 Draft Indian Standard for General requirements for design and construction of foundations in soils Code of practice third revision of IS 1904.
8. IS 456 : 2000 (Reaffirmed Year : 2021) Plain and Reinforced Concrete - Code of Practice (Including Amendment 1, 2, 3,& 4).
9. BS – 118 : 2015 Final Seismic Design of Bridges.
10. IS 2131 : 1981 (Reaffirmed Year : 2016) Method for standard penetration test for soils.
11. IS 2132 : 1986 (Reaffirmed Year : 2016) Code of practice for thin-walled tube sampling of soils.
12. IS 1892 : 1979 (Reaffirmed Year : 2016) Code of practice for subsurface investigation for foundations.
13. Bowles, J.E., 1982. Foundation design and analysis.
14. IS. 2720 (Part 3)-1980. Determination of Specific Gravity of Soil.
15. IS. 2720 (Part 4). 1985. Methods of Test for Soils: Grain Size Analysis.
16. IS. IS 2131, 1981. Method for standard penetration test for soils.
17. IS: 2720 (Part 11)–(1993). Determination of the shear strength parameters of a specimen tested in unconsolidated undrained triaxial compression without the measurement of pore water pressure.
18. IS: 2720 (Part 13) 1986 Method of test for soils, direct shear test. New Delhi, India.
19. IS: 2720 (Part 3/See 1)–(1980) Methods of test for soils, determination of specific gravity of soil. New Delhi, India.
20. IS: 2720 (Part 5) 1985 Methods of test for soils, determination of liquid and plastic limit of soils. New Delhi, India.

Abbreviations

BH	Borehole
ERT	Electrical Resistivity Test
EGL	Existing Ground Level
GWT	Ground Water Table
IS	Indian Standards
SPT	Standard Penetration Test
DS	Disturbed Soil
R.L.	Reduced Level
m	Metre
sp. gr.	Specific Gravity
%	Percentage
mg /l	Milligram per litre
mg /kg	Milligram per kilogram

APPENDIX – A (FIELD DATA RESULTS)

Appendix No.	ITEMS
A-1	LOCATION PLAN
A-2	FIELD BORE HOLE LOGS
A-3	SUB SOIL PROFILE DIAGRAM


GHS Chhaprola
SLD College
BIRENDER GENERAL STORE
Sh. Khillan Singh Tewatia Farms
CH-(-)1+969_BH-CL
CH-(-)1+500_BH-A2
CH-(-)1+500_BH-A1
CH-(-)1+241_BH-CL
CH-(-)1+269_BH-A1
CH-(-)0+934_BH-CL
CH-(-)1+269_BH-A2
CH-(-)2+514_BH-CL
BHARDWAJ GENERAL STORE
Pithla Rd
Google Earth
N

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)2+514 km	*Northing :*3126414.281 m	*Easting :*722701.988 m
Reduced Level (m):(+)195.721	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*7.15	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	SPT-1	3	5	8	13					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	7	10	18	28					
6.0											
6.5											
7.0	7	UDS-3					Brown, Medium dense to dense, Silty sand with gravel	SM	7.15m		
7.5											
8.0											
8.5	8.5	SPT-3	7	19	27	46					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+969 km	*Northing :*3126541.073 m	*Easting :*722173.198 m
Reduced Level (m):(+)195.326	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*7.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	5	9					
1.5											
2.0							Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	8	10	18					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Brown, Very stiff, Silty clay of low plasticity	CL			
7.0	7	SPT-3	10	12	14	26					
7.5									7.50m		
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
10.0	10	SPT-4	11	14	20	34					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+500 km	*Northing :*3126432.416 m	*Easting :*721737.91 m
Reduced Level (m):(+)195.309	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	6	10					
1.5											
2.0							Yellowish brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	8	10	18					
4.5											
5.0									5.10m		
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	12	15	19	34	Yellowish brown, Medium dense to dense, Silty sand	SM			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	14	21	27	48					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+500 km	*Northing :*3126432.416 m	*Easting :*721737.91 m
Reduced Level (m):(+)195.309	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Yellowish brown, Medium dense to dense, Silty sand	SM			
11.0											
11.5	11.5	UDS*									
12.0	12	SPT-5	7	9	13	22					
12.5											
13.0	13	SPT-6	9	12	20	32					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0							Yellowish brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
15.5											
16.0	16	SPT-7	14	23	30	53					
16.5											
17.0											
17.5	17.5	UDS*									
18.0	18	SPT-8	9	12	23	35					
18.5											
19.0	19	SPT-9	22	38	55	93					
19.5							Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+500 km	*Northing :*3126432.416 m	*Easting :*721737.91 m
Reduced Level (m):(+)195.309	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS*									
21.0											
21.5											
22.0	22	SPT-10	25	40	58	98					
22.5							Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
23.0											
23.5	23.5	SPT-11	32	54	44 (5cm)	>100					
24.0											
24.5											
25.0	25	SPT-12	15	23	30	53					
25.5											
26.0											
26.5	26.5	UDS*									
27.0	27	SPT-13	20	30	45	75					
27.5							Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
28.0	28	SPT-14	24	33	50	83					
28.5											
29.0											
29.5	29.5	UDS-5									
30.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+500 km	*Northing :*3126432.416 m	*Easting :*721737.91 m
Reduced Level (m):(+)195.309	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5							Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
31.0	31	SPT-15	33	70	30 (8cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-16	52	100 (10cm)	-	>100					
33.0							Yellowish brown, Very dense, Silty sand with gravel	SM			
33.5											
34.0											
34.5											
35.0	35	SPT-17	62	100 (13cm)	-	75					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+500 km	*Northing :*3126418.378 m	*Easting :*721703.826 m
Reduced Level (m):(+)195.429	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.20	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-10-2021	*Date of Completion :*12-10-2021	

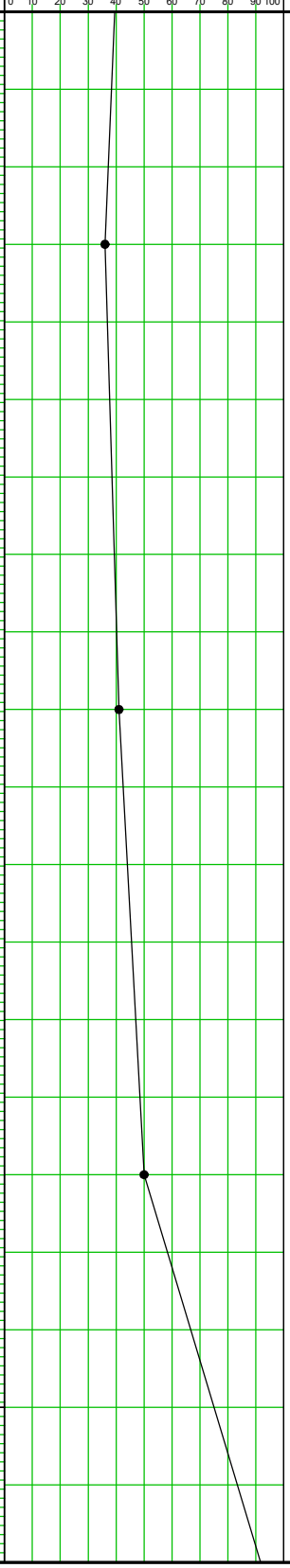
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Yellowish brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	SPT-1	5	5	8	13					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0									5.20m		
5.5	5.5	SPT-2	9	15	21	36					
6.0											
6.5											
7.0	7	UDS-3					Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
7.5											
8.0											
8.5	8.5	SPT-3	10	19	24	43					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+500 km	*Northing :*3126418.378 m	*Easting :*721703.826 m
Reduced Level (m):(+)195.429	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.20	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	9	14	22	36					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	13	17	24	41	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	14	22	28	50					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+500 km	*Northing :*3126418.378 m	*Easting :*721703.826 m
Reduced Level (m):(+)195.429	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.20	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	32	62	48 (8cm)	>100					
21.0											
21.5											
22.0	22	UDS-8									
22.5							Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
23.0											
23.5	23.5	SPT-8	22	34	68	102					
24.0											
24.5											
25.0	25	SPT-9	12	19	28	47					
25.5											
26.0											
26.5	26.5	SPT-10	12	22	30	52					
27.0											
27.5							Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
28.0	28	UDS-9									
28.5											
29.0											
29.5	29.5	SPT-11	32	69	31 (5cm)	>100					
30.0							Yellowish brown, Very dense, Silty sand with clay & gravel	SM-SC			

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+500 km	*Northing :*3126418.378 m	*Easting :*721703.826 m
Reduced Level (m):(+)195.429	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.20	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-10-2021	*Date of Completion :*12-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-12	35	72	28 (3cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-13	55	100 (5cm)	-	>100	Yellowish brown, Very dense, Silty sand with clay & gravel	SM-SC			
33.0											
33.5											
34.0	34	SPT-14	60	100 (10cm)	-	>100					
34.5											
35.0	35	SPT-15	19	28	40	68					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+269 km	*Northing :*3126336.13 m	*Easting :*721528.877 m
Reduced Level (m):(+)194.566	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*6.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-10-2021	*Date of Completion :*13-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	9	10	19					
3.0											
3.5											
4.0	4	UDS-2					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.5											
5.0											
5.5	5.5	SPT-2	7	8	10	18					
6.0									6.10m		
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	10	14	24					
9.0							Brown, Medium dense to dense, Silty sand with gravel	SM			
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+269 km	*Northing :*3126336.13 m	*Easting :*721528.877 m
Reduced Level (m):(+)194.566	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*6.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-10-2021	*Date of Completion :*13-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	10	12	18	30	Brown, Medium dense to dense, Silty sand with gravel	SM			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	17	25	35	60					
15.0											
15.5											
16.0	16	UDS-6									
16.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
17.0											
17.5	17.5	SPT-6	16	26	34	60					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+269 km	*Northing :*3126336.13 m	*Easting :*721528.877 m
Reduced Level (m):(+)194.566	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*6.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-10-2021	*Date of Completion :*13-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	30	36	39	75					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	17	30	43	73					
24.0											
24.5											
25.0	25	UDS-9					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	24	27	34	61					
27.0											
27.5											
28.0	28	UDS*									
28.5											
29.0											
29.5	29.5	SPT-10	28	30	40	70					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+269 km	*Northing :*3126327.463 m	*Easting :*721508.138 m
Reduced Level (m):(+)195.172	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*6.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-10-2021	*Date of Completion :*13-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	6	7	10	17					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	SPT-2	5	7	12	19					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5									6.55m		
7.0	7	SPT-3	12	17	22	39					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Medium dense to dense, Silty sand with gravel	SM			
9.0											
9.5											
10.0	10	SPT-4	12	19	27	46					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+269 km	*Northing :*3126327.463 m	*Easting :*721508.138 m
Reduced Level (m):(+)195.172	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*6.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-10-2021	*Date of Completion :*13-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Medium dense to dense, Silty sand with gravel	SM			
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	11	17	25	42					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
16.0	16	SPT-6	11	19	28	47					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	19	29	42	71					
19.5							Brown, Medium dense to dense, Silty sand with gravel	SM			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+269 km	*Northing :*3126327.463 m	*Easting :*721508.138 m
Reduced Level (m):(+)195.172	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*6.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-10-2021	*Date of Completion :*13-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	21	27	39	66					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	24	31	41	72	Brown, Medium dense to dense, Silty sand with gravel	SM			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	16	32	45	77					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)1+241 km	*Northing :*3126321.741 m	*Easting :*721494.114 m
Reduced Level (m):(+)194.789	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*6.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-10-2021	*Date of Completion :*14-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	4	6	10					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	9	14	23					
4.5											
5.0											
5.5	5.5	UDS-2					Brown, Medium dense, Silty sand	SM			
6.0											
6.5									6.50m		
7.0	7	SPT-3	11	17	24	41					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Dense, Silty sand with gravel	SM			
9.0											
9.5											
10.0	10	SPT-4	9	16	26	42					

UDS*-UDS not recovered

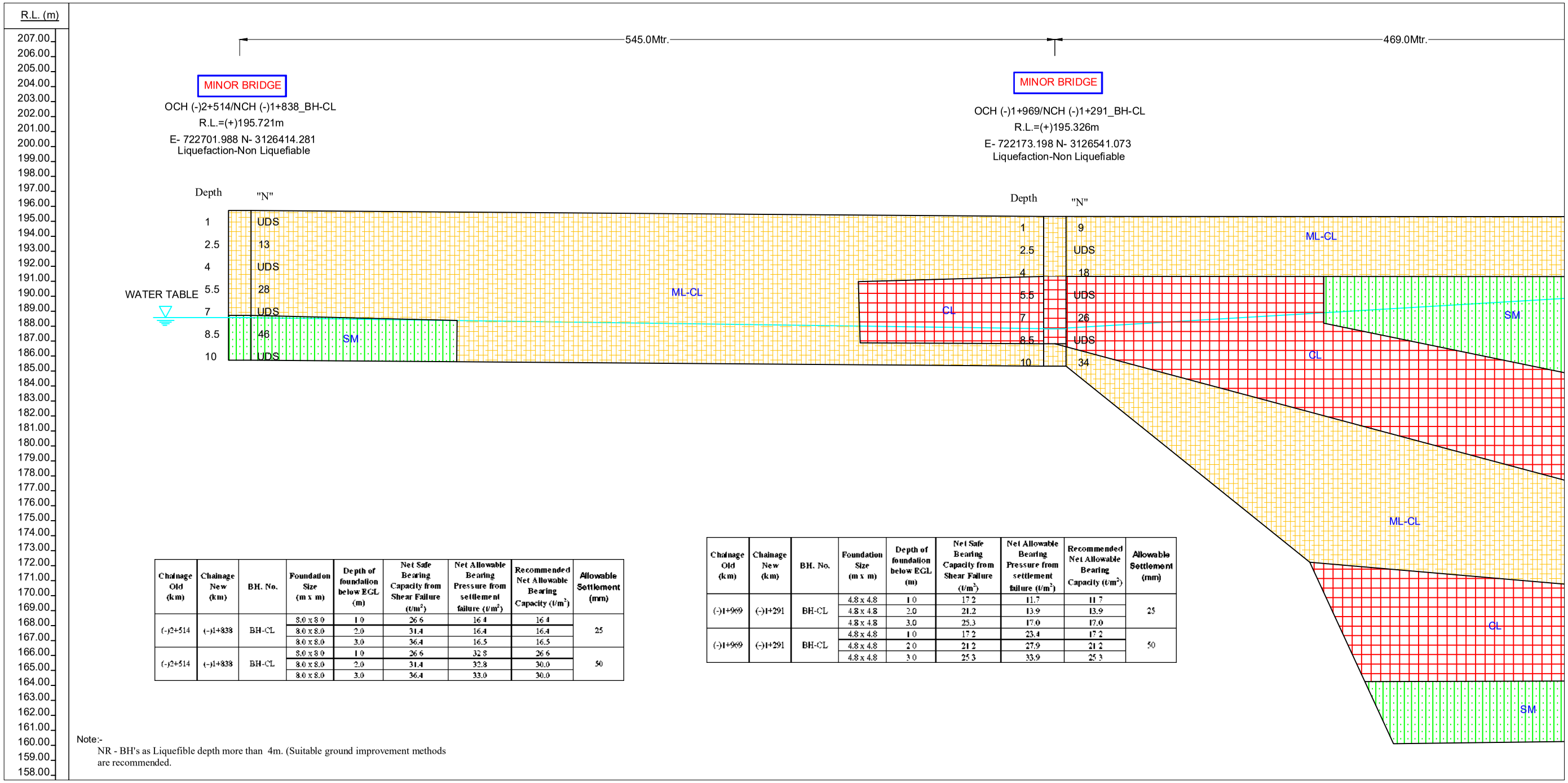
FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)0+934 km	*Northing :*3126250.134 m	*Easting :*721203.669 m
Reduced Level (m):(+)196.343	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*8.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-10-2021	*Date of Completion :*14-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Medium dense, Silty sand	SM			
2.5	2.5	SPT-1	5	6	10	16					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	17	16	23	39					
6.0											
6.5											
7.0	7	UDS-3					Brown, Dense, Silty sand with gravel	SM			
7.5											
8.0									8.10m		
8.5	8.5	SPT-3	11	17	24	41					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



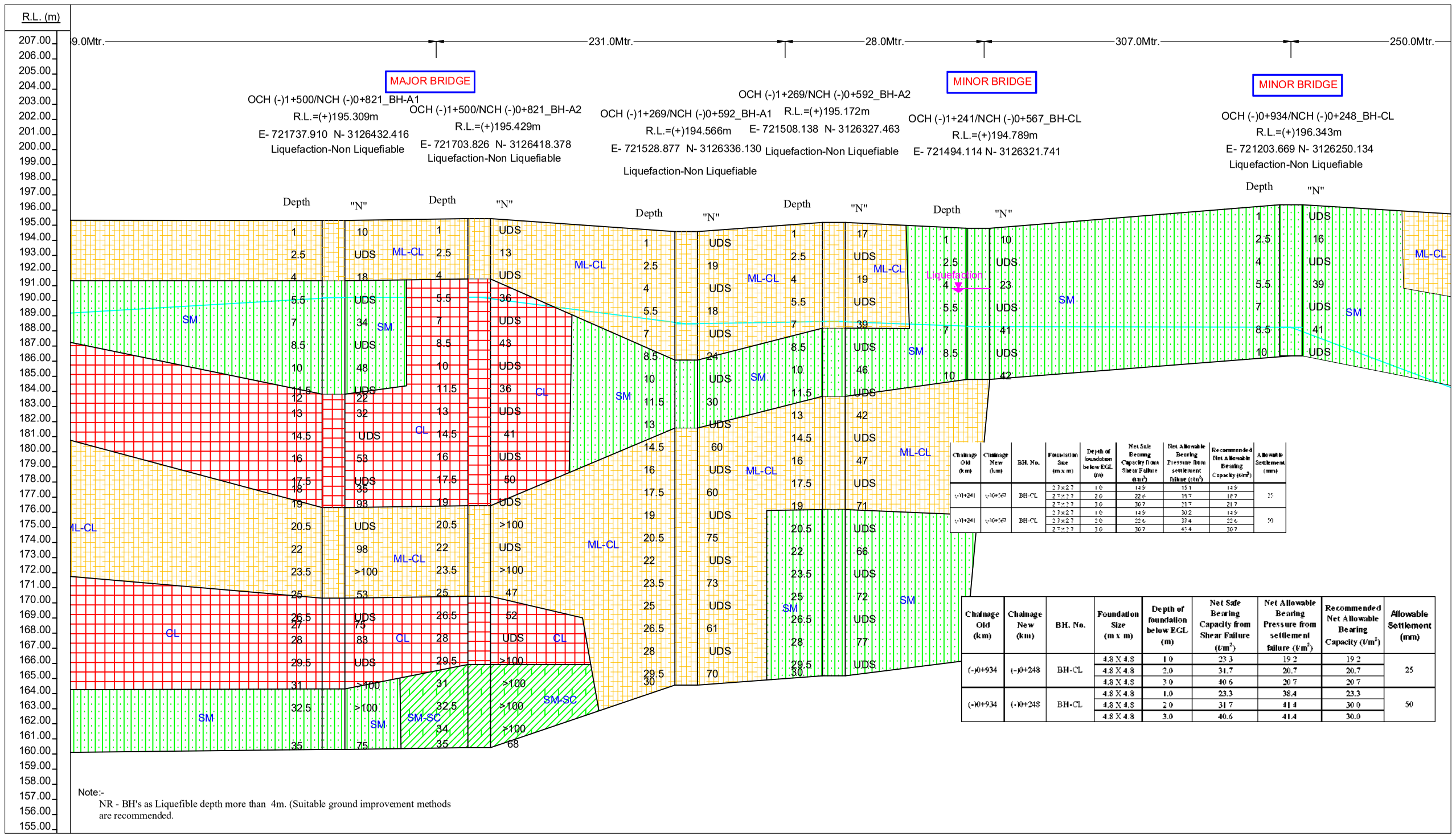
Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
(-)2+514	(-)1+838	BH-CL	8.0 x 8.0	1.0	26.6	16.4	16.4	25
			8.0 x 8.0	2.0	31.4	16.4	16.4	
			8.0 x 8.0	3.0	36.4	16.5	16.5	
(-)2+514	(-)1+838	BH-CL	8.0 x 8.0	1.0	26.6	32.8	26.6	50
			8.0 x 8.0	2.0	31.4	32.8	30.0	
			8.0 x 8.0	3.0	36.4	33.0	30.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
(-)1+969	(-)1+291	BH-CL	4.8 x 4.8	1.0	17.2	11.7	11.7	25
			4.8 x 4.8	2.0	21.2	13.9	13.9	
			4.8 x 4.8	3.0	25.3	17.0	17.0	
(-)1+969	(-)1+291	BH-CL	4.8 x 4.8	1.0	17.2	23.4	17.2	50
			4.8 x 4.8	2.0	21.2	27.9	21.2	
			4.8 x 4.8	3.0	25.3	33.9	25.3	

Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

SYMBOL	DESCRIPTION		
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)		
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)		
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)		
	CL-Silty Clay of low plasticity (Above A-line, LL<35)		
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)		LIQUEFACTION
	BOREHOLE REQUIRED		WATER TABLE
Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)		SCALE:- HOR:- 1:2850	SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
(-)1+241	(-)0+567	BH-CL	2.7 x 2.7	1.0	14.9	15.1	14.9	25
			2.7 x 2.7	2.0	22.6	19.7	19.7	
			2.7 x 2.7	3.0	30.7	21.7	21.7	
(-)1+241	(-)0+567	BH-CL	2.7 x 2.7	1.0	14.9	30.2	14.9	50
			2.7 x 2.7	2.0	22.6	37.4	22.6	
			2.7 x 2.7	3.0	30.7	45.4	30.7	

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
(-)0+934	(-)0+248	BH-CL	4.8 X 4.8	1.0	23.3	19.2	19.2	25
			4.8 X 4.8	2.0	31.7	20.7	20.7	
			4.8 X 4.8	3.0	40.6	20.7	20.7	
(-)0+934	(-)0+248	BH-CL	4.8 X 4.8	1.0	23.3	38.4	23.3	50
			4.8 X 4.8	2.0	31.7	41.4	30.0	
			4.8 X 4.8	3.0	40.6	41.4	30.0	

Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
(-)1+500	(-)0+821	BH-A1	7.2 X 7.2	2.0	21.0	10.2	10.2	25
			7.2 X 7.2	3.0	23.3	10.8	10.8	
			7.2 X 7.2	4.0	25.4	11.6	11.6	
(-)1+500	(-)0+821	BH-A1	7.2 X 7.2	2.0	21.0	20.4	20.4	50
			7.2 X 7.2	3.0	23.3	21.5	21.5	
			7.2 X 7.2	4.0	25.4	23.1	23.1	
(-)1+500	(-)0+821	BH-A2	7.2 X 7.2	2.0	35.6	12.9	12.9	25
			7.2 X 7.2	3.0	36.8	17.3	17.3	
			7.2 X 7.2	4.0	38.0	26.2	26.2	
(-)1+500	(-)0+821	BH-A2	7.2 X 7.2	2.0	35.6	25.8	25.8	50
			7.2 X 7.2	3.0	36.8	34.7	30.0	
			7.2 X 7.2	4.0	38.0	52.3	30.0	

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
(-)1+269	(-)0+592	BH-A1	7.2 X 7.2	2.0	21.7	14.9	14.9	25
			7.2 X 7.2	3.0	25.8	26.3	25.8	
			7.2 X 7.2	4.0	28.3	27.8	27.8	
(-)1+269	(-)0+592	BH-A1	7.2 X 7.2	2.0	21.7	29.7	21.7	50
			7.2 X 7.2	3.0	25.8	52.6	25.8	
			7.2 X 7.2	4.0	28.3	55.5	28.3	
(-)1+269	(-)0+592	BH-A2	7.2 X 7.2	2.0	24.5	15.1	15.1	25
			7.2 X 7.2	3.0	29.2	26.3	26.3	
			7.2 X 7.2	4.0	32.0	27.8	27.8	
(-)1+269	(-)0+592	BH-A2	7.2 X 7.2	2.0	24.5	30.1	24.5	50
			7.2 X 7.2	3.0	29.2	52.6	29.2	
			7.2 X 7.2	4.0	32.0	55.5	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

APPENDIX – B (LAB TEST RESULTS)

Appendix No.	ITEMS
B-1	SOIL CHARACTERISTICS SHEETS
B-2	RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES
B-3	RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLES
B-4	GSD CURVES
B-5	SHEAR CURVE
B-6	CONSOLIDATION CURVE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							12-10-2021	to	12-10-2021	(-)2+514 Minor Bridge	BH-CL	7.15 m	10.00 m	722701.988 m	3126414.281 m	(+)195.721 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	52	28	3	8	2	0	27	20	7	-	1.73	13.05	1.53	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense to dense, Silty sand with gravel	SM		0	19	71	4	2	4	0	-	Nil	NP	-	1.80	13.22	1.59	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	5.50	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	21	66	3	4	6	0	-	Nil	NP	-	1.83	15.10	1.59	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-3	8.50	46	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	21	71	2	0	5	1	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)				R.L.		Ref. Code					
							12-10-2021	to	12-10-2021	(-)1+969 Minor Bridge		BH-CL		7.50 m		10.00 m		722173.198 m			3126541.073 m			(+)195.326 m		SR-544_21-22				
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	47	41	3	1	1	0	27	20	7	-	1.70	13.26	1.50	2.66	DST	0.18	24	-	-	-	-	-	-	-	-
SPT-2	4.00	18	18	Brown, Very stiff, Silty clay of low plasticity	CL		11	52	28	4	3	2	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		12	52	26	5	2	3	0	33	22	11	-	1.82	16.74	1.56	2.67	UUT	0.75	5	-	-	-	-	-	-	-	-
SPT-3	7.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		8	46	37	3	1	5	0	28	21	7	-	1.85	18.65	1.56	2.66	DST	0.21	25	-	-	-	-	-	-	-	-
SPT-4	10.00	34	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							11-10-2021	to	12-10-2021	(-)1+500 Major Bridge	BH-A1	5.10 m	35.00 m	721737.910 m	3126432.416 m	(+)195.309 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Yellowish brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	16		ML-CL		6	52	32	5	3	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	52	30	4	3	4	0	27	20	7	-	1.71	12.40	1.52	2.66	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20	Yellowish brown, Medium dense to dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	31	59	4	3	3	0	-	Nil	NP	-	1.77	13.20	1.56	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	7.00	34	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	23	65	5	2	5	0	-	Nil	NP	-	1.82	13.76	1.60	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-4	10.00	48	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	11.50	-	-	Yellowish brown, Very stiff to hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	12.00	22	22		CL		12	63	18	2	2	3	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		CL		11	57	20	3	4	5	0	32	21	11	-	1.99	24.20	1.60	2.68	UUT	1.02	5	-	-	-	0.675	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	10.59 7.62 5.68 4.67	1.69 1.22 0.74 0.52	0.1100
SPT-7	16.00	53	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	18.00	35	35		CL		11	56	22	5	2	4	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	19.00	93	43	Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	52	29	3	2	8	0	27	21	6	-	1.95	19.50	1.63	2.66	DST+	0.21	27	-	-	-	-	-	-	-	-	-
UDS*	20.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	98	43		ML-CL		7	45	36	5	0	7	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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						11-10-2021	to	12-10-2021	(-)1+500 Major Bridge	BH-A1	5.10 m	35.00 m	721737.910 m	3126432.416 m	(+)195.309 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	25.00	53	53	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		11	57	20	5	1	6	0	32	21	11	-	2.01	22.50	1.64	2.67	UUT+	1.75	4	-	-	-	-	-	-	-	-
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	27.00	75	75		CL		12	55	18	2	4	9	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	28.00	83	83		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	29.50	-	-		CL		11	50	21	7	2	6	3	32	22	10	-	2.04	21.14	1.68	2.68	UUT	2.46	4	-	-	-	-	-	-	-	-
SPT-15	31.00	100 (23cm)	-	Yellowish brown, Very dense, Silty sand with gravel	SM		0	15	68	4	2	9	2	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.00	75	75	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		11	57	17	6	2	7	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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							11-10-2021	to	12-10-2021	(-)1+500 Major Bridge		BH-A2		5.20 m		35.00 m		721703.826 m			3126418.378 m			(+)195.429 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Yellowish brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	53	34	5	1	0	0	27	20	7	-	1.78	14.23	1.56	2.66	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		11	48	24	9	5	3	0	31	20	11	-	1.94	20.36	1.61	2.68	UUT	1.23	5	-	-	-	0.665	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	11.81 8.36 6.72 5.45	1.83 1.17 0.78 0.51	0.106
SPT-2	5.50	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		12	55	23	4	1	5	0	33	22	11	-	2.00	23.44	1.62	2.68	UUT	1.35	5	-	-	-	0.654	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	11.95 11.75 9.70 8.93	1.83 1.17 0.78 0.51	0.106
SPT-3	8.50	43	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		12	59	19	3	2	4	1	32	21	11	-	1.99	23.70	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		10	58	20	3	4	5	0	31	21	10	-	2.00	23.19	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		11	54	25	2	1	6	1	32	21	11	-	2.00	22.16	1.64	2.67	UUT	1.64	4	-	-	-	-	-	-	-	-	-
SPT-6	17.50	50	50		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	49	27	3	4	9	0	28	21	7	-	1.96	18.11	1.66	2.66	DST	0.21	28	-	-	-	-	-	-	-	-	-
SPT-7	20.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		6	51	30	4	2	7	0	27	21	6	-	1.96	18.20	1.66	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	102	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							11-10-2021	to	12-10-2021	(-)1+500 Major Bridge		BH-A2	5.20 m		35.00 m		721703.826 m		3126418.378 m	(+)195.429 m		SR-544_21-22				
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained						Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
									Sand			Gravel																	
							Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
SPT-9	25.00	47	47	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		11	57	20	4	3	5	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	28.00	-	-		CL		12	51	22	3	5	6	1	32	21	11	-	2.01	22.86	1.64	2.68	UUT	1.66	4	-	-	-	-	-	-	-	-
SPT-11	29.50	100 (20cm)	-	Yellowish brown, Very dense, Silty sand with clay & gravel	SM-SC		5	35	47	5	2	5	1	26	20	6	-	1.95	17.00	1.67	2.65	DST+	0.10	30	-	-	-	-	-	-	-	-
SPT-12	31.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	32.50	>100	-		SM-SC		4	33	50	5	1	7	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	34.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	35.00	68	68	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		12	54	18	6	2	6	2	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		10-10-2021	to	13-10-2021	(-)1+269 Major Bridge	BH-A1	6.10 m	30.00 m	721528.877 m	3126336.130 m	(+)194.566 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	51	29	4	7	2	0	28	21	7	-	1.74	13.10	1.54	2.66	DST	0.14	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	19	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		8	50	29	4	7	2	0	26	20	6	-	1.75	13.40	1.54	2.66	DST	0.15	23	-	-	-	-	-	-	-	-	-
SPT-2	5.50	18	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	50	30	4	7	2	0	27	20	7	-	1.76	13.80	1.55	2.66	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	24	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Medium dense to dense, Silty sand with gravel	SM		0	22	66	3	4	5	0	-	Nil	NP	-	1.75	12.40	1.56	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-4	11.50	30	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	54	29	2	6	2	0	28	21	7	-	1.83	14.60	1.60	2.66	DST	0.16	24	-	-	-	-	-	-	-	-	-
SPT-5	14.50	60	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	51	30	3	6	2	0	27	20	7	-	1.85	14.70	1.61	2.66	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	60	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	51	31	4	5	2	0	25	20	5	-	1.86	14.80	1.62	2.66	DST	0.16	25	-	-	-	-	-	-	-	-	-
SPT-7	20.50	75	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		8	52	29	3	6	2	0	26	20	6	-	1.86	15.10	1.62	2.66	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	73	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		8	49	33	3	5	2	0	26	20	6	-	1.88	15.60	1.63	2.66	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	61	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	28.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		10-10-2021	to	13-10-2021	(-)1+269 Major Bridge	BH-A1	6.10 m	30.00 m	721528.877 m	3126336.130 m	(+)194.566 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	29.50	70	30	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	54	28	2	7	2	0	27	20	7	-	1.88	15.20	1.63	2.66	DST	0.16	26	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

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							10-10-2021	to	13-10-2021	(-)1+269 Major Bridge	BH-A2	6.55 m	30.00 m	721508.138 m	3126327.463 m	(+)195.172 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	17	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		8	49	30	4	7	2	0	27	20	7	-	1.73	13.10	1.53	2.66	DST	0.13	22	-	-	-	-	-	-	-	-	-
SPT-2	4.00	19	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	52	28	4	7	2	0	26	20	6	-	1.77	13.50	1.56	2.66	DST	0.14	23	-	-	-	-	-	-	-	-	-
SPT-3	7.00	39	27	Brown, Medium dense to dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	23	66	4	4	3	0	-	Nil	NP	-	1.78	12.60	1.58	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-4	10.00	46	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		8	51	27	4	8	2	0	27	20	7	-	1.81	13.90	1.59	2.66	DST	0.16	24	-	-	-	-	-	-	-	-	-
SPT-5	13.00	42	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	52	28	4	7	2	0	26	20	6	-	1.81	14.10	1.59	2.66	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	47	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		8	55	25	4	6	2	0	27	20	7	-	1.81	14.12	1.59	2.66	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	71	35	Brown, Medium dense to dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		SM		0	32	58	2	4	4	0	-	Nil	NP	-	1.84	13.60	1.62	2.63	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-8	22.00	66	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		SM		0	30	61	2	4	3	0	-	Nil	NP	-	1.86	13.90	1.63	2.63	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	72	32				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		SM		0	30	61	2	4	3	0	-	Nil	NP	-	1.87	14.00	1.64	2.63	DST	0.00	32.00	-	-	-	-	-	-	-	-	-
SPT-10	28.00	77	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		10-10-2021	to	13-10-2021	(-)1+269 Major Bridge	BH-A2	6.55 m	30.00 m	721508.138 m	3126327.463 m	(+)195.172 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS*	29.50	-	-	Brown, Medium dense to dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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						14-10-2021	to	14-10-2021	(-)1+241 Minor Bridge	BH-CL	6.50 m	10.00 m	721494.114 m	3126321.741 m	(+)194.789 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	16		SM		0	27	70	2	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	25	69	3	2	1	0	-	Nil	NP	-	1.71	12.44	1.52	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	4.00	23	26	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	16	73	5	3	3	0	-	Nil	NP	-	1.80	14.20	1.58	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-3	7.00	41	28	Brown, Dense, Silty sand with gravel	SM		0	21	65	5	3	6	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	21	67	3	2	5	2	-	Nil	NP	-	1.85	16.33	1.59	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-4	10.00	42	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							14-10-2021	to	14-10-2021	(-)0+934 Minor Bridge		BH-CL		8.10 m		10.00 m		721203.669 m			3126250.134 m			(+)196.343 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	15	77	2	4	2	0	-	Nil	NP	-	1.73	11.34	1.55	2.62	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-1	2.50	16	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Dense, Silty sand with gravel	SM		0	17	71	4	3	5	0	-	Nil	NP	-	1.82	12.04	1.62	2.63	DST	0.00	31	-	-	-	-	-	-	-	-
SPT-2	5.50	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	19	67	6	2	4	2	-	Nil	NP	-	1.78	12.80	1.58	2.62	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-3	8.50	41	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	20	71	2	1	6	0	-	Nil	NP	-	1.81	13.11	1.60	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

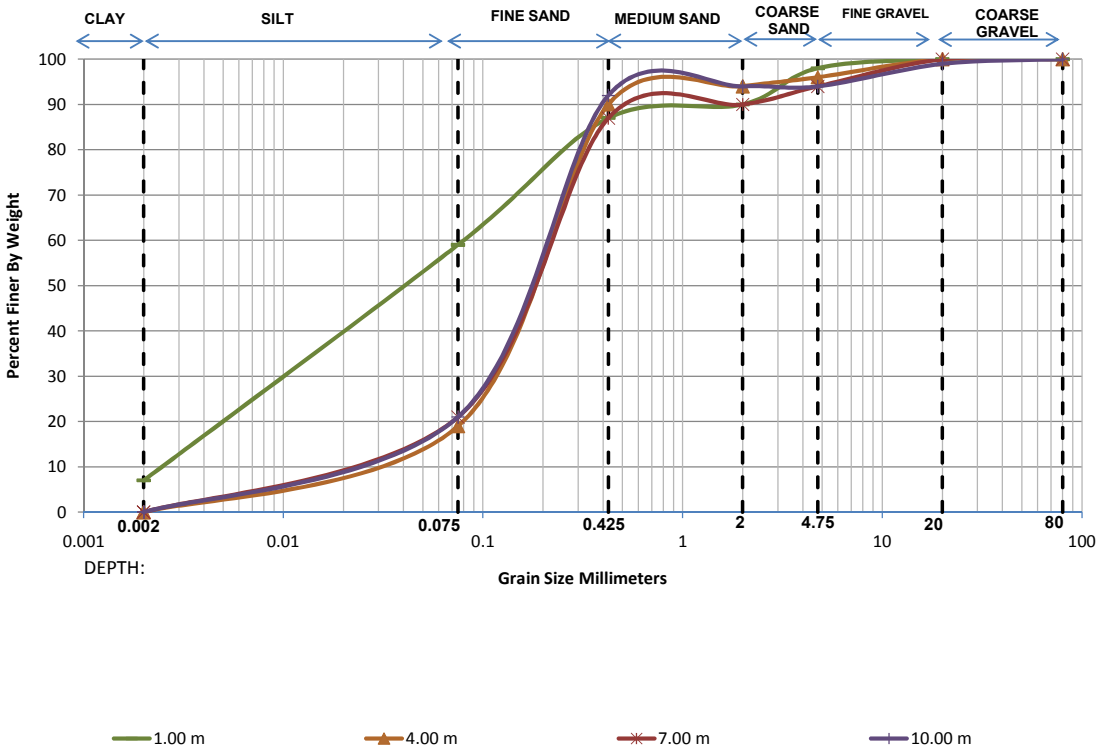
Sr. No	Chainage Old (km)	Chainage New (km)	BH No.	Depth of collected sample (m)	pH	Chlorides (Cl^-)		Sulphate (SO_3^{2-})	
						(mg/kg)	(%)	(mg/kg)	(%)
1.	(-)1+500	(-)0+821	BH-A1	2.50	8.17	84.31	0.0084	28.81	0.0029
2.			BH-A2	4.00	7.27	62.34	0.0062	20.78	0.0021
3.	(-)1+269	(-)0+592	BH-A1	23.50	7.55	87.64	0.0088	20.74	0.0021
4.			BH-A2	2.50	6.95	74.33	0.0074	26.81	0.0027

RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLE

Sr. No	Chainage Old (km)	Chainage New (km)	BH No.	pH	Chlorides (Cl^-) (mg/l)	Sulphate (SO_3^{2-}) (mg/l)
1.	(-)1+500	(-)0+821	BH-A1	8.80	45.25	18.96
2.	(-)1+269	(-)0+592	BH-A2	8.52	58.84	33.81

GRAIN SIZE DISTRIBUTION CURVES

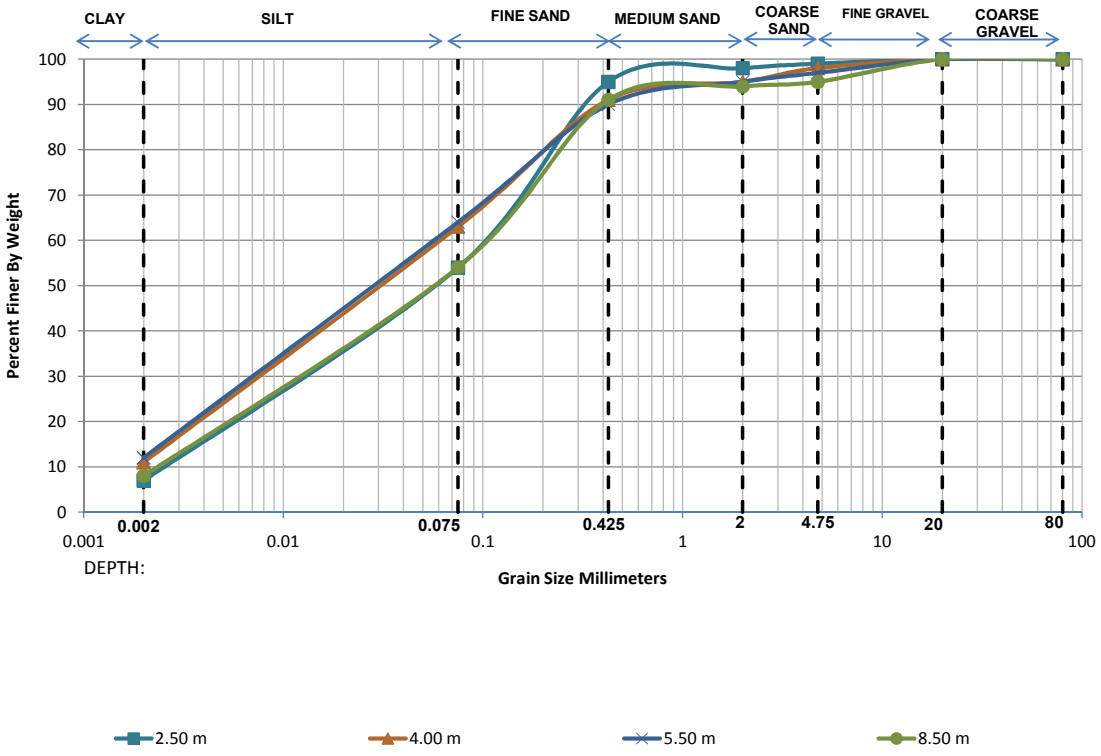
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)2+514 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	52.00	28.00	3.00	8.00	2.00	0.00	0.0036	0.0213	0.0778	21.89	1.64
4.00 m	0.00	19.00	71.00	4.00	2.00	4.00	0.00	0.0306	0.1175	0.2245	7.33	2.01
7.00 m	0.00	21.00	66.00	3.00	4.00	6.00	0.00	0.0254	0.1098	0.2256	8.88	2.10
10.00 m	0.00	21.00	71.00	2.00	0.00	5.00	1.00	0.0257	0.1087	0.2135	8.30	2.15

GRAIN SIZE DISTRIBUTION CURVES

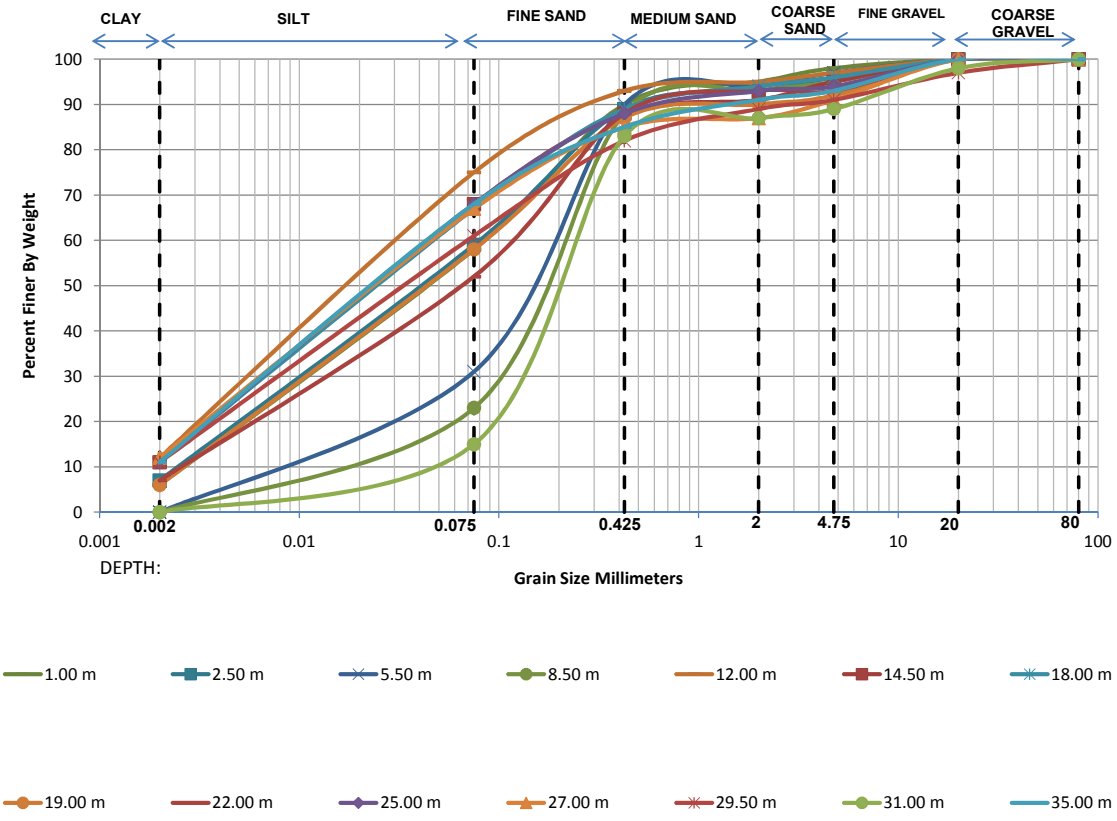
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)1+969 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	47.00	41.00	3.00	1.00	1.00	0.00	0.0037	0.0251	0.0942	25.79	1.84
4.00 m	11.00	52.00	28.00	4.00	3.00	2.00	0.00	-	0.0155	0.0676	-	-
5.50 m	12.00	52.00	26.00	5.00	2.00	3.00	0.00	-	0.0141	0.0652	-	-
8.50 m	8.00	46.00	37.00	3.00	1.00	5.00	0.00	0.0030	0.0238	0.0959	32.34	1.99

GRAIN SIZE DISTRIBUTION CURVES

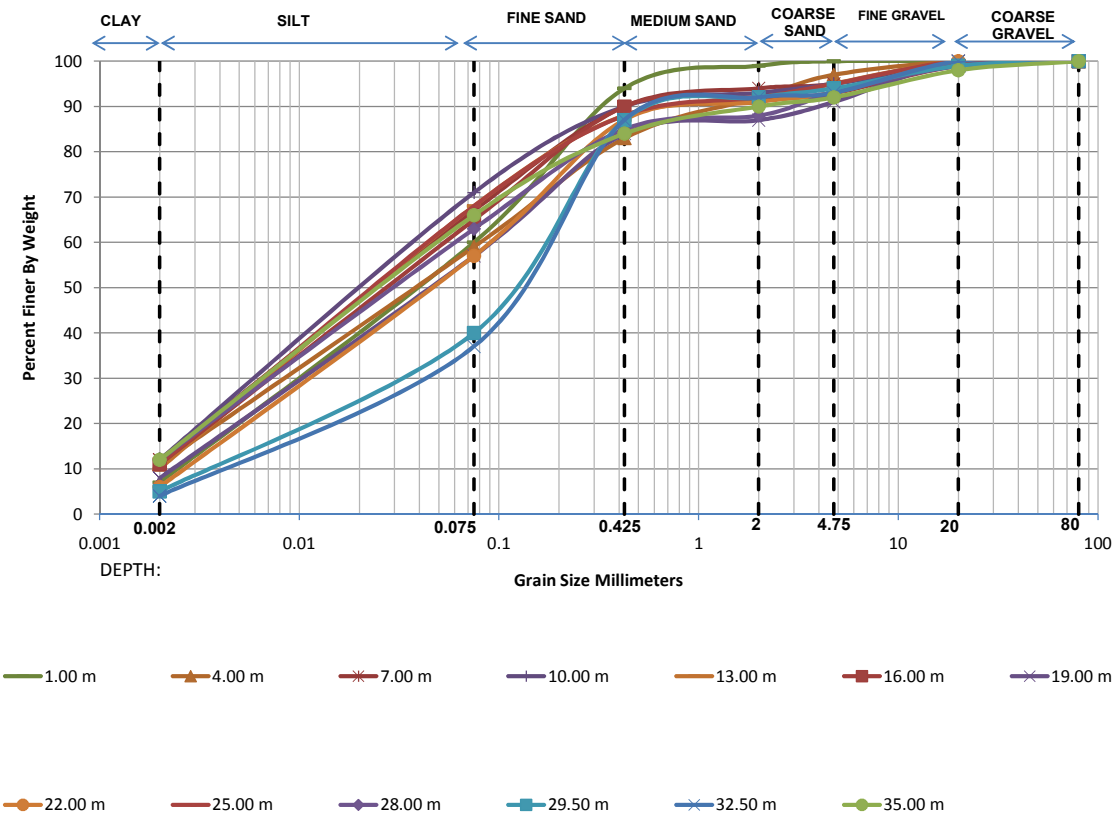
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)1+500 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	52.00	32.00	5.00	3.00	2.00	0.00	0.0044	0.0232	0.0808	18.54	1.53
2.50 m	7.00	52.00	30.00	4.00	3.00	4.00	0.00	0.0036	0.0214	0.0778	21.86	1.65
5.50 m	0.00	31.00	59.00	4.00	3.00	3.00	0.00	0.0125	0.0716	0.1861	14.86	2.20
8.50 m	0.00	23.00	65.00	5.00	2.00	5.00	0.00	0.0216	0.1014	0.2175	10.08	2.19
12.00 m	12.00	63.00	18.00	2.00	2.00	3.00	0.00	-	0.0111	0.0463	-	-
14.50 m	11.00	57.00	20.00	3.00	4.00	5.00	0.00	-	0.0135	0.0573	-	-
18.00 m	11.00	56.00	22.00	5.00	2.00	4.00	0.00	-	0.0139	0.0592	-	-
19.00 m	6.00	52.00	29.00	3.00	2.00	8.00	0.00	0.0044	0.0230	0.0811	18.64	1.50
22.00 m	7.00	45.00	36.00	5.00	0.00	7.00	0.00	0.0037	0.0264	0.1065	28.95	1.78
25.00 m	11.00	57.00	20.00	5.00	1.00	6.00	0.00	-	0.0135	0.0573	-	-
27.00 m	12.00	55.00	18.00	2.00	4.00	9.00	0.00	-	0.0129	0.0587	-	-
29.50 m	11.00	50.00	21.00	7.00	2.00	6.00	3.00	-	0.0160	0.0723	-	-
31.00 m	0.00	15.00	68.00	4.00	2.00	9.00	2.00	0.0450	0.1380	0.2554	5.68	1.66
35.00 m	11.00	57.00	17.00	6.00	2.00	7.00	0.00	-	0.0134	0.0571	-	-

GRAIN SIZE DISTRIBUTION CURVES

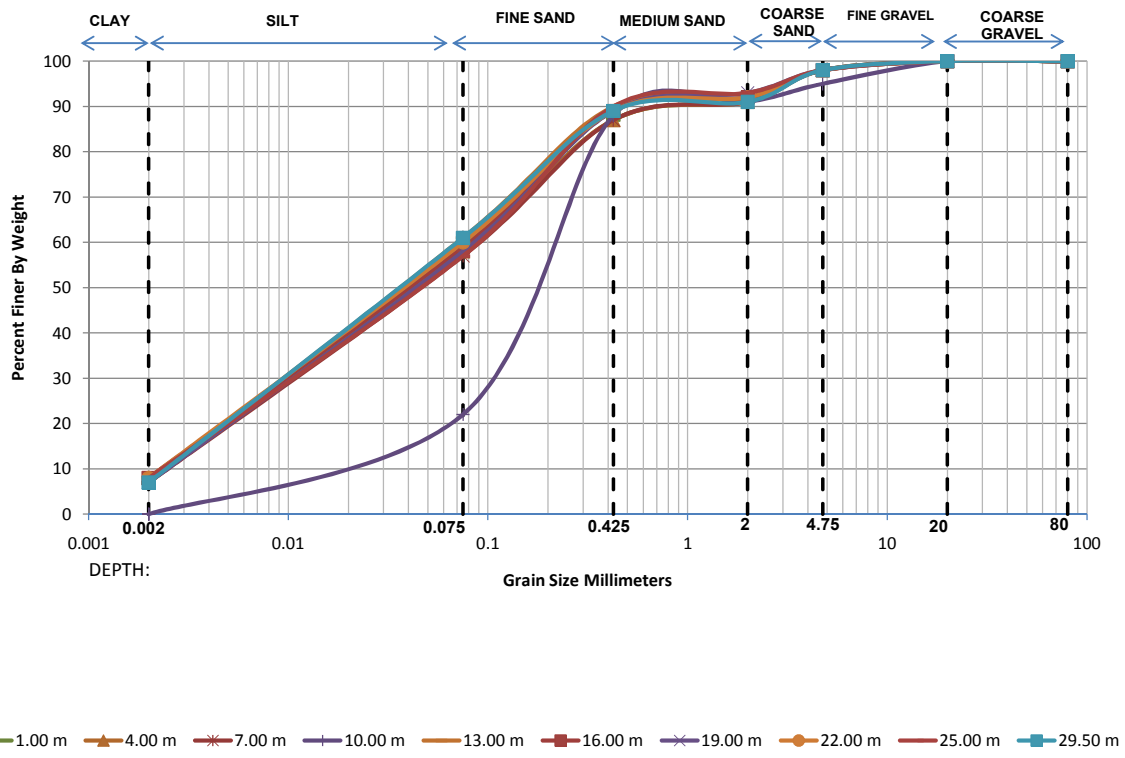
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)1+500 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	53.00	34.00	5.00	1.00	0.00	0.00	0.0035	0.0211	0.0750	21.13	1.67
4.00 m	11.00	48.00	24.00	9.00	5.00	3.00	0.00	-	0.0170	0.0782	-	-
7.00 m	12.00	55.00	23.00	4.00	1.00	5.00	0.00	-	0.0131	0.0590	-	-
10.00 m	12.00	59.00	19.00	3.00	2.00	4.00	1.00	-	0.0119	0.0519	-	-
13.00 m	10.00	58.00	20.00	3.00	4.00	5.00	0.00	0.0020	0.0144	0.0576	28.79	1.80
16.00 m	11.00	54.00	25.00	2.00	1.00	6.00	1.00	-	0.0146	0.0632	-	-
19.00 m	8.00	49.00	27.00	3.00	4.00	9.00	0.00	0.0029	0.0212	0.0858	29.26	1.79
22.00 m	6.00	51.00	30.00	4.00	2.00	7.00	0.00	0.0044	0.0237	0.0849	19.39	1.51
25.00 m	11.00	57.00	20.00	4.00	3.00	5.00	0.00	-	0.0135	0.0573	-	-
28.00 m	12.00	51.00	22.00	3.00	5.00	6.00	1.00	-	0.0143	0.0673	-	-
29.50 m	5.00	35.00	47.00	5.00	2.00	5.00	1.00	0.0065	0.0453	0.1616	24.80	1.95
32.50 m	4.00	33.00	50.00	5.00	1.00	7.00	0.00	0.0086	0.0529	0.1733	20.07	1.87
35.00 m	12.00	54.00	18.00	6.00	2.00	6.00	2.00	-	0.0132	0.0607	-	-

GRAIN SIZE DISTRIBUTION CURVES

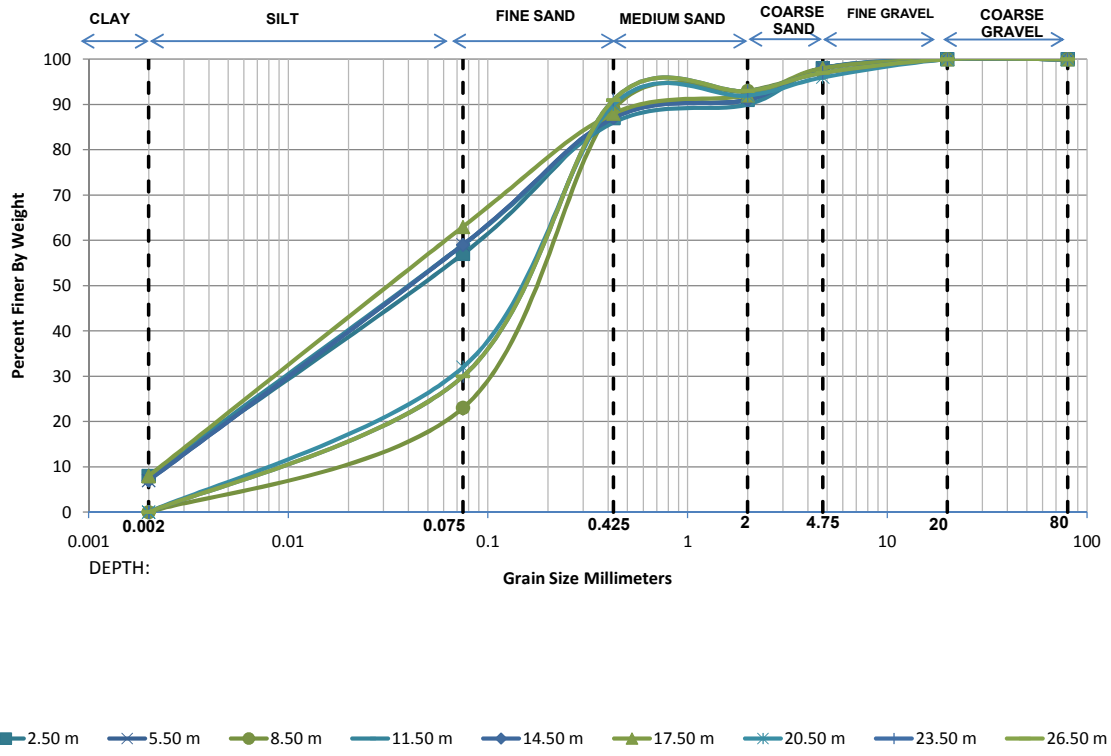
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)1+269 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	51.00	29.00	4.00	7.00	2.00	0.00	0.0036	0.0219	0.0812	22.75	1.65
4.00 m	8.00	50.00	29.00	4.00	7.00	2.00	0.00	0.0029	0.0208	0.0813	27.76	1.82
7.00 m	7.00	50.00	30.00	4.00	7.00	2.00	0.00	0.0036	0.0225	0.0850	23.71	1.66
10.00 m	0.00	22.00	66.00	3.00	4.00	5.00	0.00	0.0234	0.1055	0.2199	9.39	2.16
13.00 m	7.00	54.00	29.00	2.00	6.00	2.00	0.00	0.0035	0.0204	0.0726	20.56	1.62
16.00 m	8.00	51.00	30.00	3.00	6.00	2.00	0.00	0.0029	0.0203	0.0778	26.62	1.81
19.00 m	7.00	51.00	31.00	4.00	5.00	2.00	0.00	0.0036	0.0220	0.0810	22.67	1.67
22.00 m	8.00	52.00	29.00	3.00	6.00	2.00	0.00	0.0029	0.0197	0.0750	25.73	1.78
25.00 m	8.00	49.00	33.00	3.00	5.00	2.00	0.00	0.0029	0.0216	0.0845	28.75	1.88
29.50 m	7.00	54.00	28.00	2.00	7.00	2.00	0.00	0.0035	0.0203	0.0726	20.57	1.61

GRAIN SIZE DISTRIBUTION CURVES

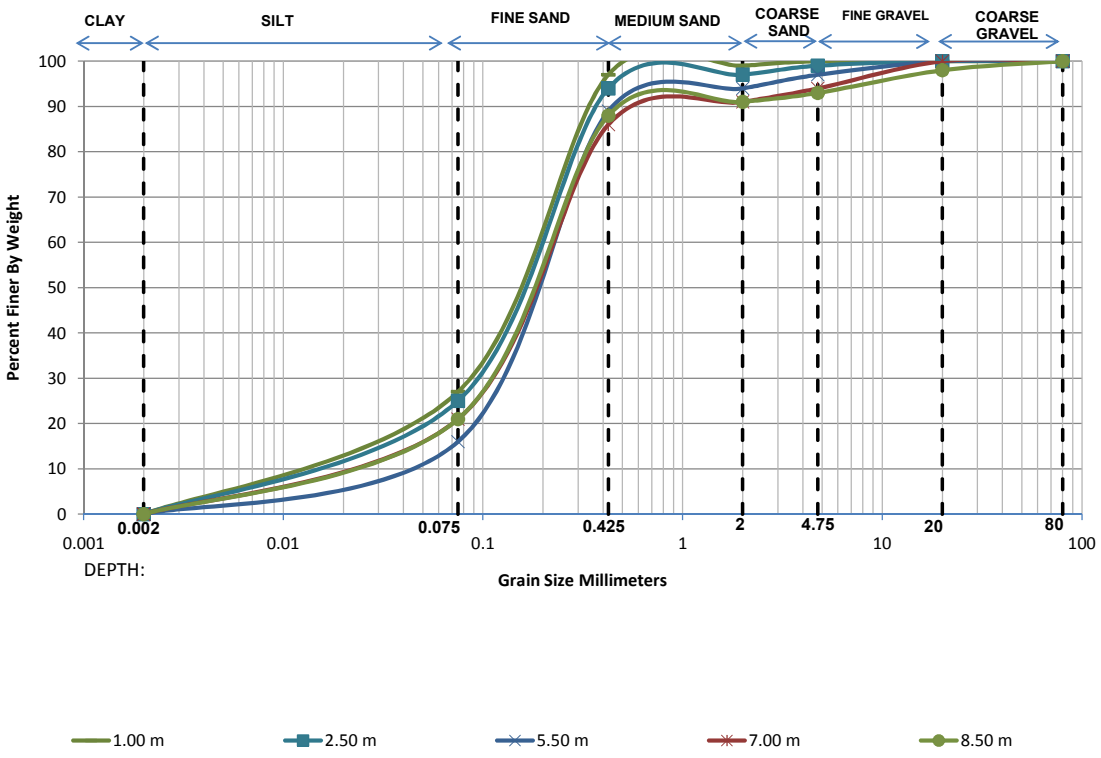
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)1+269 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	8.00	49.00	30.00	4.00	7.00	2.00	0.00	0.0029	0.0214	0.0851	28.99	1.83
5.50 m	7.00	52.00	28.00	4.00	7.00	2.00	0.00	0.0036	0.0213	0.0778	21.90	1.64
8.50 m	0.00	23.00	66.00	4.00	4.00	3.00	0.00	0.0216	0.1012	0.2146	9.92	2.21
11.50 m	8.00	51.00	27.00	4.00	8.00	2.00	0.00	0.0029	0.0201	0.0779	26.68	1.78
14.50 m	7.00	52.00	28.00	4.00	7.00	2.00	0.00	0.0036	0.0213	0.0778	21.90	1.64
17.50 m	8.00	55.00	25.00	4.00	6.00	2.00	0.00	0.0029	0.0182	0.0679	23.47	1.69
20.50 m	0.00	32.00	58.00	2.00	4.00	4.00	0.00	0.0118	0.0684	0.1820	15.40	2.17
23.50 m	0.00	30.00	61.00	2.00	4.00	3.00	0.00	0.0133	0.0750	0.1868	14.01	2.26
26.50 m	0.00	30.00	61.00	2.00	4.00	3.00	0.00	0.0133	0.0750	0.1868	14.01	2.26

GRAIN SIZE DISTRIBUTION CURVES

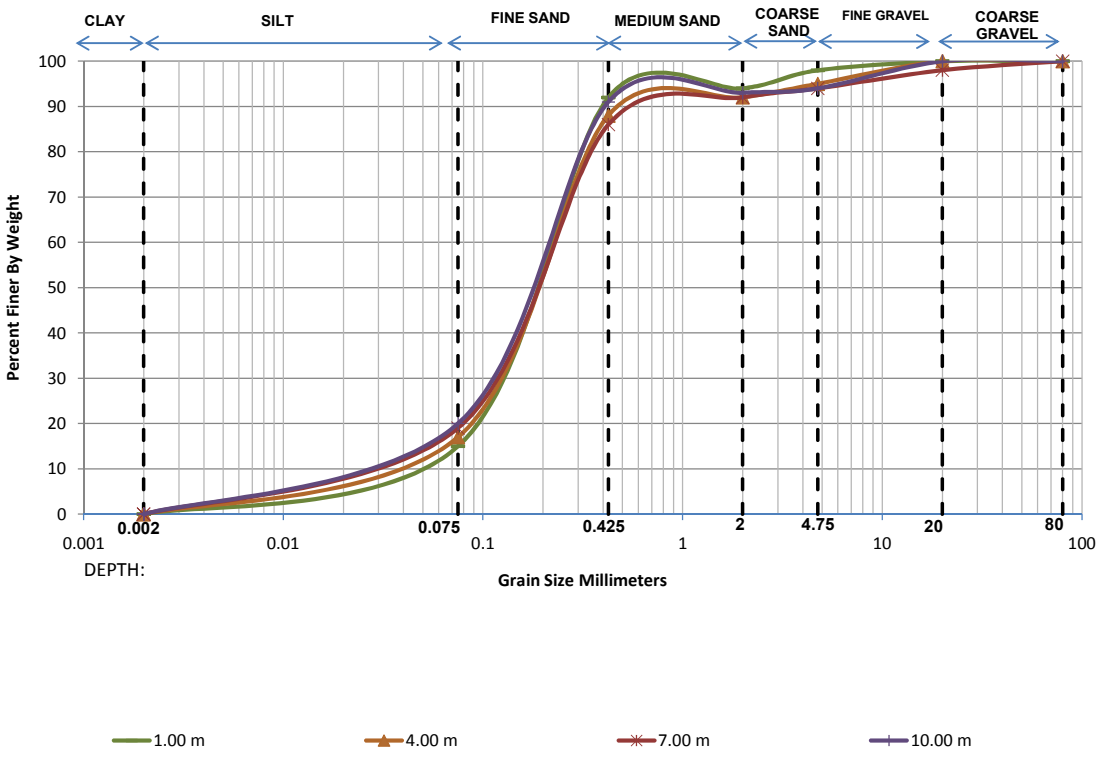
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)1+241 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	27.00	70.00	2.00	1.00	0.00	0.00	0.0164	0.0853	0.1857	11.29	2.38
2.50 m	0.00	25.00	69.00	3.00	2.00	1.00	0.00	0.0188	0.0928	0.1974	10.50	2.32
5.50 m	0.00	16.00	73.00	5.00	3.00	3.00	0.00	0.0409	0.1309	0.2361	5.77	1.77
7.00 m	0.00	21.00	65.00	5.00	3.00	6.00	0.00	0.0254	0.1101	0.2291	9.03	2.09
8.50 m	0.00	21.00	67.00	3.00	2.00	5.00	2.00	0.0255	0.1096	0.2230	8.75	2.11

GRAIN SIZE DISTRIBUTION CURVES

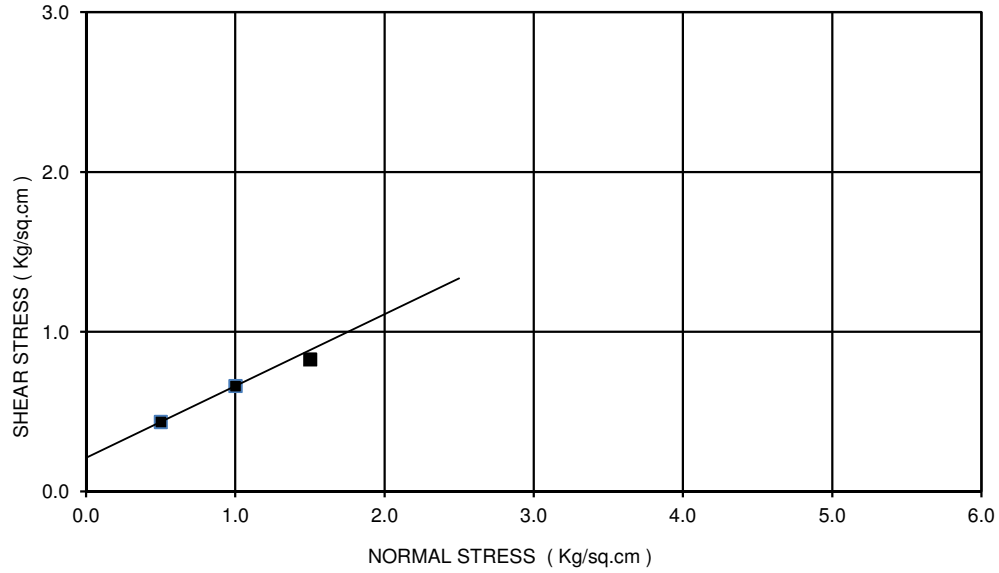
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)0+934 Minor Bridge
B.H. No.	BH-CL

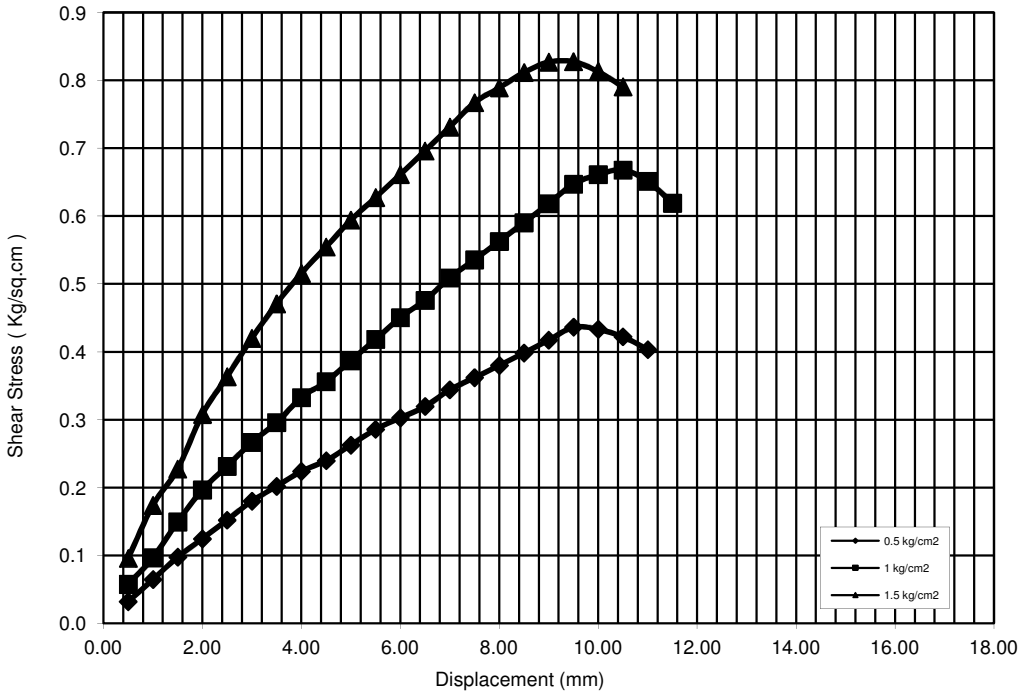


Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	15.00	77.00	2.00	4.00	2.00	0.00	0.0456	0.1341	0.2316	5.08	1.70
4.00 m	0.00	17.00	71.00	4.00	3.00	5.00	0.00	0.0369	0.1268	0.2353	6.37	1.85
7.00 m	0.00	19.00	67.00	6.00	2.00	4.00	2.00	0.0303	0.1188	0.2354	7.76	1.98
10.00 m	0.00	20.00	71.00	2.00	1.00	6.00	0.00	0.0280	0.1130	0.2187	7.81	2.08

BORE HOLE NO: BH-CL

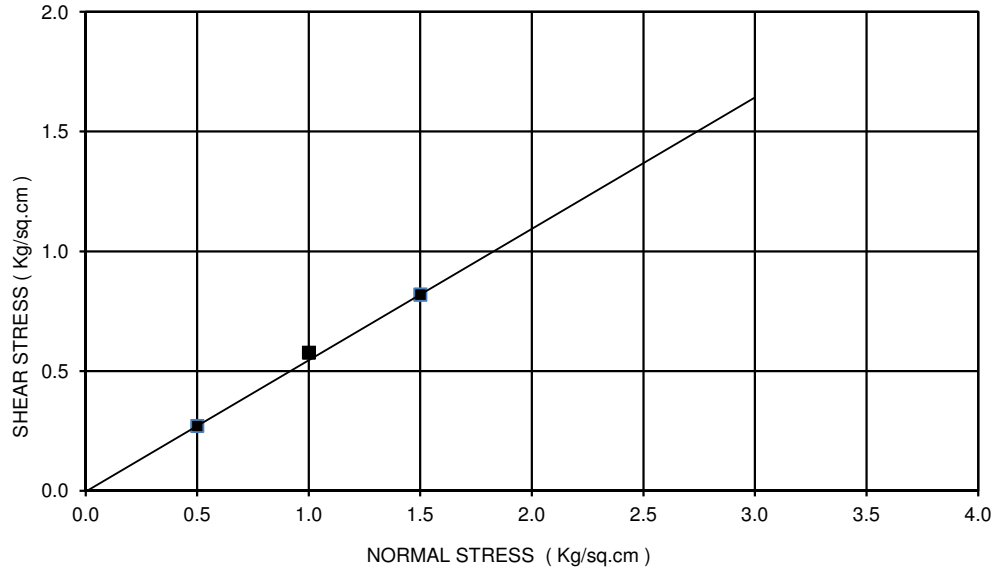
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST

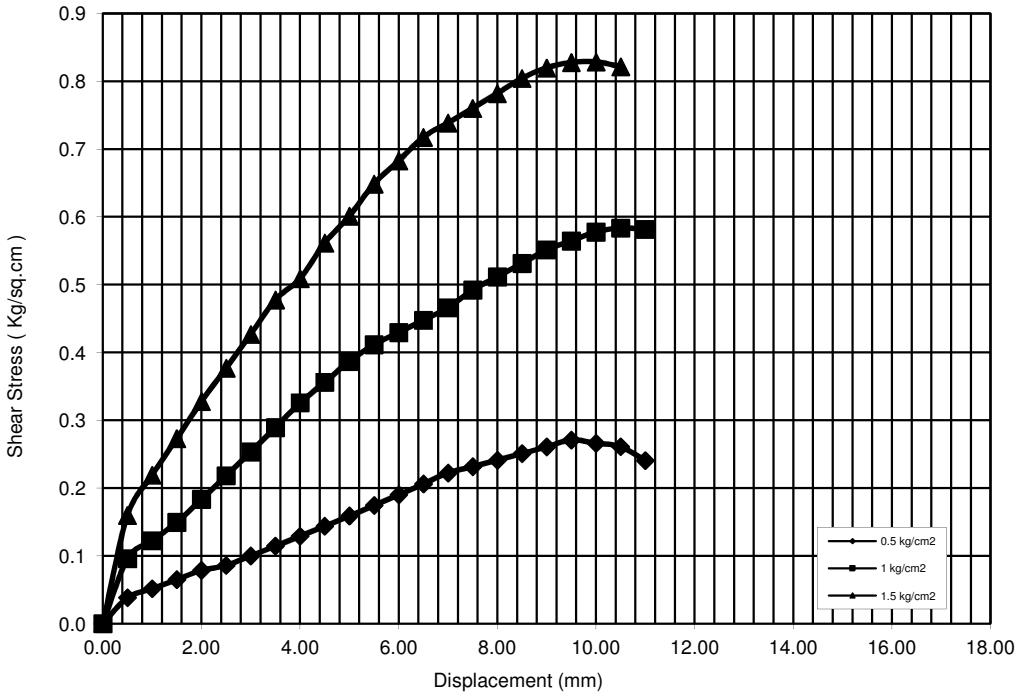




BORE HOLE NO: BH-CL

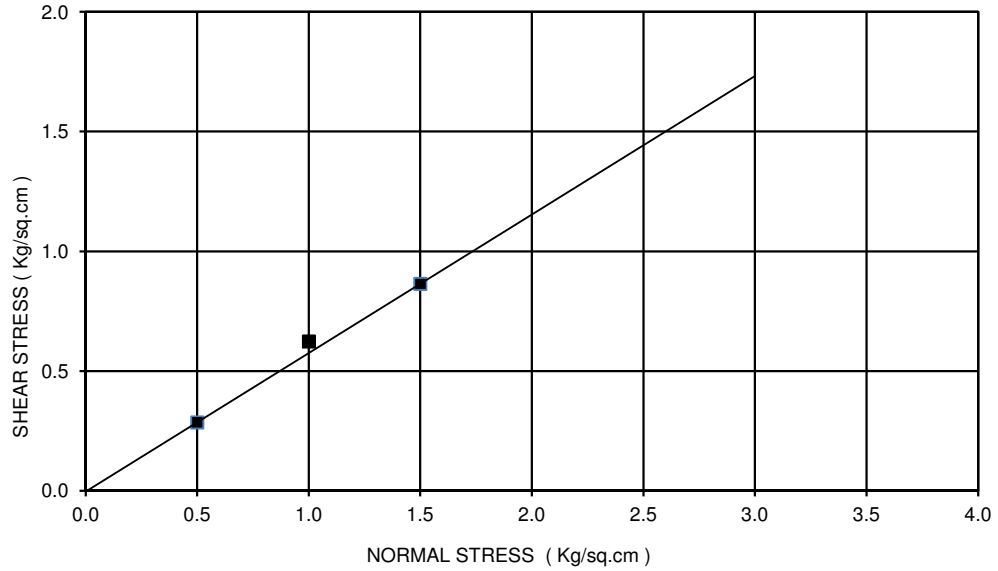
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST

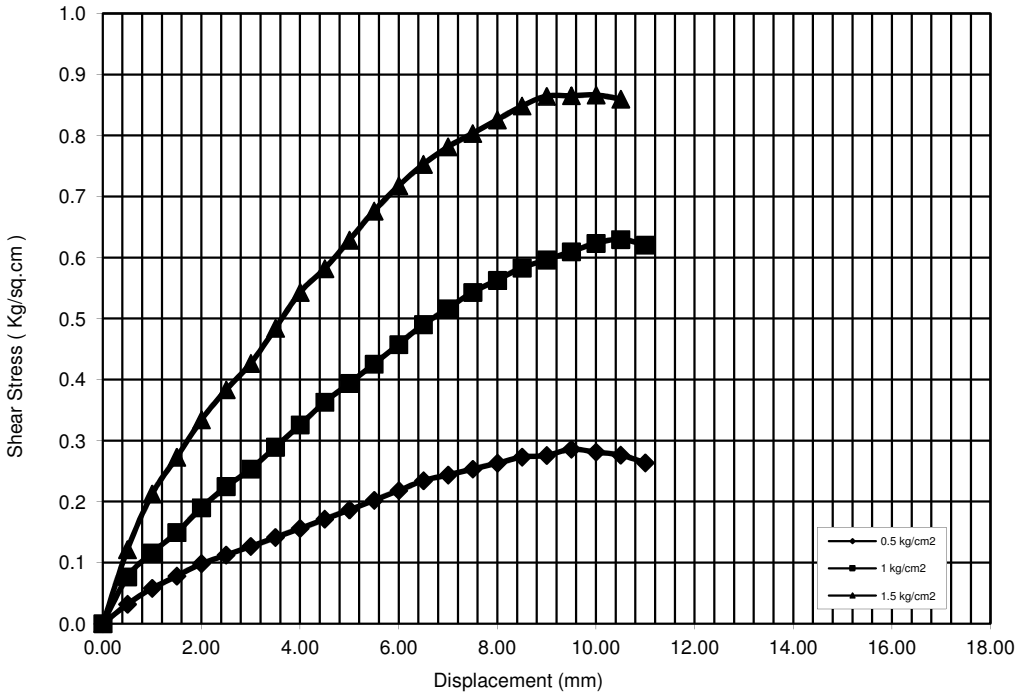




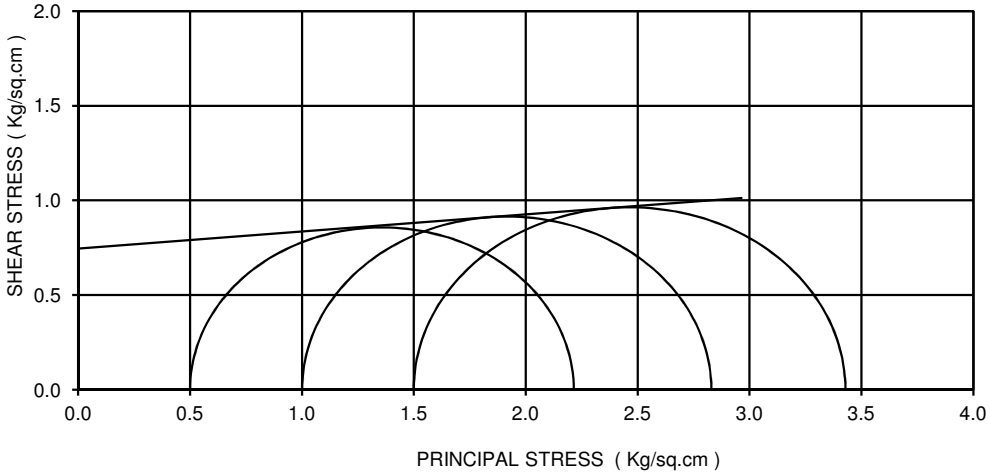
BORE HOLE NO: BH-CL

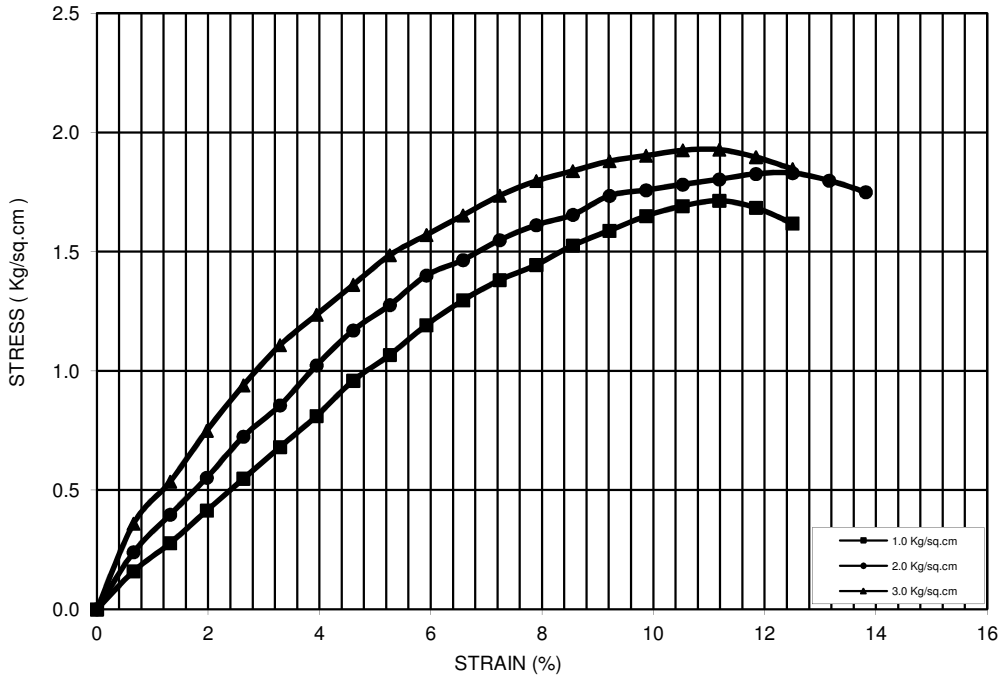
SAMPLE NO.: UDS-3
DEPTH: 7.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



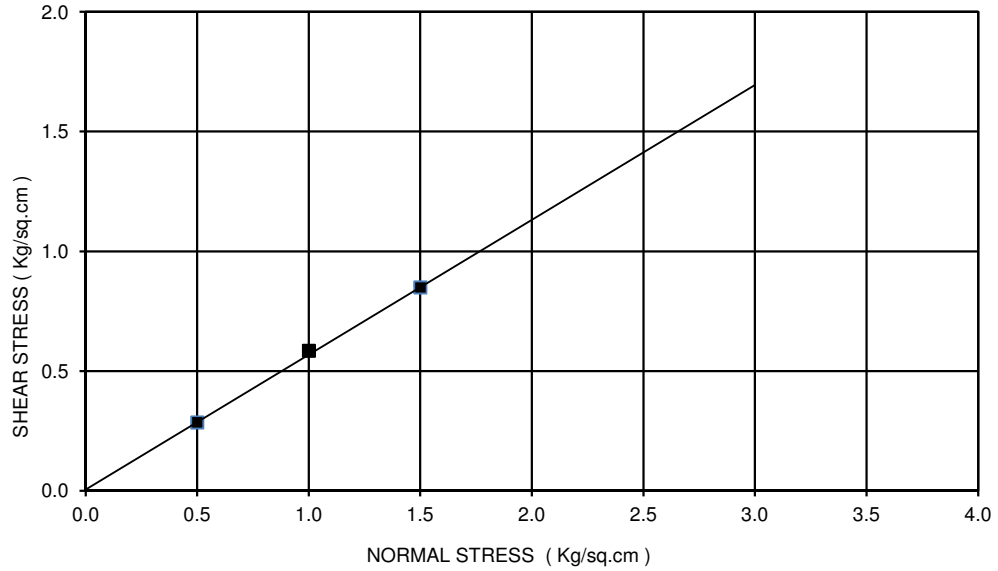


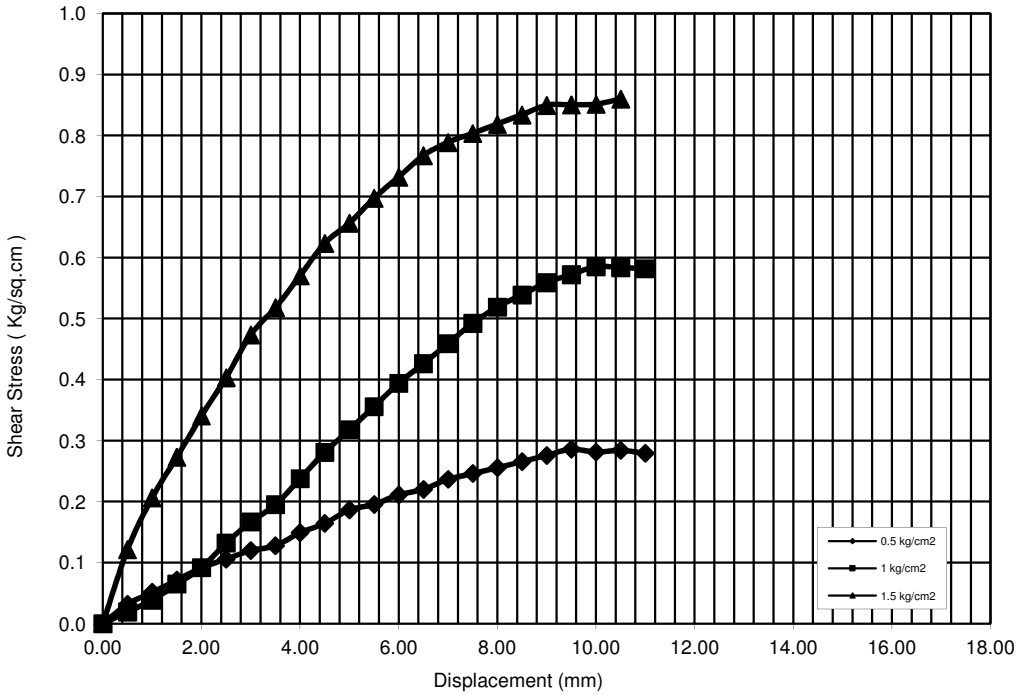
BORE HOLE NO: BH-CL
CH-1+969.2
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.75 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



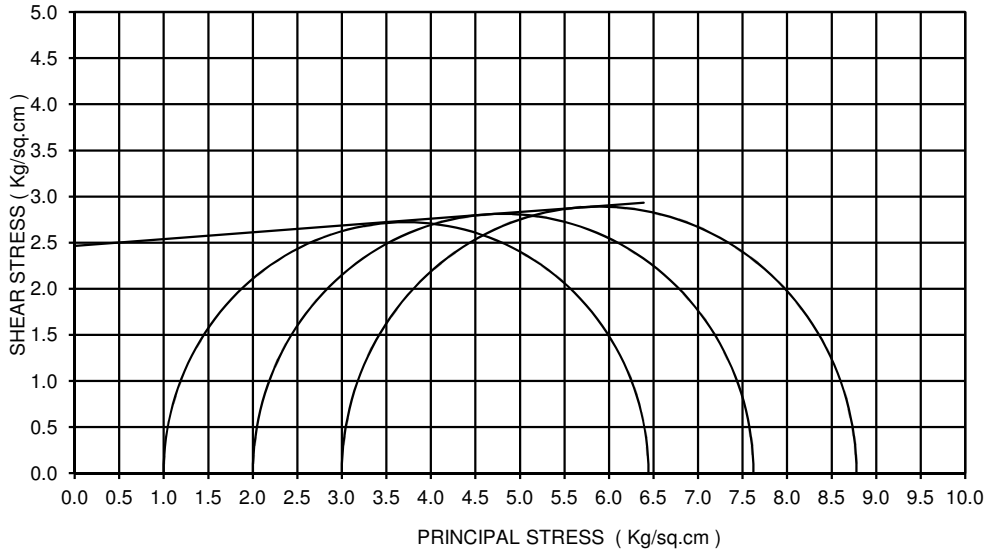


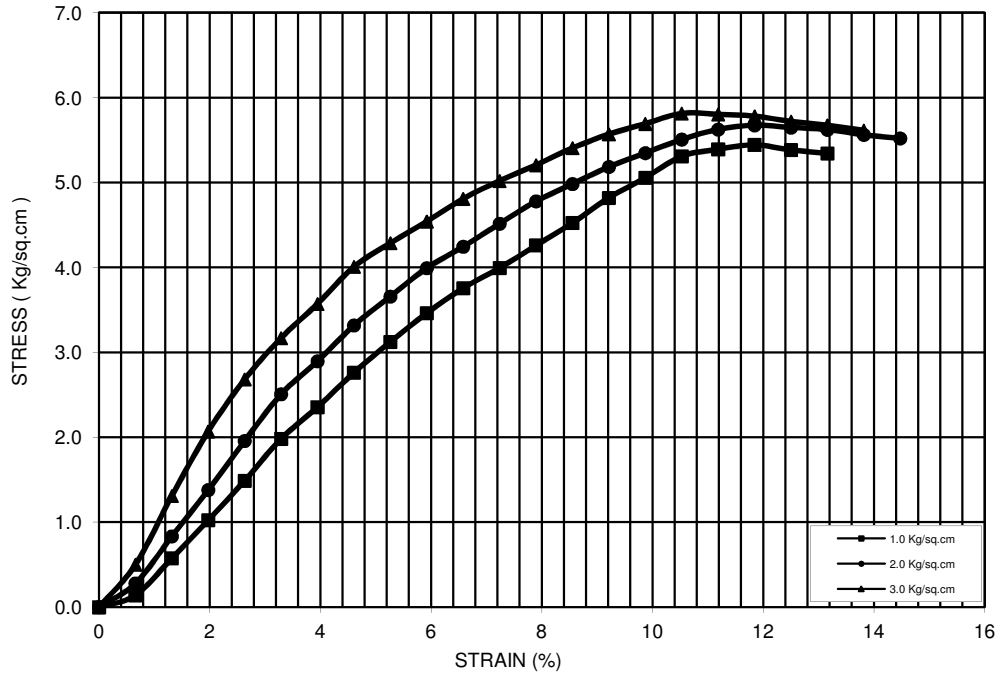
BORE HOLE NO: BH-A-1
CHAINAGE : 1+500
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST



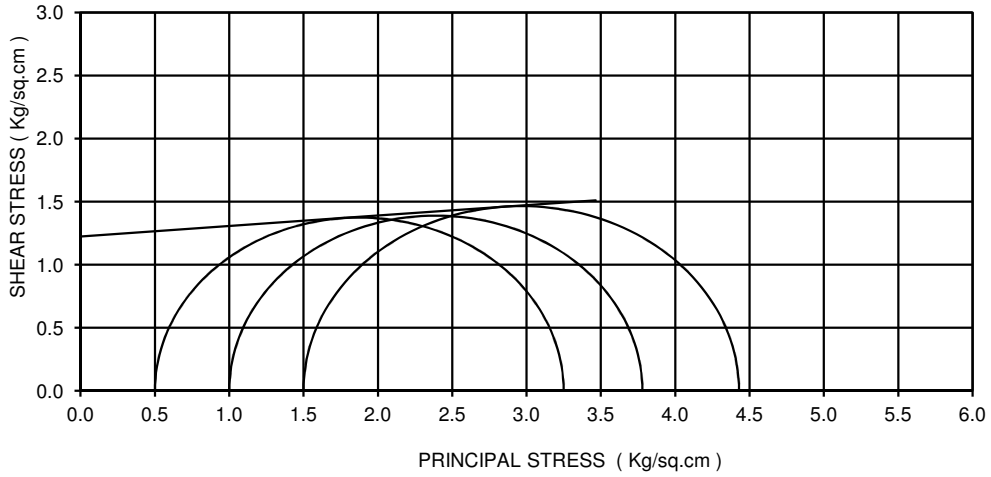


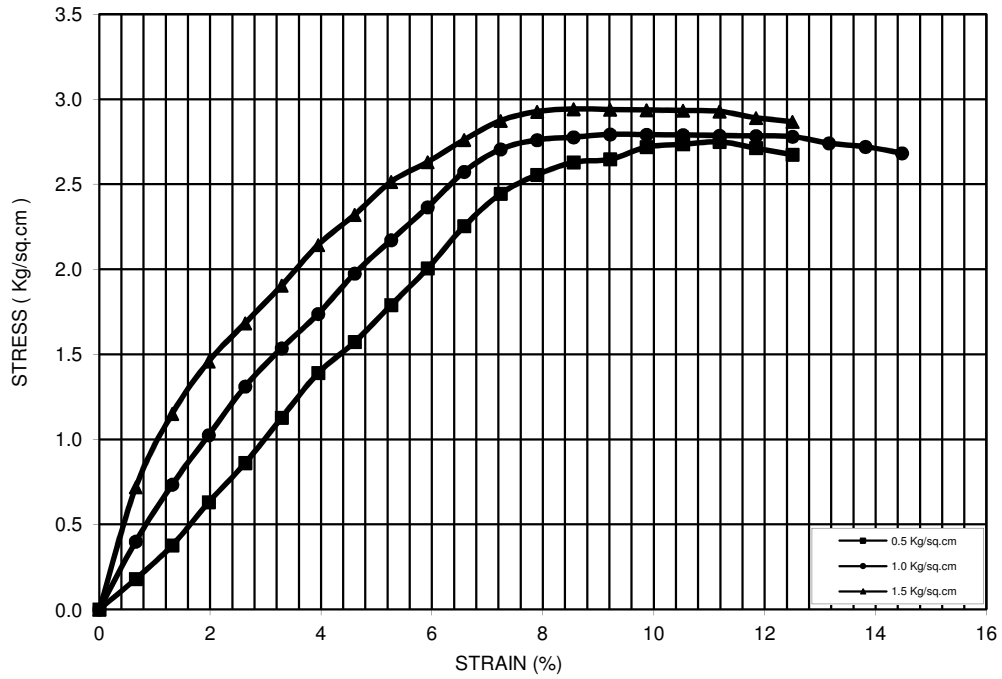
BORE HOLE NO: BH-A-1
CHAINAGE : 1+500
SAMPLE NO.: UDS-5
DEPTH: 29.50 m
COHESION(C)= 2.46 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



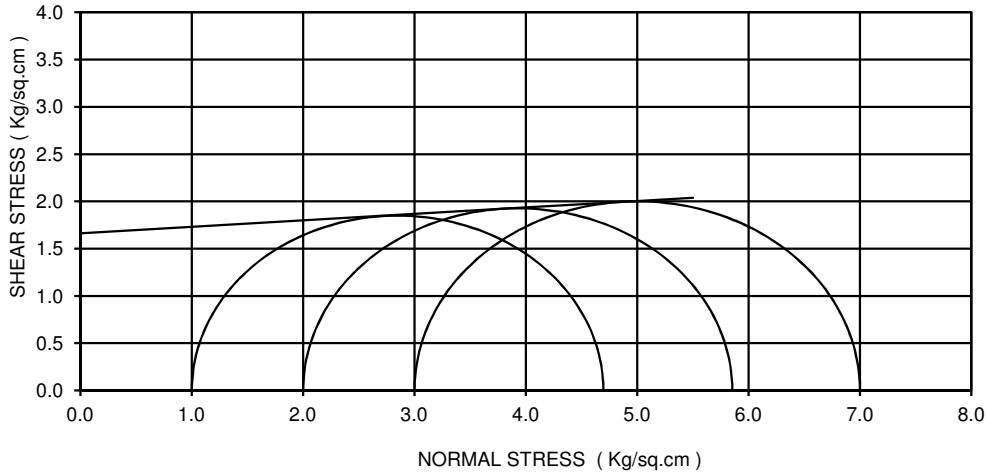


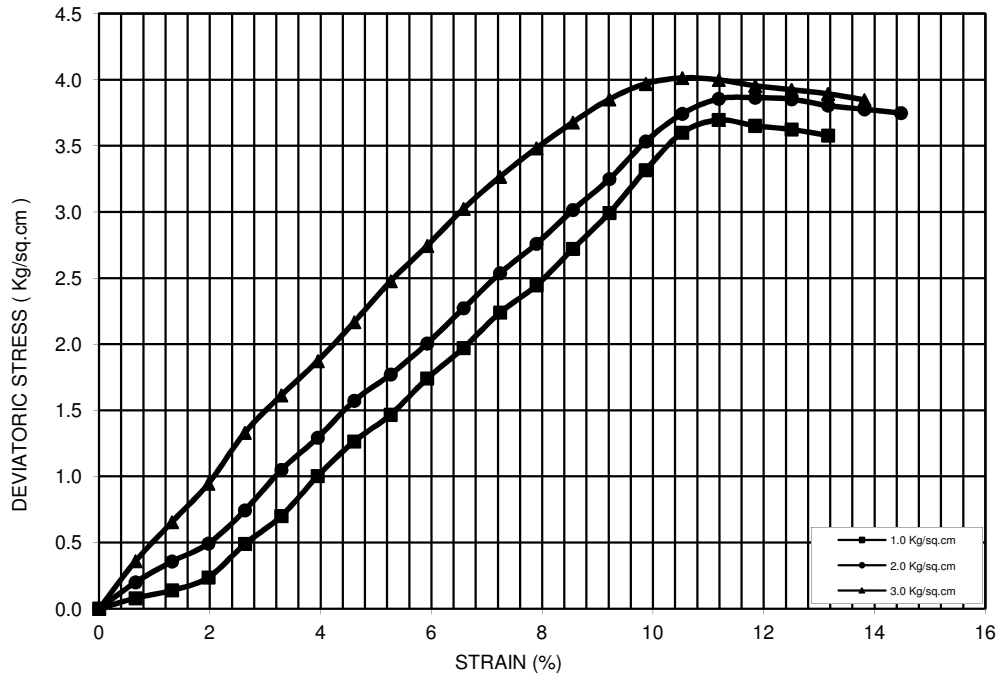
BORE HOLE NO: BH-A-2
CHAINAGE : 1+500
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 1.23 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT





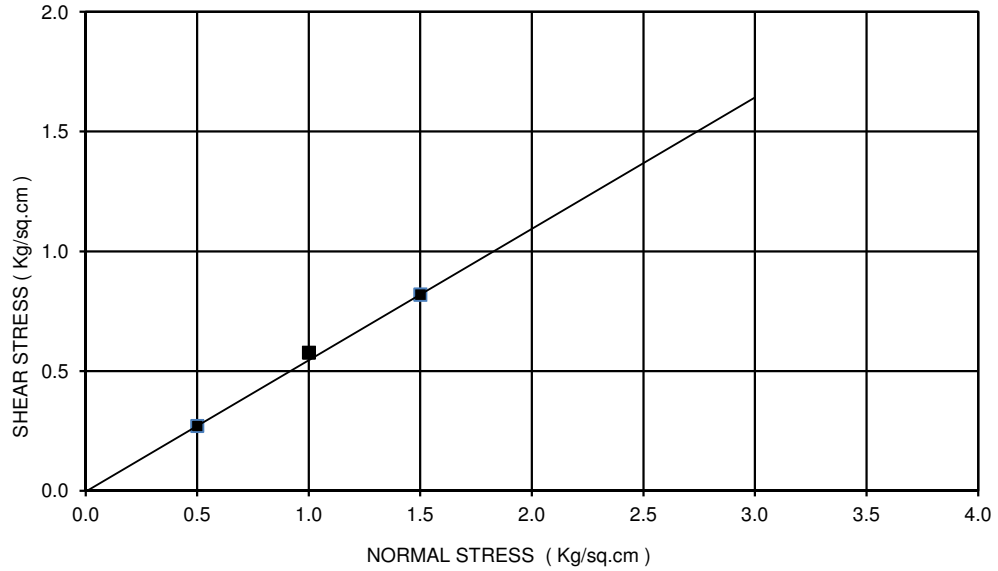
BORE HOLE NO: BH-A-2
CHAINAGE : 1+500
SAMPLE NO.: UDS-9
DEPTH: 28.00 m
COHESION(C)= 1.66 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT

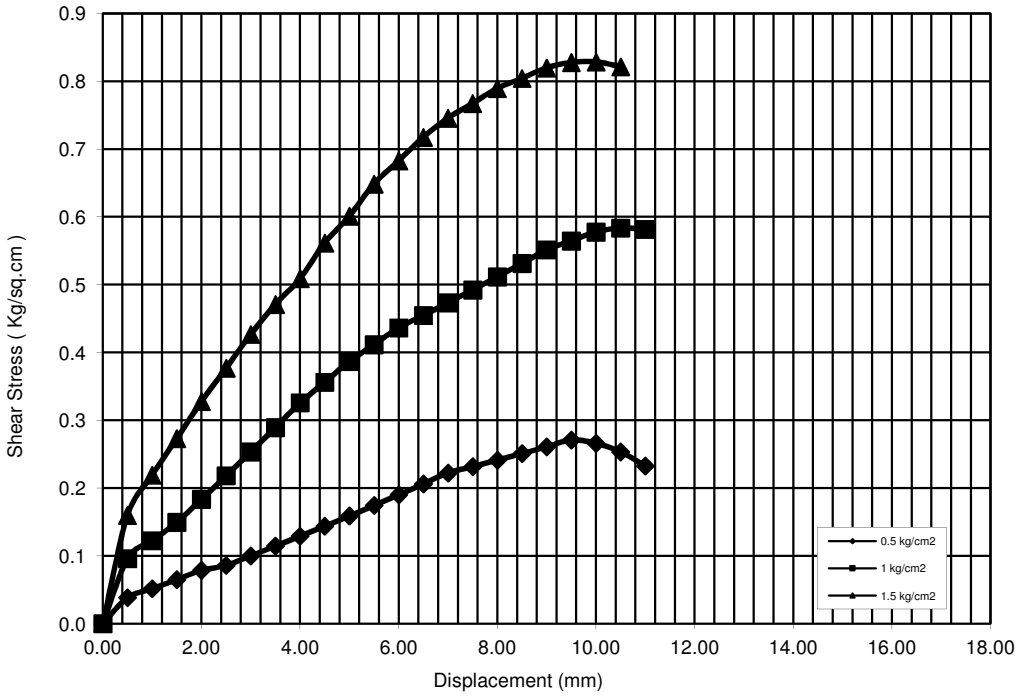




BORE HOLE NO: BH-CL

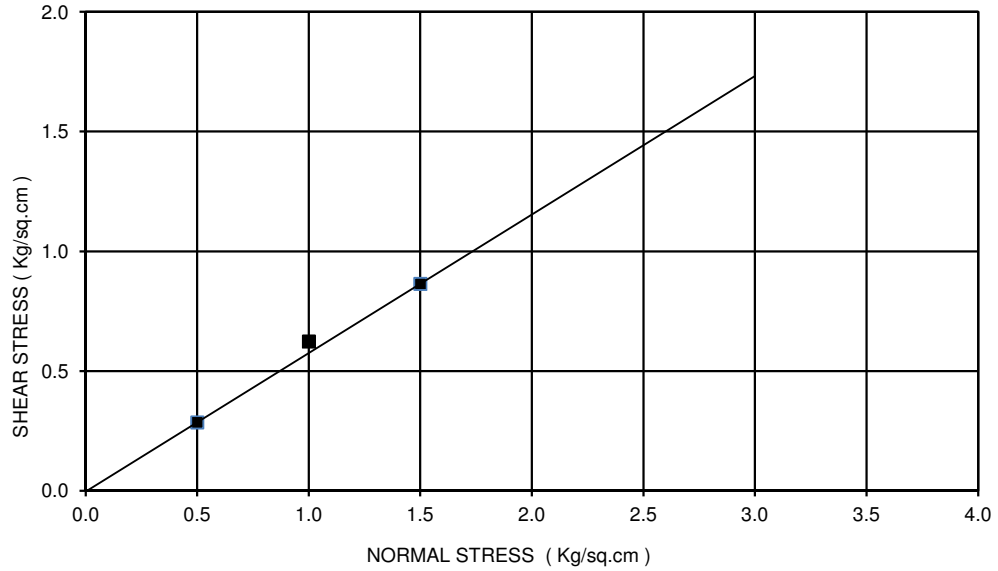
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST

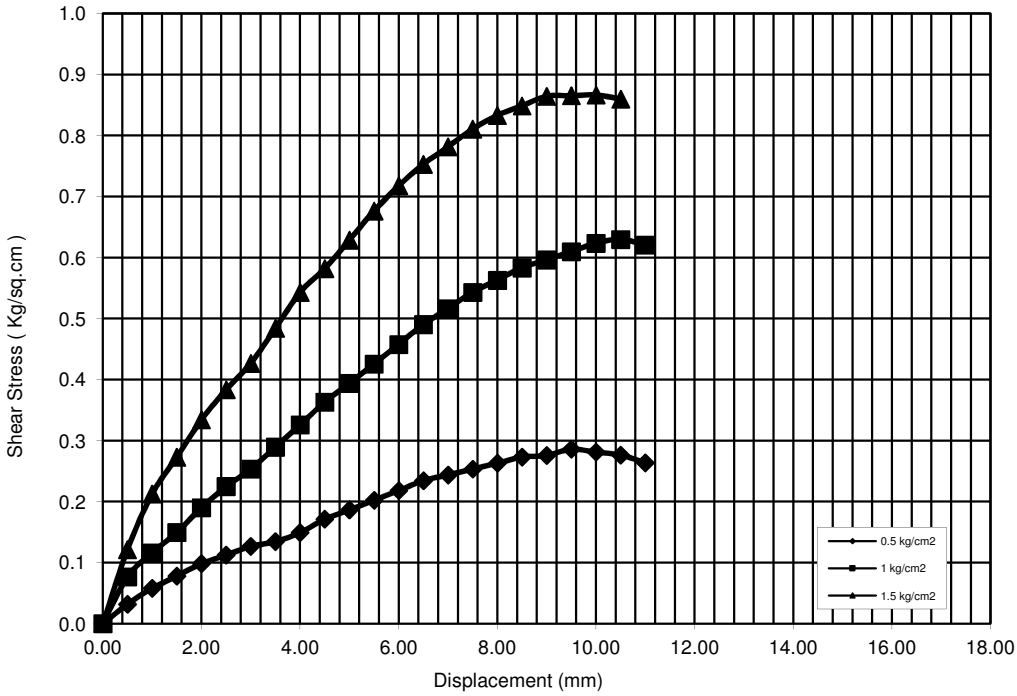




BORE HOLE NO: BH-CL

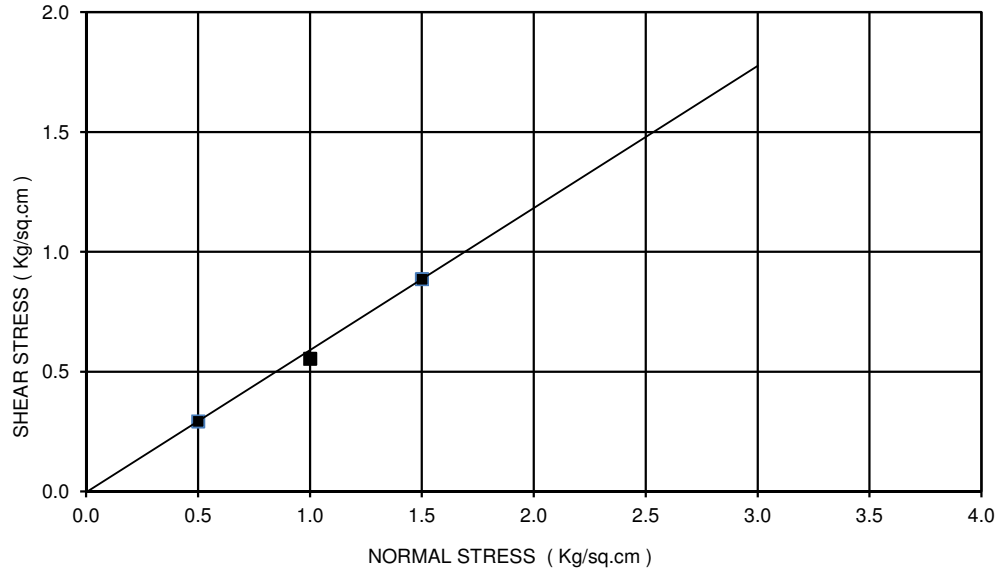
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST

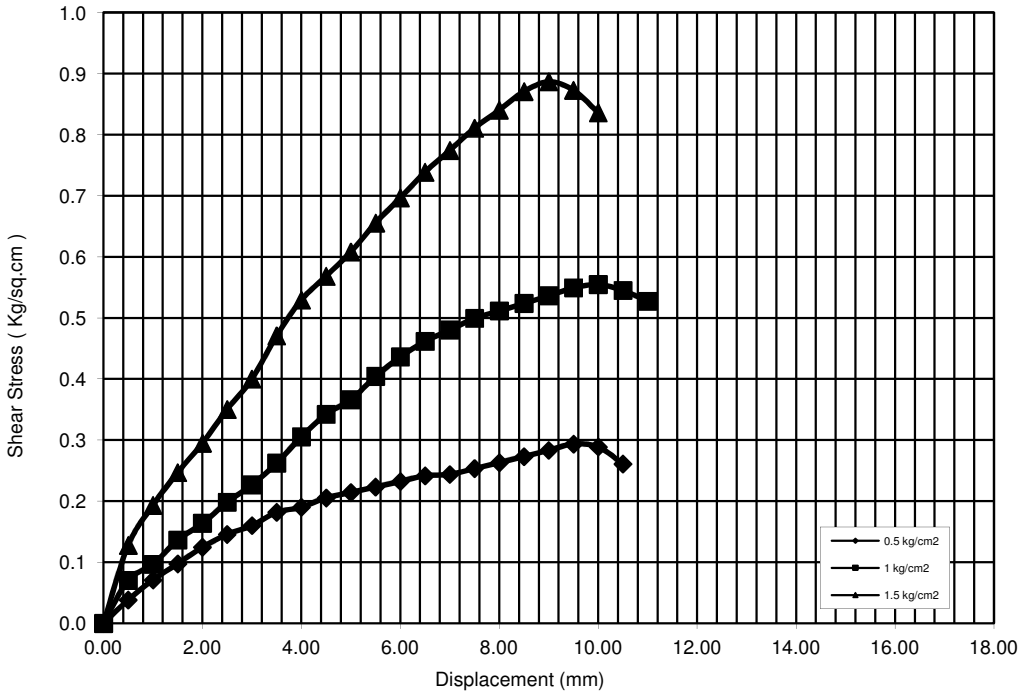




BORE HOLE NO: BH-CL

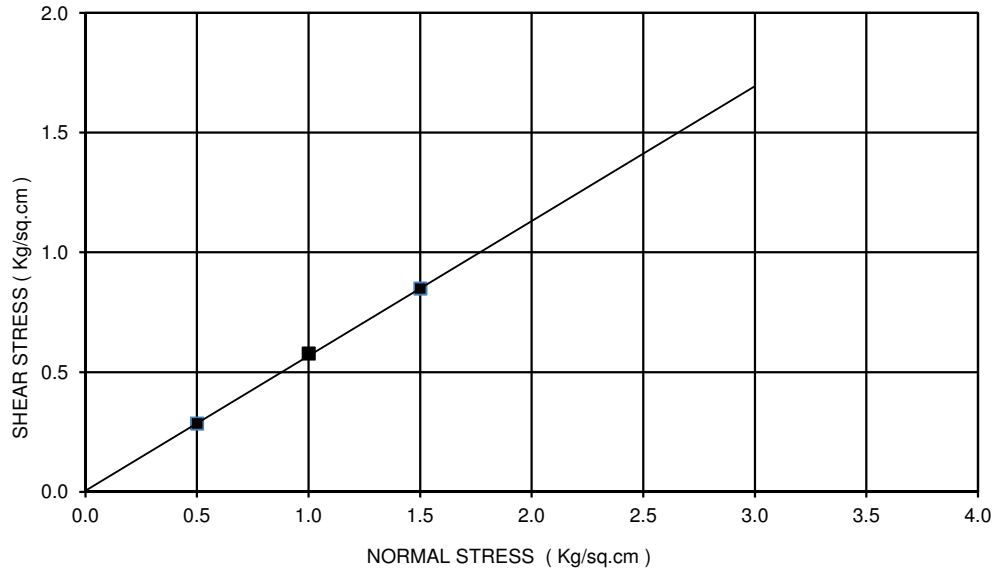
SAMPLE NO.: UDS-3
DEPTH: 8.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 31 deg
TYPE OF THE TEST: DST

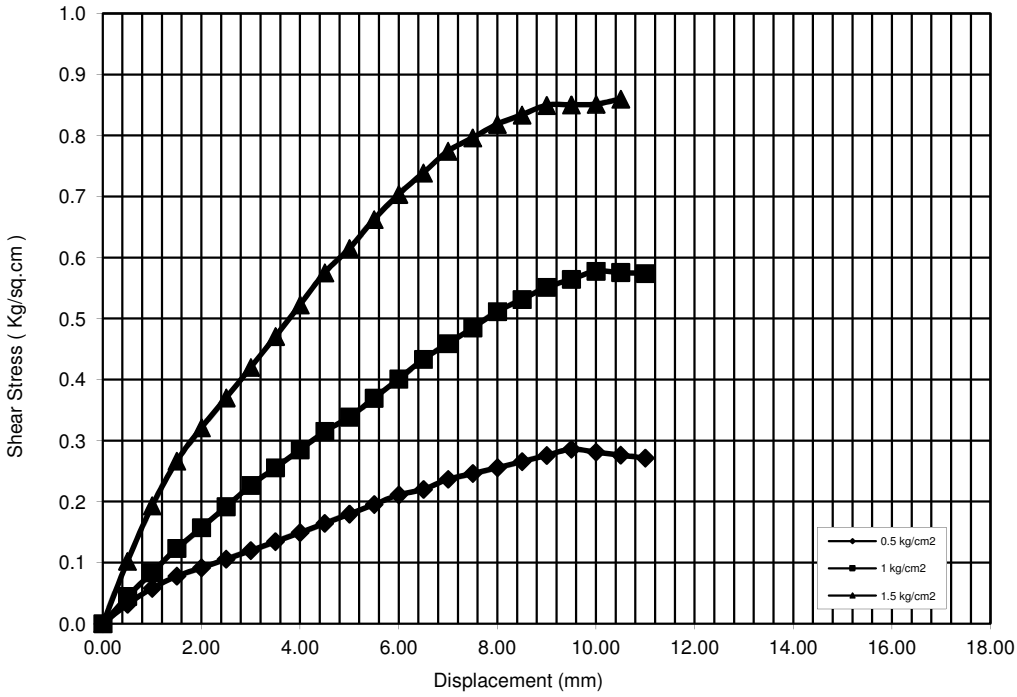




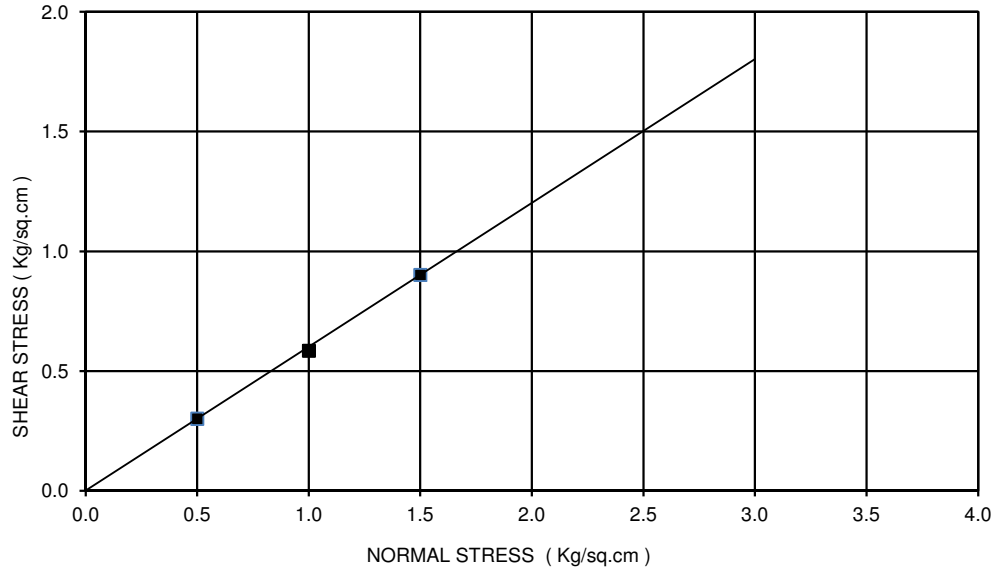
BORE HOLE NO: BH-CL

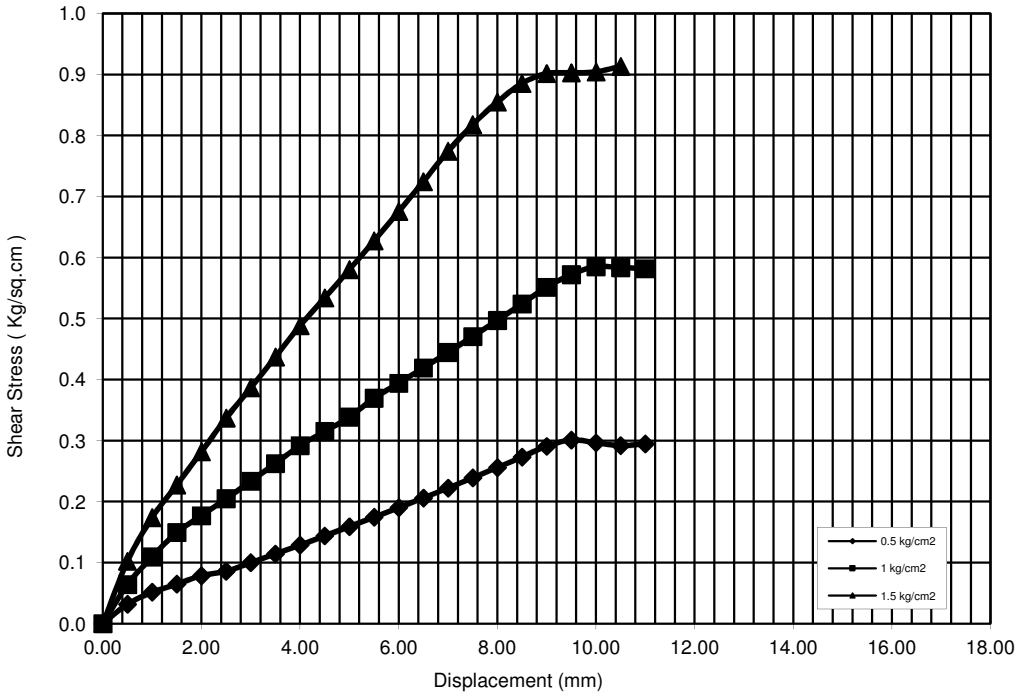
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST





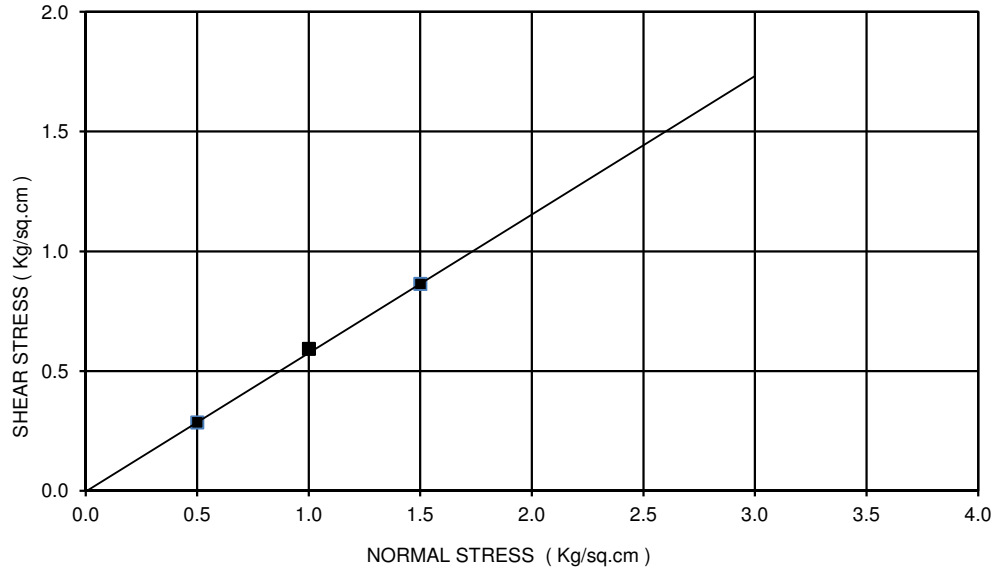
BORE HOLE NO: BH-CL
CHAINAGE : 0+934
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 31 deg
TYPE OF THE TEST: DST

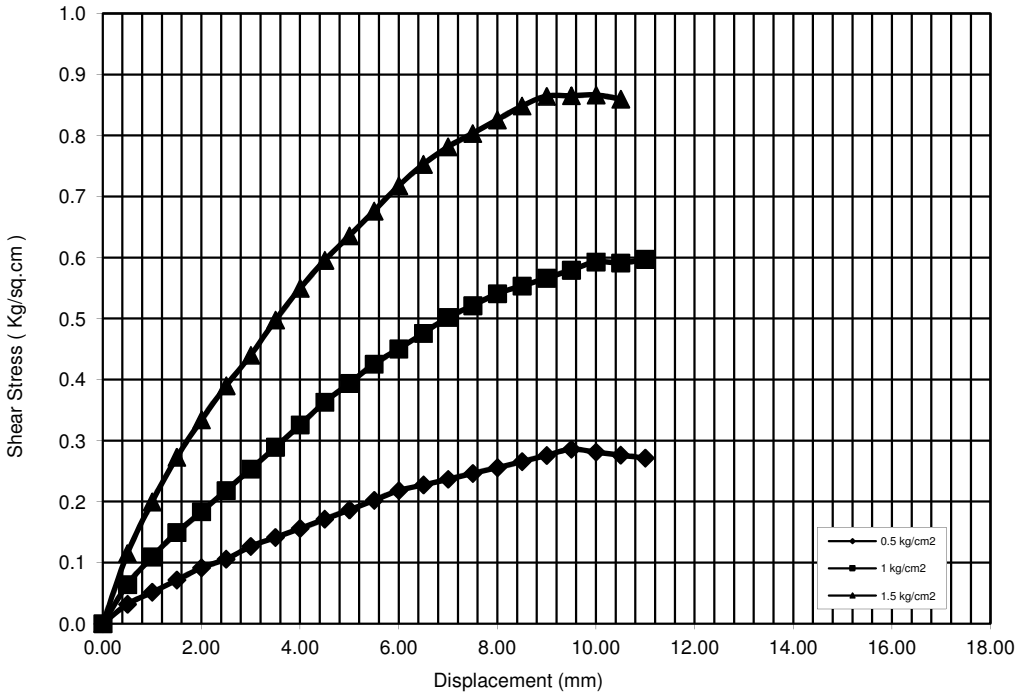


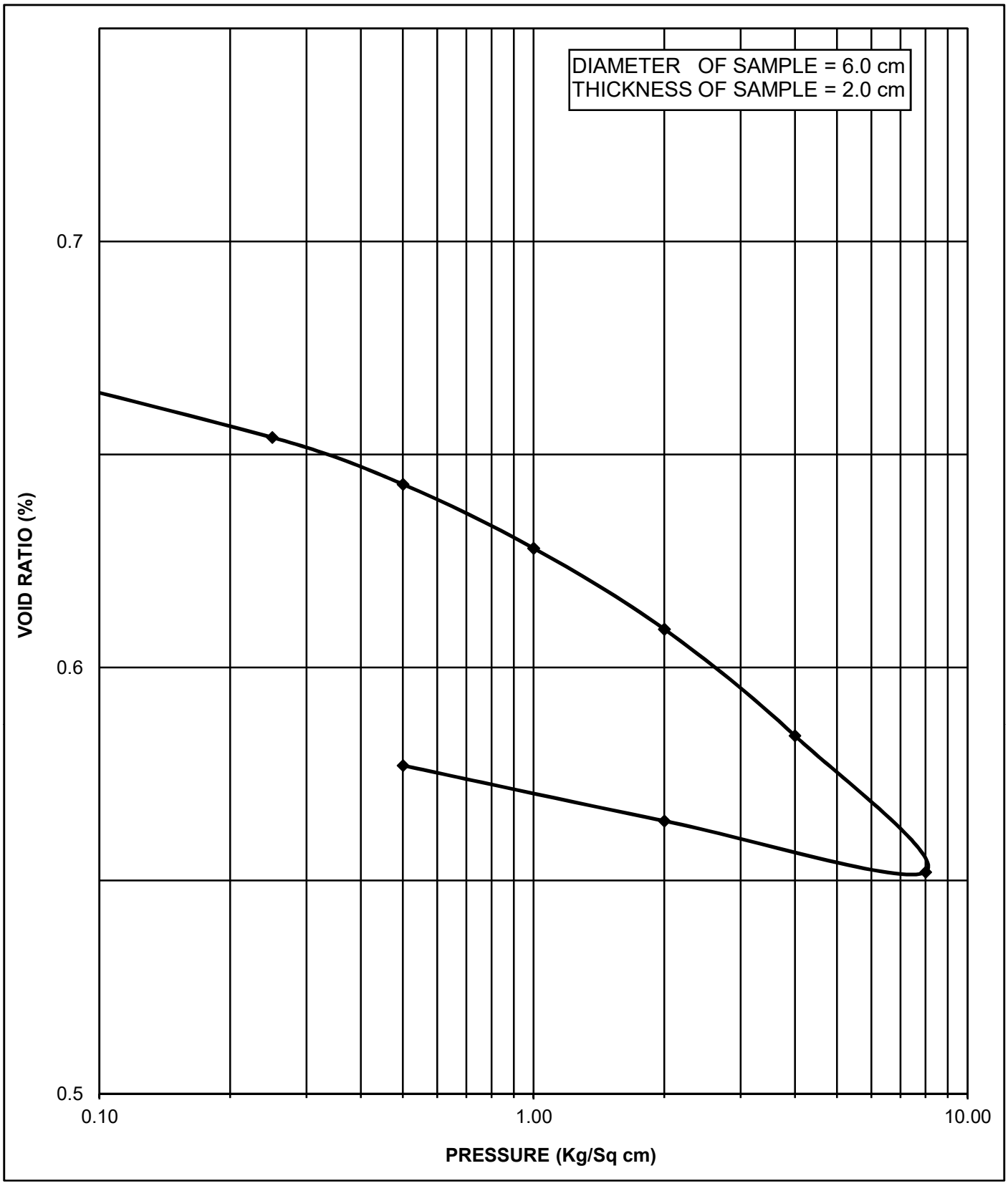


BORE HOLE NO: BH-CL

SAMPLE NO.: UDS-3
DEPTH: 7.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST







BORE HOLE NO. = BH-A2

CHAINAGE = 1+500

SAMPLE NO. = UDS-02

DEPTH = 11.50 M

TYPY OF SOIL = CL

INITIAL WATER CONTENT = 20.36 %

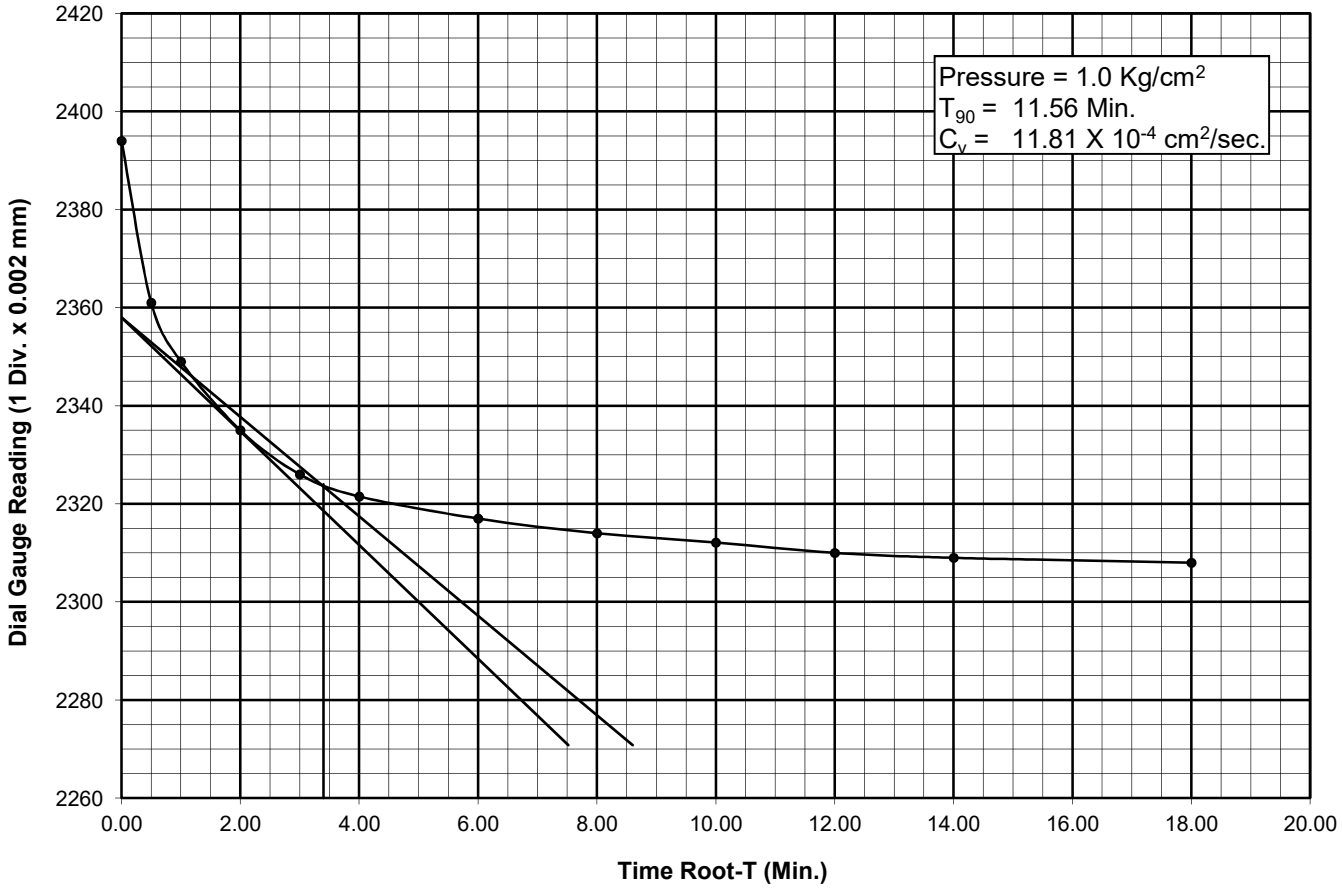
DRY DENSITY = 1.61 gm/cm^3

VOID RATIO (e_o) = 0.665

COMPRESIVE INDEX (C_c) = 0.106

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-A2
CHAINAGE = 1+500
SAMPLE NO. = UDS-02
DEPTH = 4.00 M



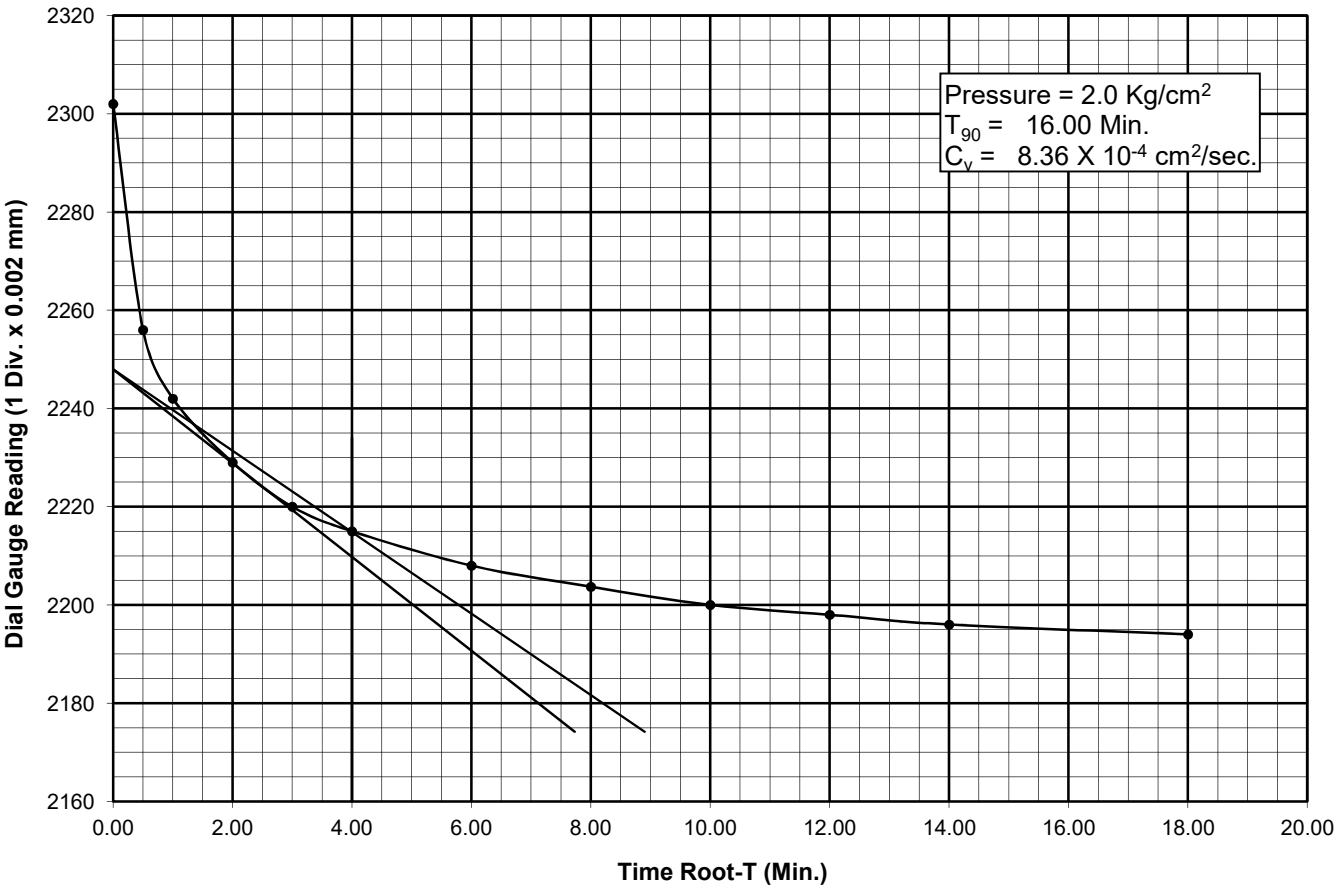
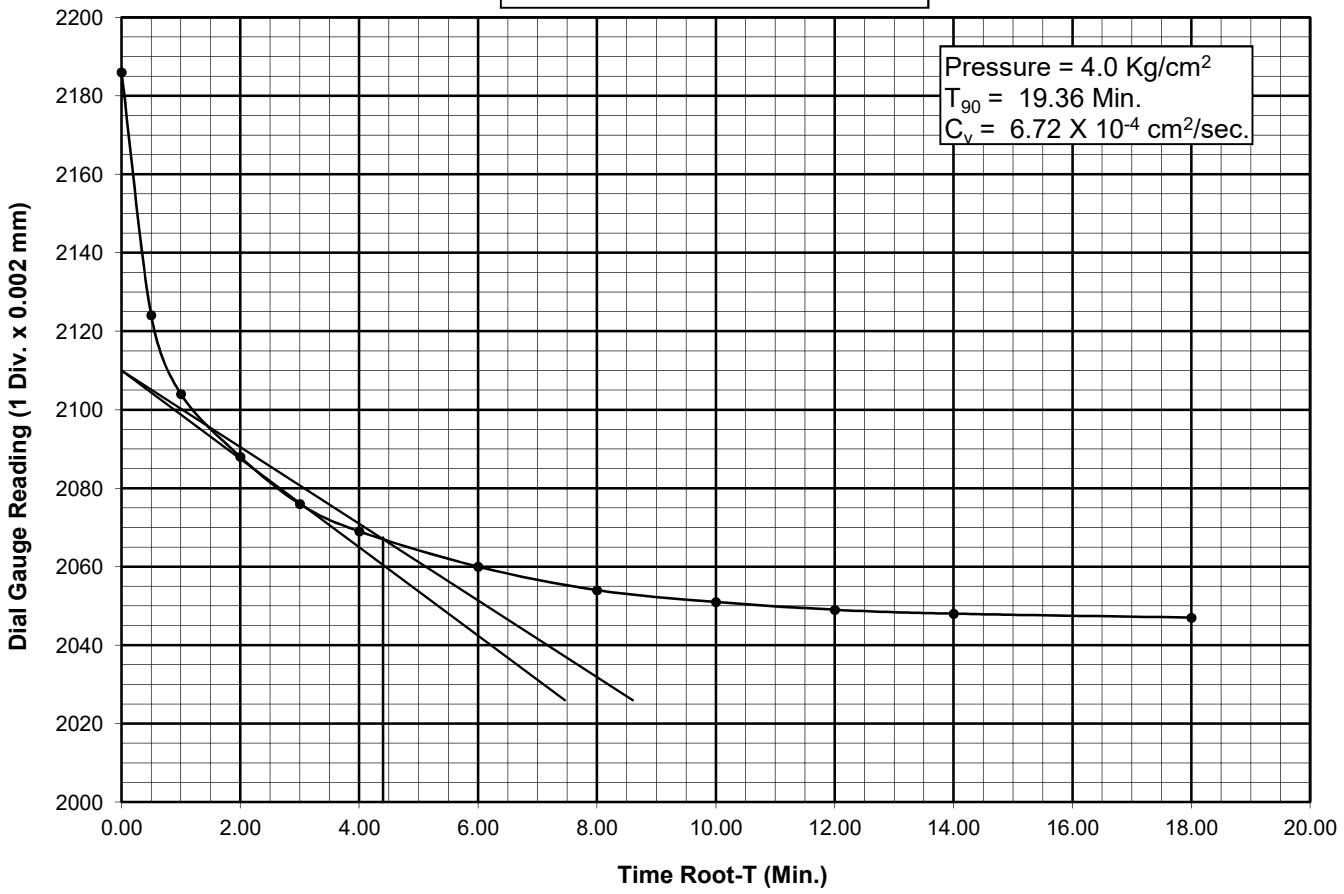


Figure No. -

BORE HOLE NO. = BH-A2
CHAINAGE = 1+500
SAMPLE NO. = UDS-02
DEPTH = 4.00 M



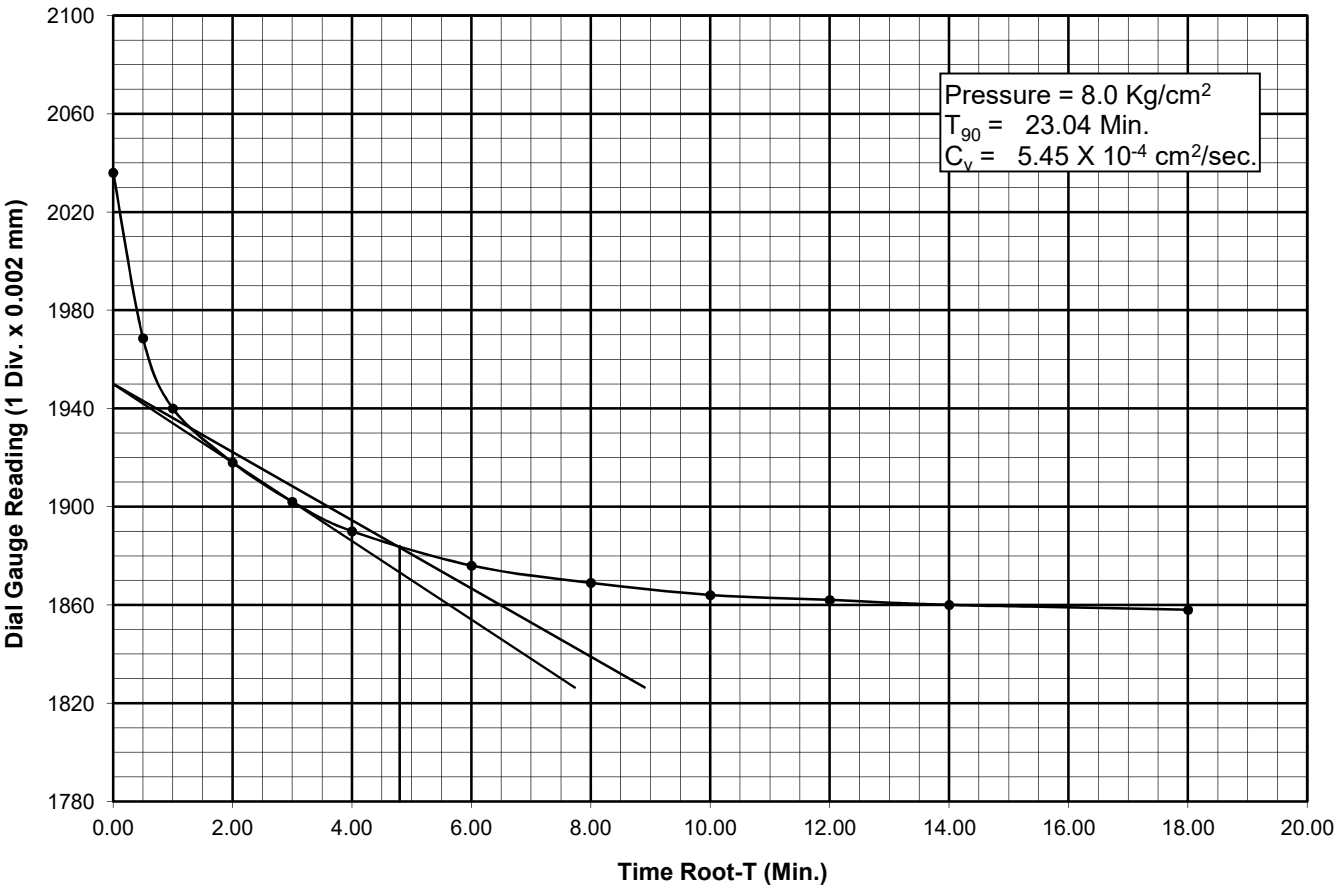
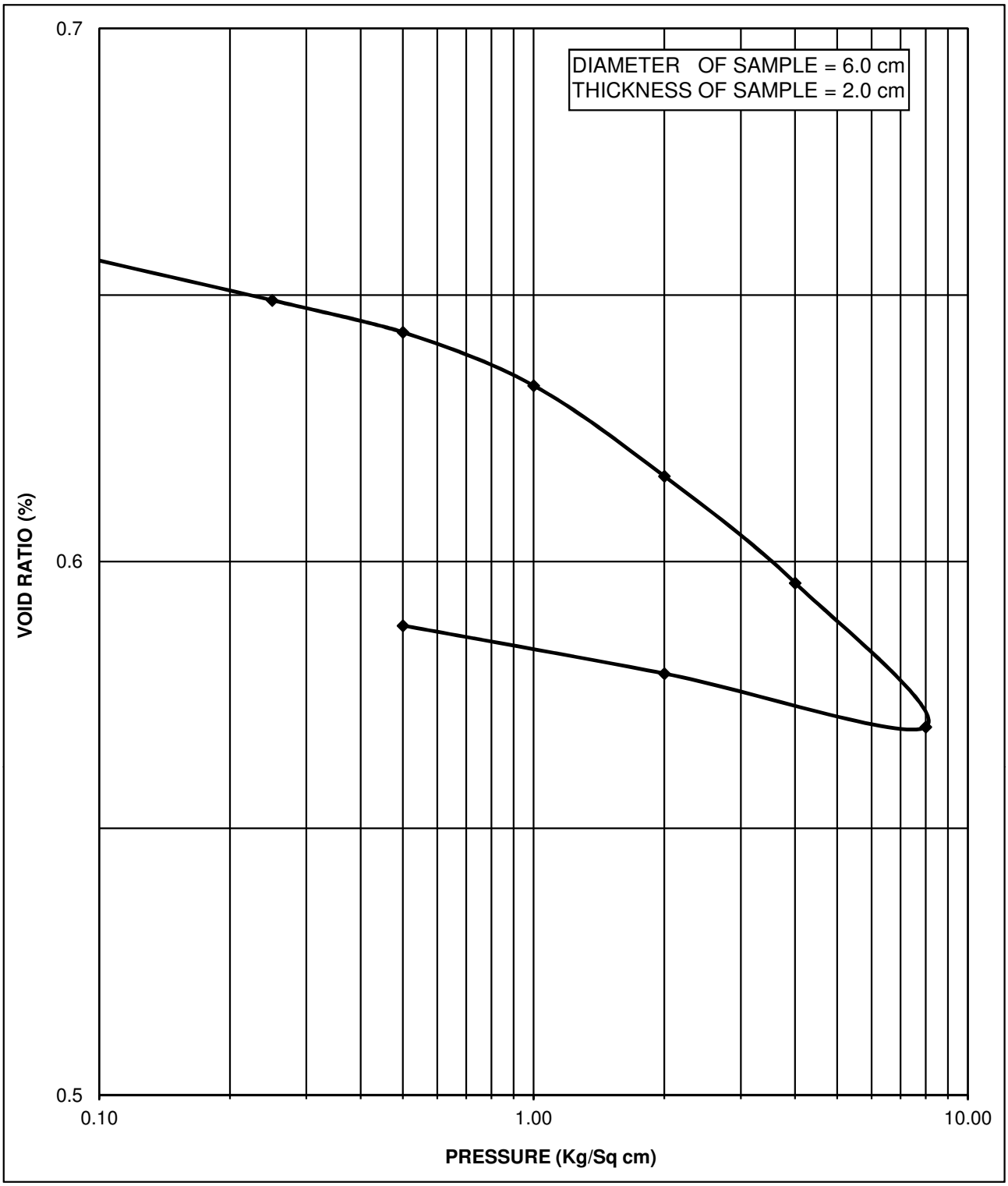


Figure No. -



BORE HOLE NO. = BH-A2

CHAINAGE = 1+500

SAMPLE NO. = UDS-03

DEPTH = 7.50 M

TYPY OF SOIL = CL

INITIAL WATER CONTENT = 23.44 %

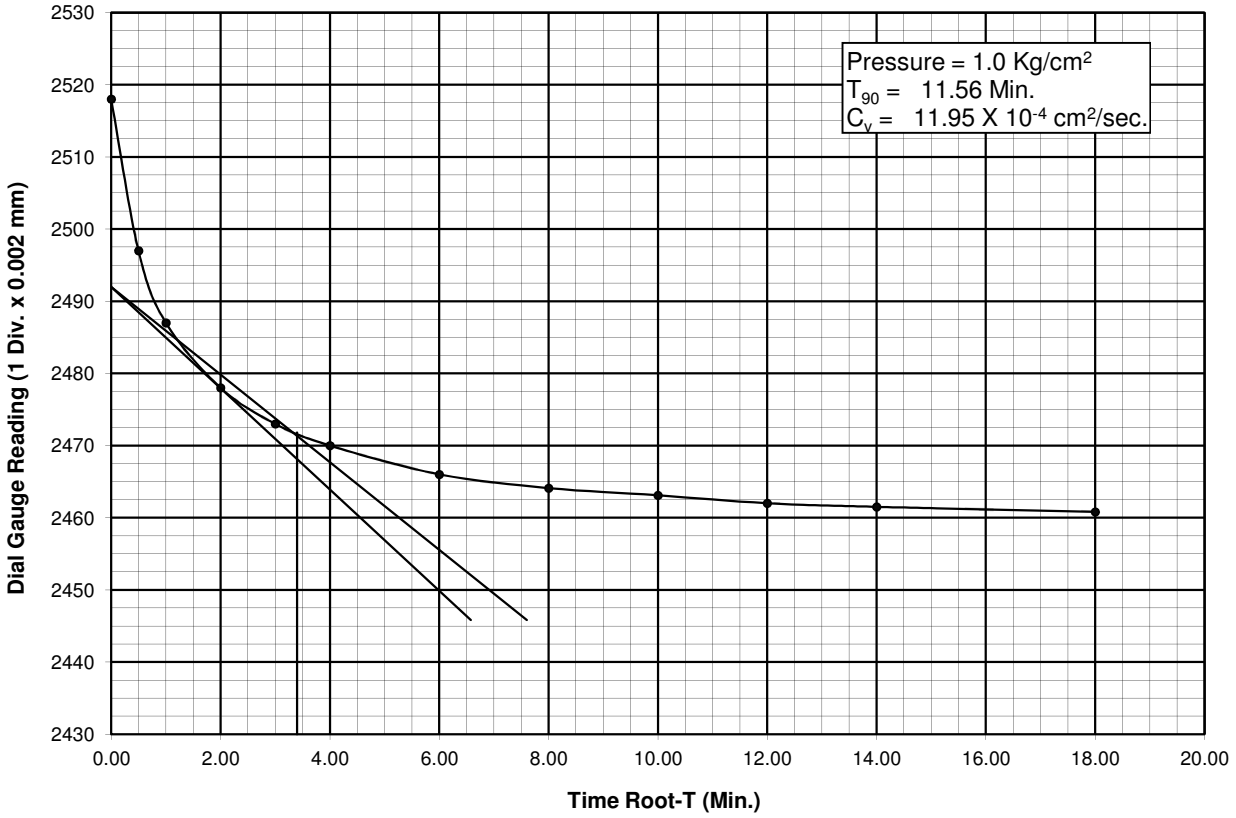
DRY DENSITY = 1.62 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESIVE INDEX (C_c) = 0.090

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO.	=	BH-A2
CHAINAGE	=	1+500
SAMPLE NO.	=	UDS-2
DEPTH	=	7.00 M



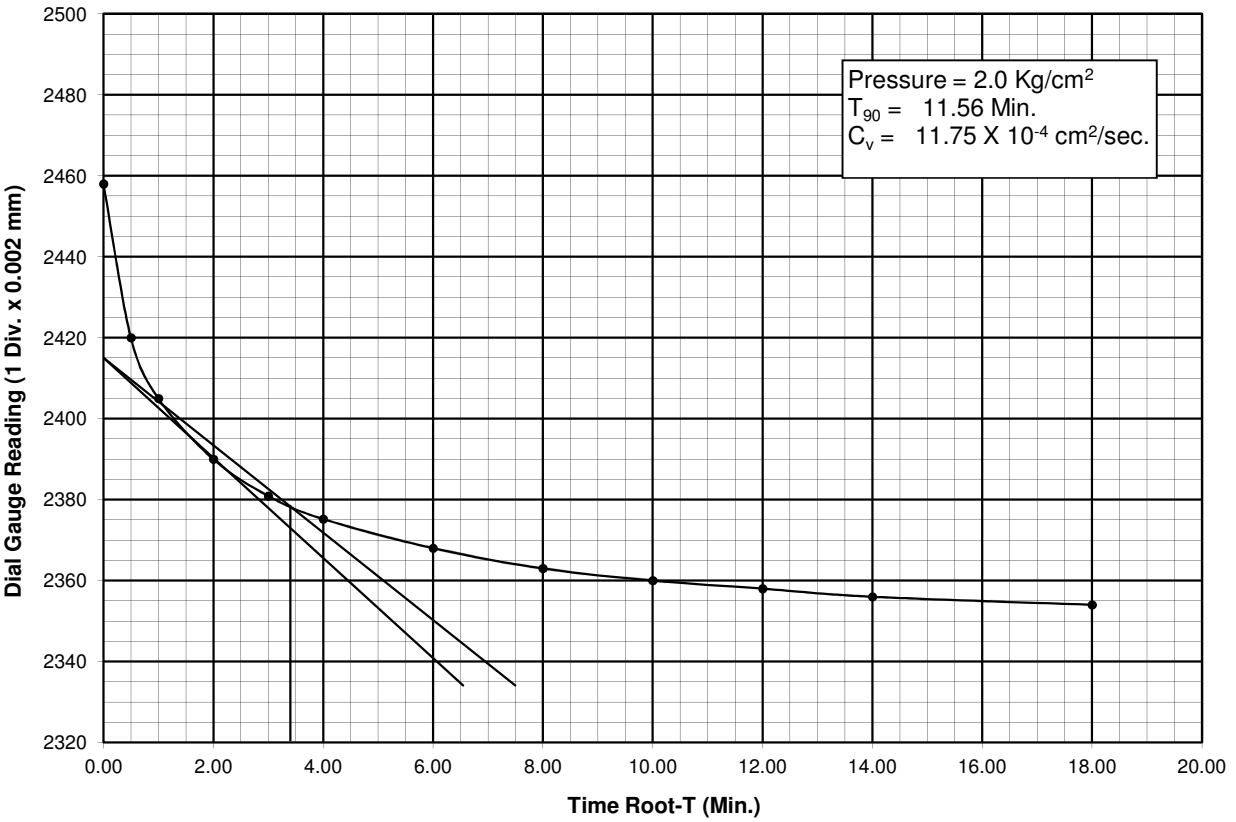
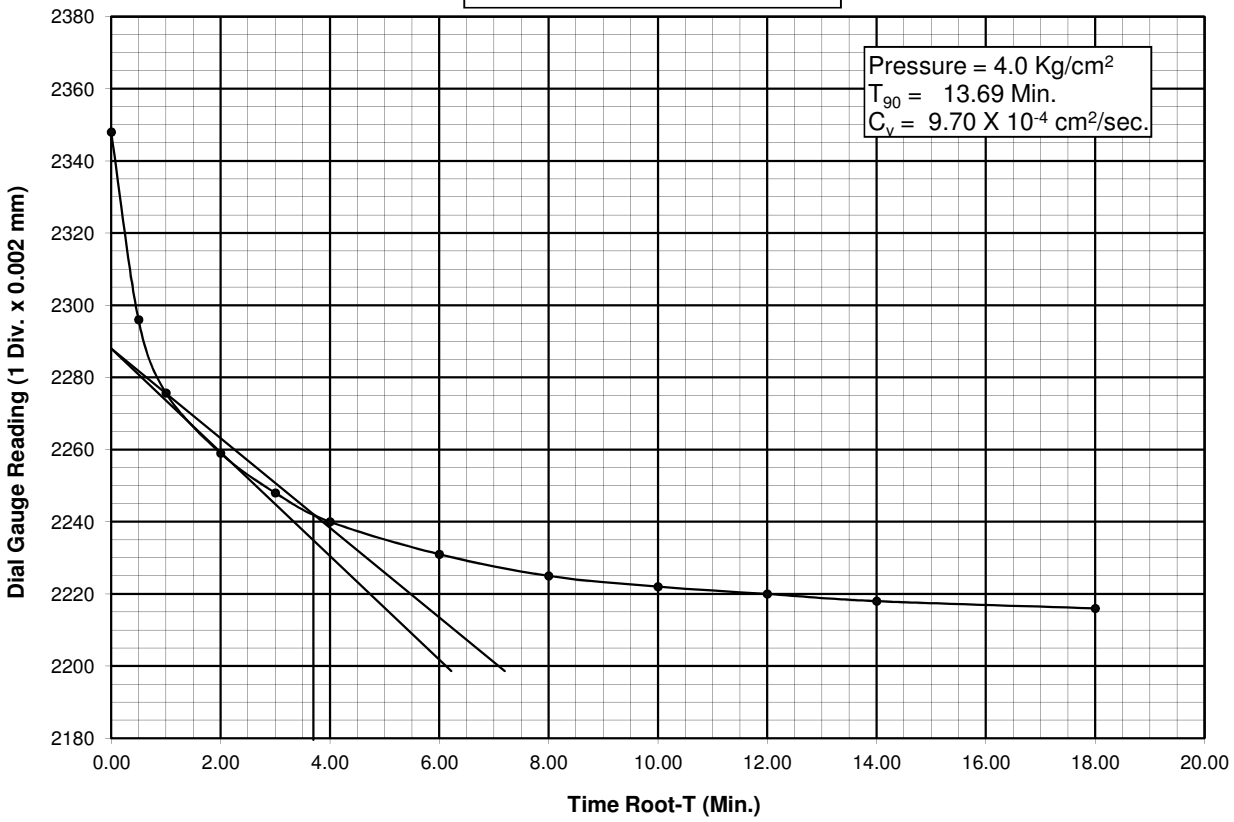


Figure No. -

BORE HOLE NO. = BH-A2
CHAINAGE = 1+500
SAMPLE NO. = UDS-2
DEPTH = 7.00 M



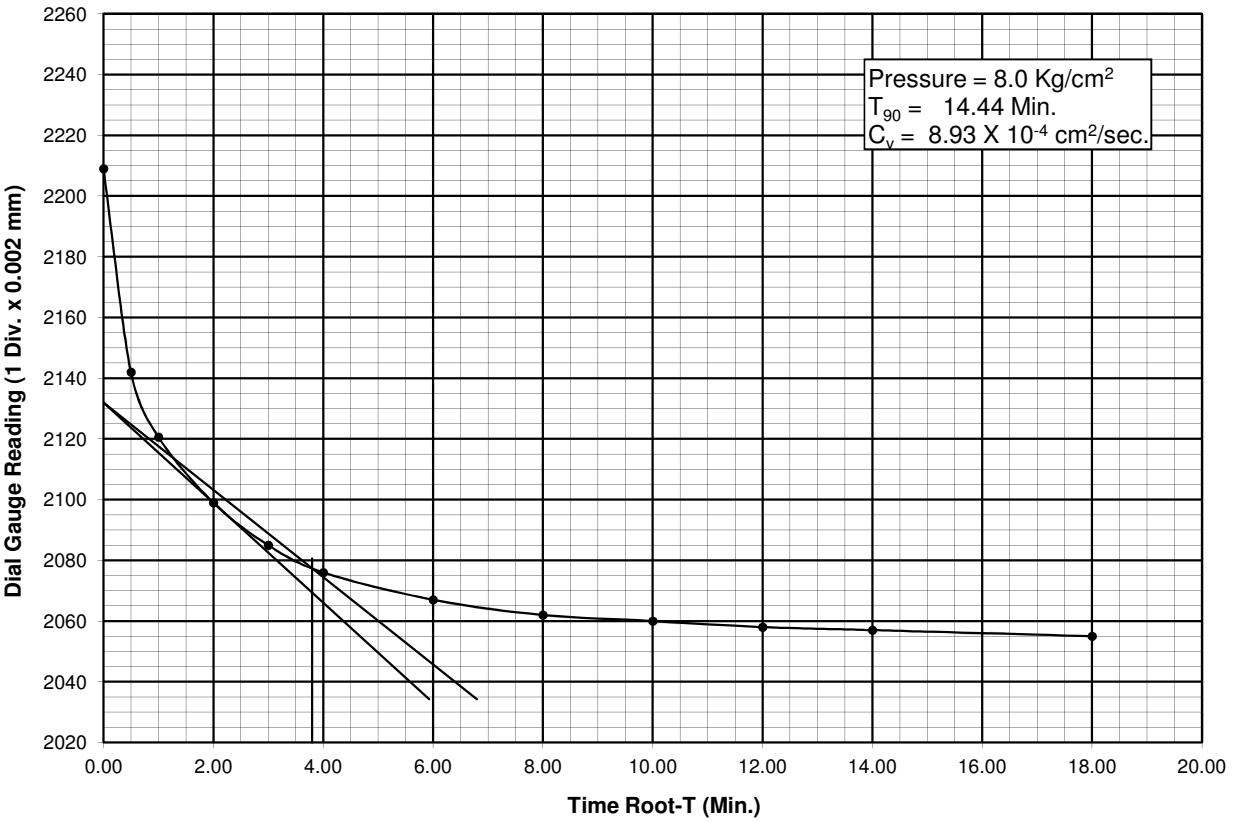


Figure No. -

APPENDIX – C
(ANALYSIS & RECOMENDATION)

Appendix No.	ITEMS
C-1	SAMPLE CALCULATION SHEET OF LIQUEFACTION ANALYSIS RESULTS
C-2	SAMPLE CALCULATIONS FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR SHALLOW 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

Liquefaction Analysis as per 2. IS code1893 Part I: 2016, IRC:75-2015 & RDSO BS-118

Chainage (Km)	(-)2+514	BH No.:-	BH-CL	Liquefiable upto=	NL		Water Table depth considered for analysis (m):-	0.00

Depth Below G.L. (z) in m	Observed SPT Value	Saturated Density (t/m^3)	Submerged Density (t/m^3)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Moisture Content @ 100% saturation	Strata Type	Liquefaction Check for Cohesive Strata	Fine Content (%)	Stress Reduction Coefficient (rd)	Total Overburden Press (σ_o), t/m^2	Effective Overburden (σ'_o), t/m^2	Critical Stress Ratio (CSR)	C_{60}	Stress Normalization Factor(C_N)	SPT Corrected $(N1)_{60}$	α	β	$(N1)_{60CS}$	$CRR_{M=7.5}$	K_M	Kα	Kσ	CRR_{Mw}	FOS	Conclusion
2.50	13	1.95	1.95	27.00	20.00	7.00	27.77	Cohesive	Liquefiable	59	0.981	4.50	2.00	0.344	1.000	1.70	22.1	5.00	1.20	31.52	NA	1.19	1	1.00	NA	>1	Non Liquefiable
5.50	28	1.98	1.98					Cohesionless		19	0.958	10.36	7.86	0.197	1.000	1.12	31.3	3.43	1.07	36.97	NA	1.19	1	1.00	NA	>1	Non Liquefiable
10.00	46	1.99	0.99					Cohesionless		21	0.907	19.29	16.79	0.163	1.000	0.76	35.1	3.78	1.09	41.95	NA	1.19	1	1.00	NA	>1	Non Liquefiable

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- (-)1+969

BH NO. :- BH-CL

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	26.00
Cohesion (c in t/m^2)	1.80
Void ratio (e), e = (G.γ_w/γ_d)-1	0.77
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.70
Depth of water table(m)	4.50
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	1.00	4.80
2	2.00	4.80
3	3.00	4.80

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	26.00	ϕ'	18.10
N_c	22.25	N'_c	13.18
N_q	11.85	N'_q	5.31
N_γ	12.54	N'_γ	4.12

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	4.80	1.30	1.20	0.80
2	4.80	1.30	1.20	0.80
3	4.80	1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.00	4.80	1.07	1.03	1.03
2	2.00	4.80	1.13	1.07	1.07
3	3.00	4.80	1.20	1.10	1.10
			#VALUE!	#VALUE!	#VALUE!
			#VALUE!	#VALUE!	#VALUE!
			#VALUE!	#VALUE!	#VALUE!

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1- \alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.00	4.80	0.73	0.86
2	2.00	4.80	0.52	0.76
3	3.00	4.80	0.31	0.66
			#VALUE!	#VALUE!
			#VALUE!	#VALUE!
			#VALUE!	#VALUE!

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	1.00	4.80	45.98	17.21	17.21
2	2.00	4.80	55.76	21.18	21.18
3	3.00	4.80	66.02	25.34	25.34

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): (-)1+969						BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/kg)	Consolidation Settlement (mm)	Water Table Correction Factor	Modulus of Soil (Kg/Cm^2)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	4.00	3.00				3.00	4.80	4.800	1.169	14			0.50	145	0.30	25.00	19.28	19.28			
Layer 2		4.00	8.20	4.20				4.20	9.900	9.900	0.275	22	0.0061	6.99	0.50	84	0.45			6.99			
	1.00				1.17	4.80	4.80														0.95	1.00	25.00
Layer 1		2.00	4.00	2.00				2.00	4.80	4.800	1.395	14			0.50	145	0.30	25.00	16.68	16.68			
Layer 2		4.00	8.50	4.50				4.50	9.050	9.050	0.392	22	0.0061	10.70	0.50	84	0.45			10.70			
Layer 3		8.50	9.20	0.70				0.70	11.300	11.300	0.252	22			0.50	92.5	0.30	13.80	0.56	1.02			
	2.00				1.39	4.80	4.80														0.88	1.00	25.00
Layer 1		3.00	4.00	1.00				1.00	4.80	4.800	1.697	14			0.50	145	0.30	25.00	10.96	10.96			
Layer 2		4.00	8.50	4.50				4.50	8.050	8.050	0.603	22	0.0061	16.45	0.50	84	0.45			16.45			
Layer 3		8.50	10.20	1.70				1.70	10.300	10.300	0.368	22			0.50	92.5	0.30	13.80	2.11	3.33			
	3.00				1.70	4.80	4.80														0.81	1.00	25.00

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): (-)1+969						BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/kg)	Consolidation Settlement (mm)	Water Table Correction Factor	Modulus of Soil (Kg/Cm^2)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	4.00	3.00				3.00	4.80	4.800	2.337	14			0.50	145	0.30	25.00	38.55	38.55			
Layer 2		4.00	8.20	4.20				4.20	9.900	9.900	0.549	22	0.0061	13.99	0.50	84	0.45			13.99			
	1.00				2.34	4.80	4.80														0.95	1.00	50.00
Layer 1		2.00	4.00	2.00				2.00	4.80	4.800	2.790	14			0.50	145	0.30	25.00	33.36	33.36			
Layer 2		4.00	8.50	4.50				4.50	9.050	9.050	0.785	22	0.0061	21.40	0.50	84	0.45			21.40			
Layer 3		8.50	9.20	0.70				0.70	11.300	11.300	0.503	22			0.50	92.5	0.30	13.80	1.12	2.04			
	2.00				2.79	4.80	4.80														0.88	1.00	50.00
Layer 1		3.00	4.00	1.00				1.00	4.80	4.800	3.393	14			0.50	145	0.30	25.00	21.93	21.93			
Layer 2		4.00	8.50	4.50				4.50	8.050	8.050	1.206	22	0.0061	32.90	0.50	84	0.45			32.90			
Layer 3		8.50	10.20	1.70				1.70	10.300	10.300	0.737	22			0.50	92.5	0.30	13.80	4.23	6.66			
	3.00				3.39	4.80	4.80														0.81	1.00	50.00

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- (-)1+969

BH NO. :- BH-CL

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	26.00
Cohesion (c in t/m^2)	1.80
Void ratio (e), e = (G.γ_w/γ_d)-1	0.77
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.70
Depth of water table(m)	4.50
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	1.00	4.80
2	2.00	4.80
3	3.00	4.80

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	26.00	ϕ'	18.10
N_c	22.25	N'_c	13.18
N_q	11.85	N'_q	5.31
N_γ	12.54	N'_γ	4.12

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	4.80	1.30	1.20	0.80
2	4.80	1.30	1.20	0.80
3	4.80	1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.00	4.80	1.07	1.03	1.03
2	2.00	4.80	1.13	1.07	1.07
3	3.00	4.80	1.20	1.10	1.10

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1-\alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.00	4.80	0.73	0.86
2	2.00	4.80	0.52	0.76
3	3.00	4.80	0.31	0.66

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	1.00	4.80	45.98	17.21	17.21
2	2.00	4.80	55.76	21.18	21.18
3	3.00	4.80	66.02	25.34	25.34

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): (-)1+969						BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/kg)	Consolidation Settlement (mm)	Water Table Correction Factor	Modulus of Soil (Kg/Cm^2)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	4.00	3.00				3.00	4.80	4.800	1.945	25			0.50	200	0.30	11.40	14.63	14.63			
Layer 2		4.00	8.20	4.20				4.20	9.900	9.900	0.457	22	0.0061	11.64	0.50	84	0.45			11.64			
	1.00				1.95	4.80	4.80														0.95	1.00	25.00
Layer 1		2.00	4.00	2.00				2.00	4.80	4.800	2.099	25			0.50	200	0.30	11.40	11.45	11.45			
Layer 2		4.00	8.50	4.50				4.50	9.050	9.050	0.591	22	0.0061	16.11	0.50	84	0.45			16.11			
Layer 3		8.50	9.20	0.70				0.70	11.300	11.300	0.379	22			0.50	92.5	0.30	13.80	0.85	0.85			
	2.00				2.10	4.80	4.80														0.88	1.00	25.00
Layer 1		3.00	4.00	1.00				1.00	4.80	4.800	2.214	25			0.50	200	0.30	11.40	6.52	6.52			
Layer 2		4.00	8.50	4.50				4.50	8.050	8.050	0.787	22	0.0061	21.47	0.50	84	0.45			21.47			
Layer 3		8.50	10.20	1.70				1.70	10.300	10.300	0.481	22			0.50	92.5	0.30	13.80	2.76	2.76			
	3.00				2.21	4.80	4.80														0.81	1.00	25.00

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): (-)1+969						BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/kg)	Consolidation Settlement (mm)	Water Table Correction Factor	Modulus of Soil (Kg/Cm^2)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	4.00	3.00				3.00	4.80	4.800	3.890	25			0.50	200	0.30	11.40	29.26	29.26			
Layer 2		4.00	8.20	4.20				4.20	9.900	9.900	0.915	22	0.0061	23.28	0.50	84	0.45			23.28			
	1.00				3.89	4.80	4.80														0.95	1.00	50.00
Layer 1		2.00	4.00	2.00				2.00	4.80	4.800	4.198	25			0.50	200	0.30	11.40	22.90	22.90			
Layer 2		4.00	8.50	4.50				4.50	9.050	9.050	1.181	22	0.0061	32.21	0.50	84	0.45			32.21			
Layer 3		8.50	9.20	0.70				0.70	11.300	11.300	0.758	22			0.50	92.5	0.30	13.80	1.69	1.69			
	2.00				4.20	4.80	4.80														0.88	1.00	50.00
Layer 1		3.00	4.00	1.00				1.00	4.80	4.800	4.427	25			0.50	200	0.30	11.40	13.05	13.05			
Layer 2		4.00	8.50	4.50				4.50	8.050	8.050	1.574	22	0.0061	42.93	0.50	84	0.45			42.93			
Layer 3		8.50	10.20	1.70				1.70	10.300	10.300	0.962	22			0.50	92.5	0.30	13.80	5.52	5.52			
	3.00				4.43	4.80	4.80														0.81	1.00	50.00

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 20.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.71	200	0.17											
1.00		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								314.29		25.38	
1.00		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								314.29		53.57	
1.00		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								314.29		121.76	
1.00		14.50	15.00	1.02	5	1.00	0.43	0.99	50	1.34								314.29		8.75	
1.00		15.00	19.00	1.02	5	1.00	0.43	0.99	400	1.37								314.29		70.30	
1.00		19.00	22.00	0.21	28	1.00	1.00	0.95	300	1.37	1.37	0.95	0.21	28	9	15.50	16.72	314.29	7857.14	88.49	187.82
																				368.25	187.82

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (368.25 + 187.82) / 2.5 Qa,uplift = 368.25 / 3 + 39.27

Qa,comp.= 222.43 T Qa,uplift = 162.02 T

Say **Qa,comp.= 222.00 T** **Qa,uplift = 162.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.71	200	0.17											
1.00		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								314.29		25.38	
1.00		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								314.29		53.57	
1.00		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								314.29		121.76	
1.00		14.50	15.00	1.02	5	1.00	0.43	0.99	50	1.34								314.29		8.75	
1.00		15.00	19.00	1.02	5	1.00	0.43	0.99	400	1.37								314.29		70.30	
1.00		19.00	24.00	0.21	28	1.00	1.00	0.95	500	1.37	1.37	1.01	1.75	4	9	1.43	0.34	314.29	7857.14	147.48	139.30
																				427.24	139.30

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (427.24 + 139.3) / 2.5 Qa,uplift = 427.24 / 3 + 43.2

Qa,comp.= 226.62 T Qa,uplift = 185.61 T

Say **Qa,comp.= 226.00 T** **Qa,uplift = 185.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.71	200	0.17											
1.00		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								314.29		25.38	
1.00		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								314.29		53.57	
1.00		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								314.29		121.76	
1.00		14.50	15.00	1.02	5	1.00	0.43	0.99	50	1.34								314.29		8.75	
1.00		15.00	19.00	1.02	5	1.00	0.43	0.99	400	1.37								314.29		70.30	
1.00		19.00	25.00	0.21	28	1.00	1.00	0.95	600	1.37								314.29		176.98	
1.00		25.00	26.00	1.75	4	1.00	0.26	1.01	100	1.37	1.37	1.01	1.75	4	9	1.43	0.34	314.29	7857.14	17.31	139.30
																				474.05	139.30

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (474.05 + 139.3) / 2.5 Qa,uplift = 474.05 / 3 + 47.12

Qa,comp.= 245.34 T Qa,uplift = 205.14 T

Say **Qa,comp.= 245.00 T** **Qa,uplift = 205.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.71	200	0.17											
1.00		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								314.29		25.38	
1.00		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								314.29		53.57	
1.00		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								314.29		121.76	
1.00		14.50	15.00	1.02	5	1.00	0.43	0.99	50	1.34								314.29		8.75	
1.00		15.00	19.00	1.02	5	1.00	0.43	0.99	400	1.37								314.29		70.30	
1.00		19.00	25.00	0.21	28	1.00	1.00	0.95	600	1.37								314.29		176.98	
1.00		25.00	28.00	1.75	4	1.00	0.26	1.01	300	1.37	1.37	1.01	1.75	4	9	1.43	0.34	314.29	7857.14	51.93	139.30
																				508.67	139.30

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (508.67 + 139.3) / 2.5 Qa,uplift = 508.67 / 3 + 51.05

Qa,comp.= 259.19 T Qa,uplift = 220.61 T

Say **Qa,comp.= 259.00 T** **Qa,uplift = 220.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.71	200	0.17											
1.00		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								314.29		25.38	
1.00		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								314.29		53.57	
1.00		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								314.29		121.76	
1.00		14.50	15.00	1.02	5	1.00	0.43	0.99	50	1.34								314.29		8.75	
1.00		15.00	19.00	1.02	5	1.00	0.43	0.99	400	1.37								314.29		70.30	
1.00		19.00	25.00	0.21	28	1.00	1.00	0.95	600	1.37								314.29		176.98	
1.00		25.00	29.50	1.75	4	1.00	0.26	1.01	450	1.37								314.29		77.90	
1.00		29.50	30.00	2.46	4	1.00	0.26	1.04	50	1.37	1.37	1.01	1.75	4	9	1.43	0.34	314.29	7857.14	11.56	139.30
																				546.20	139.30

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (546.2 + 139.3) / 2.5 Qa,uplift = 546.2 / 3 + 54.98

Qa,comp.= 274.20 T Qa,uplift = 237.04 T

Say **Qa,comp.= 274.00 T** **Qa,uplift = 237.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 30.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.71	200	0.17											
1.00		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								314.29		25.38	
1.00		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								314.29		53.57	
1.00		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								314.29		121.76	
1.00		14.50	15.00	1.02	5	1.00	0.43	0.99	50	1.34								314.29		8.75	
1.00		15.00	19.00	1.02	5	1.00	0.43	0.99	400	1.37								314.29		70.30	
1.00		19.00	25.00	0.21	28	1.00	1.00	0.95	600	1.37								314.29		176.98	
1.00		25.00	29.50	1.75	4	1.00	0.26	1.01	450	1.37								314.29		77.90	
1.00		29.50	32.00	2.46	4	1.00	0.26	1.04	250	1.37	1.37	1.04	2.46	4	9	1.43	0.34	314.29	7857.14	57.78	189.51
																				592.42	189.51

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (592.42 + 189.51) / 2.5 Qa,uplift = 592.42 / 3 + 58.9

Qa,comp.= 312.77 T Qa,uplift = 256.38 T

Say **Qa,comp.= 312.00 T** **Qa,uplift = 256.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 20.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.71	200	0.17											
1.20		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								377.14		30.46	
1.20		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								377.14		64.28	
1.20		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								377.14		146.11	
1.20		14.50	18.00	1.02	5	1.00	0.43	0.99	350	1.49								377.14		75.24	
1.20		18.00	19.00	1.02	5	1.00	0.43	0.99	100	1.67								377.14		22.07	
1.20		19.00	22.00	0.21	28	1.00	1.00	0.95	300	1.67	1.67	1.01	1.75	4	9	1.43	0.34	377.14	11314.29	124.01	205.43
																				462.17	205.43

Qu,comp.= qs + Qp

Qa,comp.= (462.17 + 205.43) / 2.5

Qa,comp.= 267.04 T

Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,uplift = 462.17 / 3 + 56.55

Qa,uplift = 210.61 T

Say **Qa,comp.= 267.00 T** **Qa,uplift = 210.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.71	200	0.17											
1.20		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								377.14		30.46	
1.20		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								377.14		64.28	
1.20		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								377.14		146.11	
1.20		14.50	18.00	1.02	5	1.00	0.43	0.99	350	1.49								377.14		75.24	
1.20		18.00	19.00	1.02	5	1.00	0.43	0.99	100	1.67								377.14		22.07	
1.20		19.00	24.00	0.21	28	1.00	1.00	0.95	500	1.67	1.67	1.01	1.75	4	9	1.43	0.34	377.14	11314.29	206.69	205.43
																				544.85	205.43

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (544.85 + 205.43) / 2.5 Qa,uplift = 544.85 / 3 + 62.2

Qa,comp.= 300.11 T Qa,uplift = 243.82 T

Say **Qa,comp.= 300.00 T** **Qa,uplift = 243.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.71	200	0.17											
1.20		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								377.14		30.46	
1.20		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								377.14		64.28	
1.20		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								377.14		146.11	
1.20		14.50	18.00	1.02	5	1.00	0.43	0.99	350	1.49								377.14		75.24	
1.20		18.00	19.00	1.02	5	1.00	0.43	0.99	100	1.67								377.14		22.07	
1.20		19.00	25.00	0.21	28	1.00	1.00	0.95	600	1.67								377.14		248.03	
1.20		25.00	26.00	1.75	4	1.00	0.26	1.01	100	1.67	1.67	1.01	1.75	4	9	1.43	0.34	377.14	11314.29	21.55	205.43
																				607.74	205.43

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (607.74 + 205.43) / 2.5 Qa,uplift = 607.74 / 3 + 67.86

Qa,comp.= 325.27 T Qa,uplift = 270.44 T

Say **Qa,comp.= 325.00 T** **Qa,uplift = 270.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.71	200	0.17											
1.20		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								377.14		30.46	
1.20		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								377.14		64.28	
1.20		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								377.14		146.11	
1.20		14.50	18.00	1.02	5	1.00	0.43	0.99	350	1.49								377.14		75.24	
1.20		18.00	19.00	1.02	5	1.00	0.43	0.99	100	1.67								377.14		22.07	
1.20		19.00	25.00	0.21	28	1.00	1.00	0.95	600	1.67								377.14		248.03	
1.20		25.00	28.00	1.75	4	1.00	0.26	1.01	300	1.67	1.67	1.01	1.75	4	9	1.43	0.34	377.14	11314.29	64.66	205.43
																				650.85	205.43

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (650.85 + 205.43) / 2.5 Qa,uplift = 650.85 / 3 + 73.51

Qa,comp.= 342.51 T Qa,uplift = 290.46 T

Say **Qa,comp.= 342.00 T** **Qa,uplift = 290.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.71	200	0.17											
1.20		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								377.14		30.46	
1.20		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								377.14		64.28	
1.20		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								377.14		146.11	
1.20		14.50	18.00	1.02	5	1.00	0.43	0.99	350	1.49								377.14		75.24	
1.20		18.00	19.00	1.02	5	1.00	0.43	0.99	100	1.67								377.14		22.07	
1.20		19.00	25.00	0.21	28	1.00	1.00	0.95	600	1.67								377.14		248.03	
1.20		25.00	29.50	1.75	4	1.00	0.26	1.01	450	1.67								377.14		97.00	
1.20		29.50	30.00	2.46	4	1.00	0.26	1.04	50	1.67	1.67	1.01	1.75	4	9	1.43	0.34	377.14	11314.29	14.26	205.43
																				697.44	205.43

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (697.44 + 205.43) / 2.5 Qa,uplift = 697.44 / 3 + 79.17

Qa,comp.= 361.15 T Qa,uplift = 311.65 T

Say **Qa,comp.= 361.00 T** **Qa,uplift = 311.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana".

Length of Pile below cut of level = 30.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** (-)1+500 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 2.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.71	200	0.17											
1.20		2.00	4.00	0.22	24	1.00	1.00	0.71	200	0.41								377.14		30.46	
1.20		4.00	8.50	0.00	30	1.00	1.00	0.77	450	0.66								377.14		64.28	
1.20		8.50	14.50	0.00	31	1.00	1.00	0.82	600	1.07								377.14		146.11	
1.20		14.50	18.00	1.02	5	1.00	0.43	0.99	350	1.49								377.14		75.24	
1.20		18.00	19.00	1.02	5	1.00	0.43	0.99	100	1.67								377.14		22.07	
1.20		19.00	25.00	0.21	28	1.00	1.00	0.95	600	1.67								377.14		248.03	
1.20		25.00	29.50	1.75	4	1.00	0.26	1.01	450	1.67								377.14		97.00	
1.20		29.50	32.00	2.46	4	1.00	0.26	1.04	250	1.67	1.67	1.04	2.46	4	9	1.43	0.34	377.14	11314.29	71.29	277.73
																				754.47	277.73

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (754.47 + 277.73) / 2.5 Qa,uplift = 754.47 / 3 + 84.82

Qa,comp.= 412.88 T Qa,uplift = 336.31 T

Say **Qa,comp.= 412.00 T** **Qa,uplift = 336.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

Lateral Load capacity of Pile

BH-A1

(-)1 +500

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 20.000 m **Fck = 35.0 N/mm^2** **D = 100 cm**

Pile cap bottom level -2.0 m

Max. of Liquefaction & Scour Depth -2.0 m

E = Young's Modulus of Pile (Kg/cm^2)	=	$5000\sqrt{F_{ck}}$	N/mm^2	=	295803.99	Kg/cm^2	
I = Moment of Inertia (cm^2)	=	$\pi xD^4/64$		=	4908738.5	cm^4	
K_1 = Constant for Sandy / Normally Consolidated Clay		(Kg/cm^3)		=	**0.284**		
T, Relative stiffness factor in Sand		$T = \sqrt[5]{EI/K_1}$		=	**348.1**	cm	

For Long Pile If $L_e > 4T$

L1 =				=	**0.000**	cm
L_1/T				=	0.00	

For Fixed Head Pile

L_f/T				=	**2.219**	From Fig. 4
Lf				=	772.48	cm
Equivalent length of cantilever	L= L1+L_F: 0.00	+	772.48209	=	**772.48**	cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\,EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection .5 cm	Q			=	18899.92	Kg
				=	**18.90**	**T**
			Say		**18.0**	**T**

Lateral Load capacity of Pile

BH-A1

(-)1 +500

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 20.000 m **Fck = 35.0 N/mm^2** **D = 120 cm**

Pile cap bottom level -2.0 m

Max. of Liquefaction & Scour Depth -2.0 m

E = Young's Modulus of Pile (Kg/cm^2)	=	$5000\sqrt{F_{ck}}$	N/mm^2	=	295803.99	Kg/cm^2	
I = Moment of Inertia (cm^2)	=	$\pi xD^4/64$		=	10178760.2	cm^4	
K_1 = Constant for Sandy / Normally Consolidated Clay		(Kg/cm^3)		=	**0.284**		
T, Relative stiffness factor in Sand		$T = \sqrt[5]{EI/K_1}$		=	**402.8**	cm	

For Long Pile If $L_e > 4T$

L1 =				=	**0.000**	cm
L_1/T				=	0.00	

For Fixed Head Pile

L_f/T				=	**2.219**	From Fig. 4
Lf				=	893.79	cm
Equivalent length of cantilever	L= L1+L_F: 0.00	+	893.78573	=	**893.79**	cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\,EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection .5 cm	Q	=	25301.71	Kg	
		=	**25.30**	**T**	
		Say	**25.0**	**T**	

PART-B (Main Line)
Old Ch. 17+625 to Old Ch. 20+300
(New Ch: 18+310 to 20+985)

Geotechnical Investigation Report

PACKAGE-C5

New Ch. 0+000 to Old Ch. 10+859 (New Ch: 11+543) &
Old Ch. 17+625 to Old Ch. 20+300 (New Ch: 18+310 to 20+985) &
Connecting Line from Prithala to New Prithla

PART-B

New Ch. 0+000 to Old Ch. 10+859 (New Ch: 11+543) &
Old Ch. 17+625 to Old Ch. 20+300 (New Ch: 18+310 to 20+985)

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
FEBRUARY - 2023

SR. No.	Report No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/1629_(76 BHs)	01	17.03.2023
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/1476_(87 BHs)	00	08.02.2023

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

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CEGTH/HRIDCL/SR-544/2022-23/1629 Date:- 17.03.2023

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 76 boreholes carried out at New Ch. 0+000 to Old Ch. 10+859 (New Ch: 11+543) & Old Ch. 17+625 to Old Ch. 20+300 (New Ch: 18+310 to 20+985) 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:-

Nehal Jain
General Manager - Geotechnical
Authorized Signatory

Dr. Ankur Mudgal
Sr. Manager

Technical Advisor **Dr. Sarvesh Chandra**
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Former Professor, IIT Kanpur

SR. No.	Report Ref. No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/1629_(76 BHs)	01	17.03.2023
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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 New Ch. 0+000 to Old Ch. 10+859 (New Ch: 11+543) & Old Ch. 17+625 to Old Ch. 20+300 (New Ch: 18+310 to 20+985) based on soil sample collected from the locations of 76 boreholes.

2.0 SITE LOCATION & GENERAL GEOLOGICAL HISTORY:

The details of the site & test locations for the proposed project are shown in location plan attached vide **Appendix A-1**. The site of proposed project is located from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV (Zone factor=0.24) of India.

Soil of the Haryana Sub-Region have been classified and described under the following major soil types as shown below:-

- Typic Ustochrepts : Soil of old alluvial plains
- Typic Ustipsamments : Soil of Aravali plains
- Typic Ustifluvents : Soil of recent alluvial plains and flood plains
- Typic Torripsamments : Soil of Aeofluvial plains
- Rocky Outcrops : Aravali rocky hills

The district wise details of soil characteristics are described below:-

Panipat: The soils are well drained, Sandy loam to clay loam/silty clay loam in plains and loam to clay loam/ silty/ loose clay loam in relic channels/depressions/basins.

Sonipat: The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. Recent flood plains occur along the Yamuna River and clearly show fluvial features. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Rohtak: The district mainly comprises of old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface. Old meander plains are almost flat with loamy sand to silty clay loam soils. Oldest among all the land forms are old alluvial plains, which cover major areas in the district. These soils are sand to loamy sand/sandy loam (surface) to silt loam/silty clay loam (sub-surface).

Jhajjar: The district mainly comprises of old alluvial plains and some parts of the district also have soil belonging to Aravali plains.

Rewari: The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand.

Gurgaon: The district comprises of sand dunes, sandy plains, alluvial plains, salt affected areas,

low lands, lakes, hills and pediments. The soil varies from sand to loamy sand in sand dunes and sandy plain areas, sandy loam to clay loam / silty clay loam in alluvial plains, calcareous, loamy sand to loam in salt affected plains, silty loam to loam in low lands and calcareous, loamy sand to loam in hills.

Mewat: The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The upper hills are mostly barren.

Faridabad and Palwal: The district comprises of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam

(surface), clay loam/silty clay (sub-surface) in low lying plains and depressions.

3.0 SCOPE OF WORK:

The stipulated scope of work involved carrying out the following operations:-

a) Mobilisation of necessary plant equipment, men and materials for the complete Geotechnical investigation work as per specifications, drawings and instructions of the Engineer and to complete the same within the stipulated time schedule and demobilisation after completion of field work.

b) Shifting of Equipments from one structure location to another including Ereaction, installation of rigs at site and dismantling of the same after completion of field work. Shifting of setup for each borehole location and associated preparation for borehole under water

c) Making 150 mm nominal diameter boreholes at various locations in all types of soils except hard rock and large boulders using suitable approved method of boring including chiselling, cleaning, providing casing pipe as required; performing Standard Penetration Test at every 3.0m interval and at change of strata; collection of water samples and disturbed soil samples, observation such as ground water, etc., collection of undisturbed soil samples at every 3.0 m interval and at change of strata; transportation of all the collected samples to the laboratory and back filling of boreholes on completion of the same, complete as per specification and instructions of the Engineer, for depths below natural ground level.

d) Conducting Electrical resistivity tests at various locations all complete as per specification and directions of the Engineer.

e) Conducting plate load test at various locations, all complete as per specification and directions of the Engineer.

f) Drilling of Nx size boreholes (75mm dia.) in all types of hard rock, collection of core samples, maintaining continuous record of core recovery/ RQD, keeping the cores in wooden core boxes, transporting to laboratory, backfilling on completion of the same, all complete as per specification and instructions of the EIC.

g) Conducting various laboratory tests on soil samples at an approved laboratory including preparation of soil samples to determine the following properties of soil, all complete as per specification.

<u>On soil Samples</u>

- Dry density test
- Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- Liquid Limit and Plastic Limit
- Specific gravity
- Shrinkage Limit
- Free Swell Index
- Direct Shear Test
- Triaxial Shear Test

- One Dimensional consolidation test
- Chemical Analysis of soil samples (pH, chloride, Sulphate)

h) Conducting laboratory tests on rock samples including preparation of the samples to determine the following properties, all complete as per specification

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.

4.0 FIELD INVESTIGATION IN SOIL STRATA:

The investigation was planned to obtain the subsurface stratification in the proposed project site and collect soil / rock core samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum.

For geotechnical investigation work, required equipements along with rotary drilling rigs and manpower were mobilized at site to carry out various field activities as per the scope of work. These were shifted from one test location to another location during execution of field work and were demobilized on satisfactory completion of field work.

For conducting the field investigations the following practices were followed at site:

- The locations of 76 boreholes carried out at New Ch. 0+000 to Old Ch. 10+859 (New Ch: 11+543) & Old Ch. 17+625 to Old Ch. 20+300 (New Ch: 18+310 to 20+985) were marked at site at specified locations. These locations are shown in **Appendix-A1** attached subsequently.

The details of various boreholes along with their coordinates are provided herein below:

Table 1.1: Details of Borehole Locations

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
1.	-	0+000	BH-PLT-09	MNB	NE	12.00	720981.000	3126079.000	195.456
2.	(-)0+627	0+057	BH-CL	MNB	8.50	10.00	720920.890	3126081.947	196.408
3.	(-)0+529	0+158	BH-CL	MNB	8.15	10.00	720826.915	3126042.507	195.851
4.	(-)0+319	0+371	BH-CL	MNB	8.10	10.00	720635.657	3125962.572	197.352
5.	0+273	0+958	BH-CL	MNB	8.25	10.00	720089.535	3125734.325	195.008
6.	1+006	1+696	BH-A1	MJB	24.90	30.00	719415.302	3125461.869	202.730
7.			BH-A2	MJB	24.80	30.00	719396.820	3125454.226	203.271
8.	1+333	2+018	BH-CL	MNB	NE	10.00	719094.132	3125351.606	202.117
9.	1+811	2+493	BH-CL	MNB	9.10	10.00	718661.831	3125172.851	197.587
10.	2+472	3+160	BH-CL	MNB	7.50	10.00	718027.804	3124979.104	197.568
11.	2+788	3+476	BH-A1	MJB	18.24	30.00	717723.179	3124953.799	195.987
12.			BH-A2	MJB	17.68	30.00	717703.270	3124952.116	196.902
13.	3+497	4+242	BH-A1	MJB	16.25	40.00	717079.294	3124900.291	196.752
14.			BH-P1	MJB	15.32	40.00	717042.421	3124897.227	195.783
15.			BH-P2	MJB	15.30	40.00	717007.541	3124894.329	195.847
16.			BH-P3	MJB	15.31	40.00	716972.661	3124891.431	195.759
17.			BH-A2	MJB	15.30	40.00	716935.788	3124888.367	195.643
18.	3+691	4+376	BH-A1	MJB	15.40	30.00	716820.675	3124880.556	196.163
19.			BH-A2	MJB	15.25	30.00	716800.700	3124877.143	196.124
20.	4+174	4+858	BH-CL	MNB	NE	10.00	716335.062	3124838.454	196.256
21.	4+207	4+892	BH-CL	MNB	NE	10.00	716300.074	3124835.546	196.348
22.	4+655	5+340	BH-CL	MNB	NE	10.00	715855.211	3124798.666	200.573
23.	5+119	5+804	BH-CL	MNB	NE	10.00	715393.751	3124750.566	202.713
24.	5+730	6+415	BH-CL	MNB	NE	10.00	714786.103	3124685.263	198.287
25.	6+197	6+881	BH-CL	MNB	2.52	10.00	714320.102	3124636.752	198.287
26.	6+877	7+559	BH-CL	MNB	1.85	10.00	713641.709	3124570.057	196.702
27.	7+078	7+759	BH-A1	MJB	1.70	30.00	713455.570	3124551.638	195.221
28.			BH-A2	MJB	1.25	30.00	713435.595	3124549.896	194.815
29.	7+256	7+941	BH-CL	MNB	1.59	10.00	713264.533	3124532.969	193.947
30.	7+351	8+036	BH-A1	MJB	3.00	40.00	713206.080	3124525.765	194.037
31.			BH-P1	MJB	2.10	40.00	713171.257	3124522.342	196.827
32.	7+351	8+036	BH-A2	MJB	0.70	40.00	713136.399	3124522.342	193.680
33.	7+457	8+141	BH-CL	MNB	0.59	10.00	713067.448	3124513.592	193.671
34.	7+613	8+298	BH-A1	MJB	0.50	40.00	712928.250	3124499.906	195.453
35.			BH-A2	MJB	0.85	40.00	712897.399	3124496.873	193.923
36.	7+907	8+592	BH-CL	MNB	1.90	10.00	712620.430	3124469.642	193.872
37.	8+207	8+891	BH-CL	MNB	2.00	10.00	712317.987	3124437.243	193.686
38.	8+610	9+295	BH-CL	MNB	1.95	10.00	711923.004	3124401.078	194.123
39.	8+852	9+537	BH-A1	MJB	0.75	30.00	711688.170	3124377.983	193.689
40.			BH-A2	MJB	1.35	30.00	711664.484	3124375.655	194.209
41.	8+907	9+591	BH-CL	MNB	0.55	10.00	711623.253	3124371.601	193.708

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
42.	-	10+340	BH-PLT-08	MNB	4.03	12.00	711500.031	3124346.490	194.158
43.	9+200	9+882	BH-CL	MNB	1.25	10.00	711334.580	3124343.215	194.672
44.	9+211	9+894	BH-CL	MNB	1.36	10.00	711325.206	3124342.307	194.649
45.	9+407	10+091	BH-CL	MNB	0.60	10.00	711125.831	3124322.695	193.387
46.	9+726	10+410	BH-A1	MJB	0.85	30.00	710810.840	3124291.156	194.097
47.			BH-A2	MJB	0.29	30.00	710802.664	3124290.194	193.613
48.	9+772	10+457	BH-CL	MNB	0.60	12.00	710762.491	3124285.182	193.598
49.	10+025	10+709	BH-A1	MJB	1.34	30.00	710515.298	3124244.432	194.595
50.			BH-A2	MJB	1.22	30.00	710507.526	3124242.990	194.589
51.	10+223	10+908	BH-CL	MNB	3.50	10.00	710317.973	3124207.834	194.116
52.	10+519	11+203	BH-CL	MNB	4.50	10.00	710023.336	3124153.189	194.584
53.	10+658	11+340	BH-CL	MNB	3.20	10.00	709890.704	3124128.590	194.898
54.	10+718	11+403	BH-CL	MNB	2.50	10.00	709831.671	3124117.642	193.997
55.	10+749	11+434	BH-CL	MNB	2.60	10.00	709801.215	3124111.993	194.893
56.	10+859	11+543	BH-A1(R)	MJB	2.99	40.00	709761.805	3124103.149	195.206
57.			BH-A1	MJB	2.95	40.00	709723.114	3124097.508	194.772
58.			BH-P1	MJB	3.35	40.00	709681.945	3124089.603	195.316
59.			BH-A2	MJB	5.60	40.00	709602.681	3124072.923	195.247
60.	17+625	18+310	BH-A1	MJB	3.00	30.00	704882.319	3119823.851	191.597
61.			BH-A2	MJB	3.05	30.00	704873.896	3119805.101	191.814
62.	17+872	18+558	BH-A1	MJB	0.95	30.00	704759.612	3119597.349	191.318
63.			BH-A2	MJB	1.00	30.00	704753.576	3119588.153	191.150
64.	-	19+010	BH-PLT-07	MNB	0.60	12.00	704417.312	3119187.740	190.138
65.	18+750	19+435	BH-A1	MJB	1.22	30.00	704113.173	3119029.392	190.420
66.			BH-A2	MJB	1.50	30.00	704095.090	3119020.849	190.095
67.	19+500	20+185	BH-A1	MJB	0.60	40.00	703426.871	3118866.702	190.997
68.			BH-P1	MJB	1.85	40.00	703375.297	3118862.655	191.964
69.			BH-A2	MJB	1.60	40.00	703323.723	3118858.609	191.063
70.	19+715	20+400	BH-A1	MJB	0.85	30.00	703175.974	3118849.670	190.645
71.			BH-P1	MJB	0.80	30.00	703164.075	3118849.544	190.671
72.	19+715	20+400	BH-A2	MJB	0.45	30.00	703152.175	3118849.568	190.592
73.	20+300	20+985	BH-A1	MJB	1.00	40.00	702617.165	3118908.161	190.950
74.			BH-P1	MJB	2.10	40.00	702589.211	3118911.568	191.187
75.			BH-P2	MJB	2.25	40.00	702570.093	3118913.897	191.622
76.			BH-A2	MJB	2.55	40.00	702548.989	3118916.469	191.622

***NE=Not Encountered**

- 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 0.29m to 24.90m below EGL. The detailed procedure adopted for conducting various field tests is given here in below:

(i) Standard Penetration Test:

The Standard Penetration Test was conducted in boreholes as per IS 2131. The test was carried out using the standard split spoon sampler to measure the number of blows 'N'.

Standard split spoon sampler was attached to an 'A' rod. It was driven from borehole bottom to a distance of 45 cm using a standard hammer of 63.5 kg falling freely from a height of 75 cm to the required depth. While driving, the number of blows required to penetrate every 15 cm are recorded. The total number of blows required for the last 30 cm is taken as 'N' value at that particular depth of the borehole. Wherever the total penetration was less than 45cm, the no. of blows & the depth penetrated is recorded in the respective borelog.

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:-

Table 1.2: Soil compactness as per SPT N values (cl. 9.7, table 9.3 & 9.4, page 330_text book of V.N.S. Murthy)

Correlation for Clay / Plastic silt		Correlation for Sand / Non-Plastic silt	
Consistency	**SPT "N" Value**	**Compactness**	**SPT "N" Value**
Very Soft	0 - 2	Very Loose	0 - 4
Soft	2 - 4	Loose	4 - 10
Medium	4 - 8	Medium	10 - 30
Stiff	8 - 15	Dense	30 - 50
Very Stiff	15 - 30	Very Dense	> 50
Hard	> 30		

The field SPT N values obtained were further corrected as per the guidelines given in IS: 2131 as follows:

(a) For overburden: - The N value for cohesionless soil is corrected with the help of fig. 1 given in IS-2131.

(b) Due to dilatancy :- Wherever N values observed below water table in fine sand, silty sand or silt was greater than 15, then corrected N values were corrected as under:

$$N' = 15 + \tfrac{1}{2}(N-15)$$

(ii) Undisturbed Sampling (Soil) in boreholes:

Undisturbed samples were collected using MS tubes of suitable diameter and length with Area ratio as per clause 4.1.1 (c) of IS: 1892 (latest) fitted to an adopter with ball and socket arrangement. Before taking any sample, sampling tube was properly greased. Immediately after taking on undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the sample were trimmed off any wet disturbed soil. The ends were coated alternately with four layers of just molten wax. More molten wax was added to give a total thickness of min. 25 mm. The samples were carefully labeled and transported to the laboratory for testing. Undisturbed samples wherever slipped during lifting were duly marked in the field logs as well as in the soil profile.

4.1 CONDUCTING PLATE LOAD TESTS

The reaction Load is applied on the test plate by reaction truss with a weight of several tonnes. The Plate Bearing Test is normally carried out at foundation level, either on the surface or in a shallow pit. The Size of Plate is 45 cm x 45 cm size (30mm thickness) and 60 cm x 60 cm size (30mm thickness) by the hydraulic jack. The test plate was placed over a horizontal sand layer of thickness 5 mm and leveled in a manner such that the center of the plate coincides with the center of application of load. The load was applied with hydraulic jack along with a pressure gauge. Settlement of the plate was measured by using two dial gauges, fixed to reference datum bars placed on firm ground, on either side of the plate. Desired seating pressure was applied on firmly seated test plate. Settlement was recorded for each increment of load. Loading was continued till a settlement of 25 mm occurred or up to desired loading intensity as per directions.

PLATE LOAD TEST LIMITATIONS

Plate load test, though useful in obtaining the necessary information about the soil with particular reference to design of foundation has some limitations:-

(a) The tests results reflect only the character of the soil located within a depth of less than twice the width of the bearing plate. Since the foundations are generally larger than the test plates, the settlement and shear resistance will depend on the properties of much thicker stratum. Moreover this method does not give the ultimate settlements particularly in case of cohesive soils. Thus the results of the test are likely to be misleading, if the character of the soil changes at shallow depths, which is not uncommon. A satisfactory load test should, therefore, include adequate soil exploration (see IS: 1892-1979) with due attention being paid to any weaker stratum below the

level of the footing.

(b) Another limitation is the concerning of the effect of size of foundation. For clayey soils the bearing capacity (from shear consideration) for a larger foundation is almost the same as that for the smaller test plate. But in dense sandy soils the bearing capacity increases with the size of the foundation. Thus tests with smaller size plate tend to give conservative values in dense sandy soils. It may, therefore, be necessary to test with plates of at least three sizes and the bearing capacity results extrapolated for the size of the actual foundation (minimum dimensions in the case of rectangular footings).

(c) It has limited depth of influence. It could only give the bearing capacity of soils with depth up to two times the diameter of plate.

(d) It may not provide information on the potential for long term consolidation of foundation soils.

(e) There is scale effect as the size of test plate is smaller than actual foundation.

(f) To gain access to test position, excavation is carried out which causes significant ground disturbance. The change in ground stress leads to the change of soil properties which the test is planned to investigate.

Hence the interpretation of the test results & recommendation has been made in view of the above limitations.

The field record of applied load and respective average settlement obtained for plate load tests is being tabulated herein below :

Plate Load Test Data PLT-09 (New Ch. 0+000)

Applied Load (T)	Applied Pressure (T/m^2)	Cumulative Settlement (mm)
0.000	0.00	0.00
1.020	5.04	0.94
2.039	10.07	2.40
3.059	15.11	4.82
4.078	20.14	9.04
5.098	25.18	14.57
6.118	30.21	19.53
7.137	35.25	25.70

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

Table 1.3: Description of Tests

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)	√	-
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)	√	-
Atterberg Limits • Liquid Limit • Plastic Limit	 IS: 2720 (Part - 5) IS: 2720 (Part - 5)	 √ √	 √ √
Specific Gravity	IS : 2720 (Part – 3)	√	-
Direct Shear Test	IS : 2720 (Part – 13)	√	-
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)	√	-
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)	√	-

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

5.1.1 Dry density and Bulk density

For determination of bulk density and dry density, a sample of known volume 'V' was extracted from the undisturbed sampling tube and it's bulk weight 'W' was noted down.Moisture content 'Wn' was determined by oven drying method.

The bulk density and dry density were determined by following equation-

Bulk density (γ_b) = W/V

Dry density (γ_d) = γ_b/ (1+Wn)

5.1.2 Natural water content

For this test, the soil sample of known quantity (Wm) was taken in a container.The container with soil sample was placed into an oven for drying at 105-110°c temperature for 16-24 hours. After drying, the dry sample was again weighted to determine the dry weight of sample (Wd).

The natural water content was computed by the following equation-

Wn = (Wm-Wd)*100/Wd

5.1.3 Grain Size Analysis (IS: 2720- Part-4)

Wet sieve analysis:

For determination of particle sizes finer than 75 micron, wet sieve analysis test was conducted. For this test, oven dried sample of known quantity was taken in a container and soaked with dispersing

agent. The soaked soil sample was washed thoroughly over 75 micron IS sieve until the water passing sieve was substantially clean.

Fraction retained on 75 micron IS sieve was carefully collected in a container without any loss in material and placed into oven for drying.

Dry sieve analysis:

For this test, the oven dried soil sample after wet sieving was sieved through the set of IS sieves 20 mm, 10 mm, 4.75 mm, 2.0 mm, 1.0 m , 425 micron , 300 micron, 150 micron and 75micron. The amounts of soil retained on each sieve were noted down. The % retained, cumulative % retained and % passing were computed accordingly. Wherever the soil sample % passing 75 micron sieve was significant, Hydrometer method was used to find the percentage of silt and clay fraction.

Grain size analysis for the fraction passing 75 micron IS Sieve (Hydrometer method)

Calibration of Hydrometer

Hydrometer was calibrated to determine a relationship (an equation) between the effective depth H_R and corresponding hydrometer reading R_h (obtained during test).

50 to 100 gm of soil sample passing through 75 micron IS Sieve was taken. It was mixed with 100 ml of sodium hexametaphesphate solution and the mixture was warmed for about 10 minutes. It was then transferred to the cup of the mechanical mixer and the soil suspension was stirred for 15 minutes. The soil suspension was transferred into 1000 ml measuring cylinder and distilled water was added to make 1000ml solution. This solution was mixed vigorously. The measuring cylinder was then allowed to stand and the stopwatch was started. Hydrometer was immersed in the solution and reading were taken after half, one, two and four minutes. The hydrometer was then removed slowly and kept in distilled water at the same temperature as the soil suspension. Readings were taken after the periods of 8, 15 and 30 minutes, and one, two and four hours. Hydrometer was removed, rinsed and placed in the distilled water after each reading. After 4 hours reading was taken once or twice within 24 hours. Finally a reading was taken at the end of 24 hours. The temperature of the suspension was observed and recorded.

Calculations

Diameter of the particles (D):

$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = M\sqrt{\frac{H_R}{t}}$$

Where,

D = diameter of particle in suspension, in mm;

μ = co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;

G = specific gravity of the soil fraction used in the sedimentations analysis;

H_R = effective depth corresponding to R_n, in cm.

t = time elapsed between the beginning of sedimentation and taking of hydrometer reading in minutes

$M = \sqrt{\frac{30\mu}{980(G-1)}}$ = a constant factor for given values of μ and G at the temperature of the suspension.

Percentage finer than diameter D:

The percentage by mass (w) of particles smaller than corresponding equivalent particle diameters (D) was calculated from the formula:

$$w = \frac{100G_s}{W_b(G_s-1)} \times R_h$$

Where

w = percentage finer

G_s = specific gravity of soil particle

W_b = weight of soil

R_h = Hydrometer reading

5.1.4 Specific Gravity (IS: 2720-Part-3 Sec-1)

The specific gravity of soil sample was determined by density bottle method. For this test 5-10g oven dried and cooled soil sample was taken in 50ml capacity density bottle and its weight was noted down as W_2 .The soil was covered with distilled water and left for sufficient period for suitable soaking. The entrapped air was removed by vacuum. The bottle with soil was filled fully with water and its weight was noted down (W_3). The mass of empty bottle and bottle filled with distilled water were noted down as W_1 and W_4 respectively.

The Specific Gravity was determined by using following equation :

$G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$

5.1.5 Liquid Limit (IS: 2720- Part-5)

By Cone Penetrometer Method

The 'Cone Penetrometer Apparatus' is a variant of the fall-cone and consists of a cone with a smooth polished surface and angle of 30° ± 1/2°. The weight of the cone, together with its

associated shaft is 80g ± 0.5g. A support assembly with an automatic cone release mechanism and cone height adjustment mechanism used to hold the cone vertically. The angle and weight of the cone were calibrated at regular intervals, and the sharpness of the cone tip was checked daily.

Distilled water was added and thoroughly mixed with the soil sample to produce a homogeneous paste. The paste was then placed in a cup with a diameter of at least 55mm and a depth of at least 40mm. The surface of the soil was smoothed off level and parallel to the base. The support assembly was used to position the tip of the cone so that it was just touching the top surface of the soil, and the automatic tripping mechanism was released. The cone was allowed to penetrate into the soil for a period of 5 (± 1) s, then the cone was locked off to stop further movement and the penetration was recorded. The cup was refilled and the test was repeated. The two recorded penetrations need to be within 0.5mm of each other, otherwise a third test is performed. when the three test vary by more than 1mm the test was repeated.

Further tests were conducted, at varying water contents, in order to produce a series of cone penetrations (usually 4) in the range 15mm to 25mm. The resulting cone penetrations were plotted verses the water content of the test specimens. The Liquid Limit (W_L) was read off the graph, being the water content at which the line of best fit through the test points crosses 20mm penetration.

5.1.6 Plastic Limit (IS: 2720-Part-5)

For this test, soil sample was prepared in the same way as for liquid limit test. A ball of soil sample weighed about 5 gm was formed. The ball was rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm was reached, soil was again remolded into a ball. The process of rolling and remolding was repeated until the thread started just crumbing at a diameter of 3 mm. The crumbled thread was immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content has been termed as plastic limit. (W_P)

5.1.7 Plasticity Index (IS: 2720-Part-5)

The plasticity index Ip was given by

$I_p=W_L-W_P$ (in percent)

5.1.8 Direct Shear Test (IS:2720-Part-13):

For this test shear box test apparatus was used. The prepared specimen from remolded/undisturbed sample was placed carefully in the box. The plain grid was kept on top of the specimen with its directions at right angles to the direction of shear. The upper porous stone was placed on the grid and loading pad on the stone. The box with specimen was gently placed in the container (water

jacket). The specimen was submerged with water. The container was mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box was so adjusted that it touchéd the proving ring. The jack was brought forward to bear up against the box container. The proving ring dial gauge was set to read zero.

The steel ball was placed in the recess of the loading pad. The loading yoke was set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load was applied and any change in thickness of specimen was recorded. Shear displacement dial gauge was also set to read zero. The locking screw was now removed and two parts of the shear box were separated by advancing the spacing screws.

The specimen was sheared at constant rate of strain. The readings of the proving ring dial gauge were noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge were also recorded at the same time interval. The test was continued until the specimen fails. The specimen was assumed to fail when the proving ring dial gauge started receding or at shear displacement of approximately 15% of the length took place.

The soil was removed from the box and test was repeated on the identical specimen under increased normal load.

The rate of strain for conducting Direct Shear Test is kept as 0.25 mm/min as per codal/literature provision based on strata.

5.1.9 Triaxial Shear Test_UUT (IS: 2720-Part-11)

For this test, Triaxial Shear Test apparatus was used. The plain disc was placed on the pedestal of the triaxial cell. The specimen was placed centrally on the disc. A correct size rubber membrane was fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum was applied to stretch the membrane to the inside surface of the stretcher which was carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane was released. Its bottom part was rolled down into the pedestal. plain disc was placed on the top of the specimen and then loading pad was placed. The top part of membrane was rolled on to the loading pad. Then the stretcher was removed and ends were sealed with ‘O’ rings. With the properly sealed specimen placed centrally on the pedestal, the cell was assembled, keeping the loading piston initially clear of the loading pad of the specimen, the assembly was placed in the loading frame.

For unconsolidated undrained test, the bottom drainage value (BDV) and top drainage value (TDV) of cell, was closed and air release valve (ARV) was opened. The cell was filled with water through the cell water value CWV. ARV was closed when water begins to escape through it. The cell pressure was raised to the desired value and kept constant till the end of the test.

When the cell pressure was applied, the load piston rises upward, the loading machine was operated at the anticipated rate to bring the load piston slightly above the loading pad of the specimen and the load measuring dial gauge on proving ring was set to zero.

The piston was brought just in contact with loading pad by hand operation of the machine. The axial compression dial gauge was mounted and set to read zero.

The axial loading was started at 1.25 mm/min rate of strain. Simultaneous readings on the load and compression dial gauges were noted down. The test was continued until a recession of the axial load is observed or 20% of strain.

After failure, the specimen was unloaded by reversing the loading machine, cell pressure was reduced and cell water was drained out through BRV. The cell was dismantled and the specimen was taken out, rubber membrane was removed and weight of the failed sample and its water content was determined. The test was repeated on two more identical specimens with increasing cell pressure.

The rate of strain for conducting UUT is kept as 1.25 mm/min as per codal/literature provision based on strata.

5.1.10 Chemical Testing

Chemical Testing was generally performed in accordance with IS: 2720, but the different parts of method as described below:

a) Total Sulphate Content Of Soil

Samples were tested according to IS 2720 (Part 27). The dried soil was extracted with a 10% solution of hydrochloric acid. The extract was adjusted to slightly alkaline pH with ammonia, and then barium chloride solution was added to precipitate the sulphate. The barium sulphate precipitate was collected by filtration, and it was washed, dried and weighed. The mass of barium sulphate recovered was used to calculate the sulphate content of the original soil.

b) pH Value

Samples were tested according to IS: 2720 (Part 26). The soil sample (30 ± 0.1g) was extracted with 75 ml of distilled water and the pH of the resulting suspension was measured with a calibrated (by means of Standard buffer solution) pH meter.

c) Chloride Content

For the water soluble content, soil samples were extracted with a volume of water equal to twice the mass of the soil. The extract was filtered and acidified with a small amount of nitric acid. Standardized silver nitrate solution was then added to precipitate the chloride as its silver salt. The amount of precipitated silver remaining in solution was then determined by titration.

An acid-soluble version of the test was also available, with the initial extraction being with nitric acid instead of water.

CHAPTER 2 ANALYSIS OF TEST RESULTS AND INTERPRETATION

6.0 STRATIFICATION

From the study of the borehole carried out at New Ch. 0+000 to Old Ch. 10+859 (New Ch: 11+543) & Old Ch. 17+625 to Old Ch. 20+300 (New Ch: 18+310 to 20+985), it is revealed that the substrata of all boreholes mainly consisit of Silty Clay of low plasticity (CL), sandy silt of low plasticity (ML-CL), Silty Sand with Clay (SM-SC), Silty Sand (SM).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table was met at depths of from 0.29m to 24.90m below EGL as given in Table 1.1, 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 2.0 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 :-

Summary of chemical analysis of soil samples

Chemical Property	Findings (Min. to Max.)	Remarks (Required limits as per IS 456-2000)
pH	6.54 to 9.51	> 6.0
Sulphite as SO_3^{2-} (%)	0.0015 (%) to 0.0033 (%)	< 0.2% (Class I)
Chlorides as Cl^- (%)	0.0067 (%) to 0.0093 (%)	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

6.3 COMPUTATION OF LIQUEFACTION POTENTIAL

Liquefaction is the sudden loss of shear strength of the sub soil strata due to earthquake-induced vibration under saturated conditions.

Assessment of liquefaction potential of foundation strata is made by simplified approach proposed as per IS: 1893 (Part-1)-2016, from the SPT data and peak ground acceleration likely to occur at the site. In this method, cyclic shear stress likely to be induced in the foundation strata by Design Basis Earthquake (DBE) is first evaluated.

Next threshold cyclic shear stress, which is good enough to cause liquefaction, is determined from SPT data and the empirical relations. Finally, comparison of these two stresses is used in the estimation of liquefaction susceptibility of the foundation strata.

Unsaturated soils are not subjected to liquefaction because vibratory forces from earthquakes do not cause any increase in pore water pressure in such soils.

The area of site from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV of India as per IS: 1893. Further as per the provisions of IS: 1893 in soil deposits consisting of submerged loose sands & soils falling under classification of SP with standard penetration N value less than 15, the shaking caused by earthquake ground motion may cause liquefaction or excessive total and differential settlements.

For the analysis of liquefaction potential, following constant parameters are considered:

EQ Zone	IV
Earthquake Magnitude (Mw)	7.0
Peak Horizontal Ground Acceleration (amax /g)	0.24

The Ground Water Table was met at depths of from 0.29m to 24.90m below EGL as given in Table 1.1. For the analysis of liquefaction potential, the water table is generally considered to rise by about 3.0m at the location of all boreholes. The strata in the boreholes are not likely to liquefy as mentioned above and the same is tabulated below:-

Table 2.1: Liquefaction Analysis

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Water table depth Considered for Liquefaction Analysis	Liquefiable Depth (m)
1.	-	0+000	MNB	BH-PLT-09	Not Encountered	Not Encountered	Non Liquefiable
2.	(-)0+627	0+057	MNB	BH-CL	8.50	5.50	Non Liquefiable
3.	(-)0+529	0+158	MNB	BH-CL	8.15	5.00	Non Liquefiable
4.	(-)0+319	0+371	MNB	BH-CL	8.10	5.10	Non Liquefiable
5.	0+273	0+958	MNB	BH-CL	8.25	5.25	Non Liquefiable
6.	1+006	1+696	MJB	BH-A1	24.90	20.00	Non Liquefiable
7.			MJB	BH-A2	24.80	20.00	Non Liquefiable
8.	1+333	2+018	MNB	BH-CL	Not Encountered	Not Encountered	Non Liquefiable
9.	1+811	2+493	MNB	BH-CL	9.10	6.00	Non Liquefiable
10.	2+472	3+160	MNB	BH-CL	7.50	4.50	Non Liquefiable

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Water table depth Considered for Liquefaction Analysis	Liquefiable Depth (m)
11.	2+788	3+476	MJB	BH-A1	18.24	15.00	Non Liquefiable
12.			MJB	BH-A2	17.68	14.00	Non Liquefiable
13.	3+497	4+242	MJB	BH-A1	16.25	13.00	Non Liquefiable
14.			MJB	BH-P1	15.32	11.00	Non Liquefiable
15.			MJB	BH-P2	15.30	11.00	Non Liquefiable
16.			MJB	BH-P3	15.31	11.00	Non Liquefiable
17.			MJB	BH-A2	15.30	11.00	Non Liquefiable
18.	3+691	4+376	MJB	BH-A1	15.40	12.00	Non Liquefiable
19.			MJB	BH-A2	15.25	12.00	Non Liquefiable
20.	4+174	4+858	MNB	BH-CL	Not Encountered	Not Encountered	Non Liquefiable
21.	4+207	4+892	MNB	BH-CL	Not Encountered	Not Encountered	Non Liquefiable
22.	4+655	5+340	MNB	BH-CL	Not Encountered	Not Encountered	Non Liquefiable
23.	5+119	5+804	MNB	BH-CL	Not Encountered	Not Encountered	Non Liquefiable
24.	5+730	6+415	MNB	BH-CL	Not Encountered	Not Encountered	Non Liquefiable
25.	6+197	6+881	MNB	BH-CL	2.52	0.00	Non Liquefiable
26.	6+877	7+559	MNB	BH-CL	1.85	0.00	Non Liquefiable
27.	7+078	7+759	MJB	BH-A1	1.70	0.00	Non Liquefiable
28.			MJB	BH-A2	1.25	0.00	7.00
29.	7+256	7+941	MNB	BH-CL	1.59	0.00	Non Liquefiable
30.	7+351	8+036	MJB	BH-A1	3.00	0.00	4.00
31.			MJB	BH-P1	2.10	0.00	5.50
32.			MJB	BH-A2	0.70	0.00	7.00
33.	7+457	8+141	MNB	BH-CL	0.59	0.00	Non Liquefiable
34.	7+613	8+298	MJB	BH-A1	0.50	0.00	4.00
35.			MJB	BH-A2	0.85	0.00	Non Liquefiable
36.	7+907	8+592	MNB	BH-CL	1.90	0.00	Non Liquefiable
37.	8+207	8+891	MNB	BH-CL	2.00	0.00	Non Liquefiable
38.	8+610	9+295	MNB	BH-CL	1.95	0.00	Non Liquefiable
39.	8+852	9+537	MJB	BH-A1	0.75	0.00	Non Liquefiable
40.			MJB	BH-A2	1.35	0.00	Non Liquefiable
41.	8+907	9+591	MNB	BH-CL	0.55	0.00	4.00
42.	-	10+340	MNB	BH-PLT-08	4.03	0.00	3.75
43.	9+200	9+882	MNB	BH-CL	1.25	0.00	5.50
44.	9+211	9+894	MNB	BH-CL	1.36	0.00	4.00
45.	9+407	10+091	MNB	BH-CL	0.60	0.00	8.50

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Water table depth Considered for Liquefaction Analysis	Liquefiable Depth (m)
46.	9+726	10+410	MJB	BH-A1	0.85	0.00	4.00
47.			MJB	BH-A2	0.29	0.00	4.50
48.	9+772	10+457	MNB	BH-CL	0.60	0.00	3.00
49.	10+025	10+709	MJB	BH-A1	1.34	0.00	Non Liquefiable
50.			MJB	BH-A2	1.22	0.00	Non Liquefiable
51.	10+223	10+908	MNB	BH-CL	3.50	0.00	3.00
52.	10+519	11+203	MNB	BH-CL	4.50	0.00	1.50
53.	10+658	11+340	MNB	BH-CL	3.20	0.00	3.00
54.	10+718	11+403	MNB	BH-CL	2.50	0.00	6.00
55.	10+749	11+434	MNB	BH-CL	2.60	0.00	Non Liquefiable
56.	10+859	11+543	MJB	BH-A1(R)	2.99	0.00	4.00
57.			MJB	BH-A1	2.95	0.00	4.50
58.			MJB	BH-P1	3.35	0.00	6.00
59.			MJB	BH-A2	5.60	0.00	8.50
60.	17+625	18+310	MJB	BH-A1	3.00	0.00	5.50
61.			MJB	BH-A2	3.05	0.00	4.00
62.	17+872	18+558	MJB	BH-A1	0.95	0.00	7.00
63.			MJB	BH-A2	1.00	0.00	Non Liquefiable
64.	-	19+010	MNB	BH-PLT-07	0.60	0.00	2.25
65.	18+750	19+435	MJB	BH-A1	1.22	0.00	4.00
66.			MJB	BH-A2	1.50	0.00	11.50
67.	19+500	20+185	MJB	BH-A1	0.60	0.00	4.50
68.			MJB	BH-P1	1.85	0.00	4.00
69.			MJB	BH-A2	1.60	0.00	11.50
70.	19+715	20+400	MJB	BH-A1	0.85	0.00	7.00
71.			MJB	BH-P1	0.80	0.00	11.50
72.			MJB	BH-A2	0.45	0.00	7.00
73.	20+300	20+985	MJB	BH-A1	1.00	0.00	Non Liquefiable
74.			MJB	BH-P1	2.10	0.00	5.50
75.			MJB	BH-P2	2.25	0.00	4.00
76.			MJB	BH-A2	2.55	0.00	Non Liquefiable

6.4 INTERPRETATION OF LAB TEST RESULTS

Grain Size Analysis

1. **Clay content:** It generally varies from 4 to 11%.
2. **Silt content:** It generally varies from 20 to 66%.
3. **Sand content:** It generally varies from 22 to 85%.

4. **Gravel content:** It generally varies from 1 to 10%.

Atterberg's Limit

5. **Liquid limit:** The test results of liquid limit of the soil samples reveal that it generally varies from 24 to 28% in ML-CL type of soil, 32 to 33% in CL type of soil.
6. **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.
7. **Plasticity index*:*** The plasticity index of the soil samples generally varies from 5 to 6% in ML-CL type of soil, 9 to 11% in CL type of soil whereas ML-CL and SM/ SM-SC/ SC type of soil are non-plastic.

Natural moisture content & Bulk density

The bulk density of soil samples generally varies from 1.84 gm/cc to 1.97gm/cc whereas natural moisture content varies from 10% to 21%.

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 28^o to 32^o, whereas cohesion varies from 0.00 kg/cm^2 to 0.11 kg/cm^2.

For Silty strata (ML-CL), the value of angle of internal friction varies from 24^o to 27^o, whereas cohesion varies from 0.11 kg/cm^2 to 0.22 kg/cm^2.

Triaxial shear tests:

Triaxial shear test under undrained condition have been conducted in silty clay (CL) type of soil.

For silty clay (CL) strata, the value of angle of internal friction varies from 4^o to 5^o, whereas cohesion varies from 1.41kg/cm^2 to 2.22 kg/cm^2.

FROM THE STUDY OF PRESSURE-SETTLEMENT CURVE (ON ARITHMETIC SCALE) OF 01 PLATE LOAD TESTS AS PROVIDED VIDE APPENDIX A-4, IT IS REVEALED THAT

For PLT-09 New Ch-0+000

1. Ultimate bearing capacity and Safe bearing capacity of the sandy soil with respect to plate is found to be 17.05 t/m^2 and 6.82 t/m^2, respectively.
2. Safe bearing capacity of soil for 2.70 m foundation depth is found to be 22.75 t/m^2 at 25 mm settlement. As per shear failure criteria (Bowles, J.E., 1982. Foundation design and analysis), it is found to be 20.4 t/m^2.

Note:

The Safe bearing capacity of sandy soil as per shear failure criteria is computed by the following given relation (Bowles, J.E., 1982. Foundation design and analysis),

$$q_{Safe} = q_{safe\,(Plate)}\, X \left(\frac{B_{Foundation}}{B_{Plate}}\right)$$

J.E., 1982 recommended that the above equation is valid when the ratio lies between 3 to 6. However for better understanding the ratio is conservatively restricted to 3. The use of this equation is not recommended unless the ratio is not much more than about 3. When the ratio is more than 6 to 15 or more the extrapolation from a plate load test is little more than a guess that could be obtained at least as reliably using an SPT or CPT corerection.

CHAPTER 3 TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS

7.0 TYPE & DEPTH OF FOUNDATION:

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

Table 3.1 : Shallow Foundation

Type of foundation	Depth of Foundation below E.G.L. (m)	Size of Foundation (m x m)
Shallow Foundation	1.0, 2.0, 3.0	1.5 x 1.5
	1.0, 2.0, 2.7, 3.0	2.0 x 2.0
	1.0, 2.0, 3.0	2.7 x 2.7
	1.0, 2.0, 3.0	3.7 x 3.7
	1.0, 2.0, 3.0	4.8 x 4.8
	1.0, 2.0, 3.0	5.5 x 5.5
	1.0, 2.0, 3.0	6.0 x 6.0
	1.0, 2.0, 3.0	7.2 x 7.2
	1.0, 2.0, 3.0	12.5 x 12.5

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	14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0 & 32.0	1.0 & 1.2

The details of foundation analysis are given in the subsequent paragraph.

7.1 ANALYSIS OF SHALLOW FOUNDATION

7.1.1 From Shear Failure Criteria

Net Safe Bearing capacity from Shear Failure consideration has been computed in accordance with IS: 6403-1981, which is based on, modified Terzaghi's classical approach. The weighted average of shear strength parameters for various strata upto depth equal to 0.5*B*Tan (45+Ø/2) (where B = Width of the Foundation, Ø = Angle of internal friction) is used in the analysis. A factor of safety of 2.5 to estimate the net safe bearing capacity from ultimate net bearing capacity.

For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse

grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria.

The ultimate net bearing capacity in case of general shear failure is given by following expression,

$q_d = c\, N_c\, s_c\, d_c\, i_c + q\,(N_q-1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

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,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure $= \tan^{-1}(0.67 \tan\phi)$

7.1.2 From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure.

The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B below the base to account for the effects of energy ratio, adopted bearing pressure, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure.

Further for settlement Calculation in cohesive soil the following equation has been used.

$S_t = \Delta P\, M_v\, H$

Where,

M_v = Coefficient of volume compressibility, cm^2/kg

ΔP = Pressure increment, kg/cm^2

H = Thickness of layers

Note: - Value of Coefficient of volume compressibility (Mv) has been calculated by using the following co-relation [Ref. Stroud and Butler, 1975] :-

Coefficient of Volume Compressibility derived from SPT N-Value (after Stroud and Butler, 1975)

Plasticity Index (%)	Conversion Factor (f_2)	m_v (10^{-3} kPa^{-1}) based on N-Value: $m_v = 1/(f_2 N)$				
		N=10	N=20	N=30	N=40	N=50
10	800	0.12	0.06	0.04	0.03	0.02
20	525	0.19	0.09	0.06	0.05	0.04

Plasticity Index (%)	Conversion Factor (f_2)	m_v (10^{-3} kPa^{-1}) based on N-Value: $m_v = 1/(f_2N)$				
		N=10	N=20	N=30	N=40	N=50
30	475	0.21	0.10	0.07	0.05	0.04
40	450	0.22	0.11	0.07	0.06	0.04

$Mv = 1/(f_2N_{corr.})$

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 constraint to lesser than 25mm.

As per IS- 8009 part 1 clause 9.2.2.1, If the clay layer is sandwitched between cohesionless soil layers, the immediate settlement is zero. Hence, even though the immediate settlement has been calculated during analysis, however it is ignored in the calculation of total settlement.

The sample calculations for computation of allowable bearing capacity of sub-strata for shallow foundation vide **Appendix – C-2.**

7.2 ANALYSIS OF PILE FOUNDATION

(A) DEEP FOUNDATION

The safe Load Carrying Capacity of normal bored cast in-situ RCC pile is determined in compression, uplift and lateral as per IS: 2911 (Part-1/sec-2) – 2010. The axial capacity of a pile depends upon the soil skin friction along the shaft and end bearing at it's tip.

Thus Axial load = Skin Friction + End-bearing

a) For piles in granular soils (using the static formula)

$$\mathbf{Q_u = (0.5*D*\gamma*N_\gamma + P_D*N_q)*A_p + (\Sigma K_i*P_{Di}*\tan\delta_i)*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

D = dia. of pile shaft in m

γ = effective unit weight of the soil at pile tip in kN/m^3

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction Φ at pile tip (N_γ from IS 6403 for general shear failure case & N_q from Fig. 1, IS 2911)

P_D = effective overburden pressure at pile tip in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

K_i = coefficient of earth pressure applicable for the ith layer

P_{Di} = effective overburden pressure for the ith layer in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

δ_i = angle of wall friction between pile and soil for ith layer, and

A_{si} = surface area of pile shaft in the ith layer in m^2

b) For piles in cohesive soils (using the static formula)

$$\mathbf{Q_u = cp*Nc*A_p + \Sigma\alpha_i*c_i*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

A_p = cross-sectional area of pile tip in m^2

N_c = bearing capacity factor (= 9)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

α_i = adhesion factor for the ith layer depending on the consistency of soil

c_i = average cohesion for ith layer in kN/m^2

A_{si} = surface area for pile shaft in the ith layer in m^2

c) For computation of safe load carrying capacity of pile in lateral, the following equation has been used:

i. <u>Fixed Head Condition</u>

$$\mathbf{Q = (12 * E * I * Y) / (L_1 + L_f)^3}$$

ii. <u>Free Head Condition</u>

$$\mathbf{Q = (3 * E * I * Y) / (L_1 + L_f)^3}$$

Where,

Q = Lateral Load (in kg)

Y = Permissible lateral deflection taken as 5mm

E = Modulus of Elasticity of concrete

I = Moment of Inertia of the pile cross-section

L_1 = Length of pile above cut-off level

L_f = Length of fixity

The effective length of the pile has been considered below the cut-off level taken as 2.0m below the EGL. Normal Bored cast in-situ RCC piles having stem diameter equal to 100cm & 120cm and of effective length varying from 16.0m to 32.0m were selected.

For the analysis of the pile foundations the soil parameters used for computation of safe load carrying capacity of pile is tabulated below:-

Table 3.3 : Design Soil Parameter

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
-	0+000	BH-PLT-09	0.00	4.50	4.50	SandySilt	9	11	1.64	0.15	26
			4.50	6.00	1.50	SandySilt	-	-	1.67	0.18	27
			6.00	12.00	6.00	SiltySand	34	28	1.68	0.00	30
(-) 0+627	0+057	BH-CL	0.00	5.50	5.50	SiltySand	24	32	1.78	0.00	30
			5.50	10.00	4.50	SiltySand	46	34	1.85	0.00	31
(-) 0+529	0+158	BH-CL	0.00	4.00	4.00	SiltySand	18	23	1.74	0.00	29
			4.00	7.00	3.00	SiltySand	37	37	1.80	0.00	30
			7.00	10.00	3.00	SiltySand	43	27	1.85	0.00	31
(-) 0+319	0+371	BH-CL	0.00	5.50	5.50	SiltySand	27	34	1.79	0.00	30
			5.50	8.50	3.00	SiltyClay	23	23	1.86	0.79	5
			8.50	10.00	1.50	SiltySand	36	24	1.84	0.00	30
0+273	0+958	BH-CL	0.00	2.50	2.50	SiltySand	12	19	-	-	-
			2.50	8.50	6.00	SandySilt	31	32	1.82	0.21	25
			8.50	10.00	1.50	SiltySand	32	21	1.79	0.00	29
1+006	1+696	BH-A1	0.00	4.00	4.00	SiltySand	9	14	1.67	0.00	29
			4.00	7.00	3.00	SiltySand	22	25	1.76	0.00	30
			7.00	11.50	4.50	SiltySand	52	45	1.83	0.00	32
			11.50	14.50	3.00	SiltySand	69	50	1.84	0.00	32
			14.50	19.00	4.50	SiltySand	97	62	1.88	0.00	32
			19.00	23.50	4.50	SandySilt	56	31	1.88	0.18	27
			23.50	29.50	6.00	SandySilt	100	39	1.97	0.18	28
			29.50	30.00	0.50	SiltyClay	48	48	1.98	1.56	4
		BH-A2	0.00	4.00	4.00	SiltySand	7	9	1.62	0.00	28
			4.00	7.00	3.00	SiltySand	14	14	1.70	0.06	29
			7.00	10.00	3.00	SiltySand	20	18	1.74	0.09	30
			10.00	13.00	3.00	SiltySand	42	32	1.82	0.11	32
			13.00	19.00	6.00	SiltySand	84	56	1.92	0.10	32
			19.00	22.45	3.45	SiltySand	84	47	1.90	0.08	32
			22.45	25.00	2.55	SiltyClay	39	39	1.94	1.29	4
			25.00	29.50	4.50	SandySilt	65	24	1.92	0.22	26
			29.50	30.00	0.50	SiltyClay	64	64	2.02	2.05	4

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
1+333	2+018	BH-CL	0.00	4.00	4.00	SiltySand	35	44	1.80	0.00	32
			4.00	7.00	3.00	SiltySand	41	41	1.81	0.00	32
			7.00	10.00	3.00	Silty Clay	48	48	1.89	1.58	5
1+811	2+493	BH-CL	0.00	4.00	4.00	SiltySand	13	21	1.72	0.00	30
			4.00	7.00	3.00	SiltySand	33	37	1.82	0.00	31
			7.00	10.00	3.00	SandySilt	30	28	1.87	0.21	26
2+472	3+160	BH-CL	0.00	4.00	4.00	SiltySand	11	17	1.72	0.08	28
			4.00	10.00	6.00	SandySilt	32	32	1.91	0.18	27
2+788	3+476	BH-A1	0.00	5.50	5.50	SiltySand	15	19	1.71	0.00	30
			5.50	8.50	3.00	SiltySand	54	50	1.84	0.00	32
			8.50	11.50	3.00	SiltySand	84	68	1.87	0.00	32
			11.50	14.50	3.00	SiltySand	71	51	1.86	0.00	32
			14.50	20.50	6.00	SandySilt	40	22	1.80	0.20	26
			20.50	23.50	3.00	SandySilt	55	23	1.88	0.21	27
			23.50	26.50	3.00	SandySilt	48	21	1.88	0.21	27
			26.50	30.00	3.50	SandySilt	73	27	1.90	0.20	28
		BH-A2	0.00	4.00	4.00	SiltySand	22	28	1.79	0.00	31
			4.00	7.00	3.00	SiltySand	30	30	1.79	0.00	31
			7.00	10.00	3.00	SiltySand	59	51	1.86	0.00	32
			10.00	13.00	3.00	SiltySand	64	48	1.86	0.00	32
			13.00	16.00	3.00	SandySilt	33	22	1.82	0.18	27
			16.00	19.00	3.00	SandySilt	32	20	1.83	0.18	27
			19.00	22.00	3.00	SandySilt	36	18	1.84	0.18	27
			22.00	25.00	3.00	SandySilt	83	31	1.93	0.19	28
			25.00	30.00	5.00	SandySilt	75	28	1.93	0.19	28
3+497	4+242	BH-A1	0.00	4.00	4.00	Sandy Silt	5	8	1.64	0.21	23
			4.00	8.50	4.50	SiltyClay	26	26	1.82	0.85	4
			8.50	11.50	3.00	SiltySand	53	43	1.80	0.00	32
			11.50	14.50	3.00	SiltyClay	21	21	1.80	0.72	5
			14.50	17.50	3.00	SiltyClay	33	33	1.88	1.13	5
			17.50	20.50	3.00	SandySilt	61	26	1.89	0.22	28
			20.50	23.50	3.00	SandySilt	77	30	1.92	0.22	28
			23.50	26.50	3.00	SandySilt	57	24	1.90	0.22	28
			26.50	29.50	3.00	SandySilt	62	24	1.90	0.22	28
			29.50	32.50	3.00	SiltyClay	79	79	2.04	2.51	5
			32.50	40.00	7.50	SiltyClay	90	90	2.05	3.12	4
		BH-P1	0.00	4.00	4.00	SandySilt	45	57	1.82	0.22	27
			4.00	7.00	3.00	SandySilt	35	35	1.81	0.22	27

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
3+497	4+242	BH-P1	7.00	10.00	3.00	SiltySand	55	47	1.80	0.00	31
			10.00	13.00	3.00	SiltySand	51	39	1.81	0.00	31
			13.00	17.50	4.50	SandySilt	40	27	1.83	0.20	27
			17.50	22.00	4.50	SiltySand	64	28	1.86	0.00	32
			22.00	25.00	3.00	SiltyClay	57	57	2.02	1.96	5
			25.00	28.00	3.00	SiltyClay	61	61	2.02	1.96	5
			28.00	31.00	3.00	SiltyClay	50	50	2.02	1.96	5
			31.00	34.00	3.00	SiltyClay	65	65	2.02	1.96	5
			34.00	40.00	6.00	SiltyClay	90	90	2.03	2.41	5
		BH-P2	0.00	4.00	4.00	SandySilt	7	11	1.66	0.18	24
			4.00	8.50	4.50	SiltySand	18	19	1.72	0.00	30
			8.50	11.50	3.00	SiltySand	23	19	1.73	0.00	30
			11.50	13.00	1.50	SiltySand	-	-	1.74	0.00	30
			13.00	17.50	4.50	SiltyClay	22	22	1.82	0.75	5
			17.50	20.50	3.00	SandySilt	60	27	1.87	0.21	26
			20.50	23.50	3.00	SandySilt	38	19	1.89	0.21	26
			23.50	26.50	3.00	SiltyClay	42	42	2.00	1.49	5
			26.50	28.00	1.50	SiltyClay	-	-	2.01	1.49	5
			28.00	34.00	6.00	SiltyClay	56	56	2.02	2.02	5
			34.00	40.00	6.00	SiltySand	94	31	1.95	0.10	32
		BH-P3	0.00	4.00	4.00	SiltySand	11	14	1.68	0.00	30
			4.00	7.00	3.00	SiltySand	22	22	1.75	0.00	31
			7.00	10.00	3.00	SiltySand	25	22	1.75	0.00	31
			10.00	13.00	3.00	SiltyClay	28	28	1.86	1.00	6
			13.00	16.00	3.00	SiltyClay	32	32	1.87	1.00	6
			16.00	19.00	3.00	SandySilt	56	26	1.91	0.21	28
			19.00	23.50	4.50	SandySilt	67	28	1.91	0.21	28
			23.50	28.00	4.50	SiltyClay	60	60	2.03	1.98	6
			28.00	31.50	3.50	SiltyClay	70	70	2.03	2.24	5
			31.50	40.00	8.50	SandySilt	85	29	-	-	-
		BH-A2	0.00	5.50	5.50	SandySilt	21	27	1.79	0.21	26
			5.50	8.50	3.00	SiltySand	47	43	1.82	0.00	33
			8.50	11.50	3.00	SiltySand	36	29	1.81	0.00	33
			11.50	14.50	3.00	SiltySand	60	43	1.83	0.00	33
			14.50	17.50	3.00	SandySilt	43	22	1.83	0.19	27
			17.50	23.50	6.00	SandySilt	83	34	1.94	0.20	31
			23.50	26.50	3.00	SiltyClay	58	58	2.01	1.82	6
			26.50	40.00	13.50	SiltyClay	63	63	2.05	3.15	6

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
3+691	4+376	BH-A1	0.00	4.00	4.00	SiltySand	5	8	1.67	0.11	26
			4.00	8.50	4.50	SandySilt	23	24	1.79	0.18	26
			8.50	11.50	3.00	SandySilt	27	22	1.81	0.18	26
			11.50	14.50	3.00	SandySilt	22	16	1.81	0.18	26
			14.50	17.50	3.00	SiltyClay	40	40	1.94	1.36	4
			17.50	26.50	9.00	SandySilt	71	29	1.93	0.20	28
			26.50	30.00	3.50	SandySilt	87	31	-	-	-
		BH-A2	0.00	4.00	4.00	SiltyClay	12	12	1.70	0.43	4
			4.00	7.00	3.00	SandySilt	16	16	1.72	0.20	25
			7.00	10.00	3.00	SandySilt	20	17	1.74	0.20	25
			10.00	13.00	3.00	SandySilt	27	21	1.78	0.19	26
			13.00	16.00	3.00	SiltyClay	22	22	1.87	0.75	5
			16.00	19.00	3.00	SiltyClay	30	30	1.96	1.02	4
			19.00	25.00	6.00	SandySilt	48	22	1.88	0.22	27
			25.00	30.00	5.00	SandySilt	58	24	1.91	0.22	27
4+174	4+858	BH-CL	0.00	2.50	2.50	SiltySand	14	18	1.68	0.00	30
			2.50	5.50	3.00	SiltyClay	14	14	1.78	0.63	5
			5.50	10.00	4.50	SiltySand	42	39	1.82	0.00	32
4+207	4+892	BH-CL	0.00	5.50	5.50	SandySilt	21	27	1.78	0.18	26
			5.50	10.00	4.50	SiltySand	49	42	1.83	0.00	31
4+655	5+340	BH-CL	0.00	5.50	5.50	SiltySand	28	34	1.81	0.00	32
			5.50	10.00	4.50	SiltySand	58	50	1.84	0.00	33
5+119	5+804	BH-CL	0.00	4.00	4.00	SiltySand	10	13	1.66	0.00	29
			4.00	7.00	3.00	SiltySand	28	29	1.78	0.00	30
			7.00	10.00	3.00	SiltySand	33	29	1.79	0.00	31
5+730	6+415	BH-CL	0.00	5.50	5.50	SiltySand	12	15	1.69	0.00	28
			5.50	10.00	4.50	SiltySand	29	25	1.79	0.00	30
6+197	6+881	BH-CL	0.00	4.00	4.00	SandySilt	13	17	1.78	0.21	24
			4.00	7.00	3.00	SandySilt	21	19	1.84	0.21	24
			7.00	10.00	3.00	SiltySand	47	31	1.86	0.00	31
6+877	7+559	BH-CL	0.00	5.50	5.50	SiltySand	16	20	1.80	0.09	28
			5.50	10.00	4.50	SiltySand	36	27	1.84	0.00	31
7+078	7+759	BH-A1	0.00	10.00	10.00	SandySilt	17	18	1.80	0.18	24
			10.00	11.50	1.50	SandySilt	-	-	1.88	0.23	24
			11.50	16.00	4.50	SiltyClay	31	31	1.99	1.02	4
			16.00	23.50	7.50	SandySilt	83	41	1.94	0.22	27
			23.50	30.00	6.50	SiltyClay	74	74	2.03	2.40	4

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
7+078	7+759	BH-A2	0.00	5.50	5.50	SiltyClay	6	6	1.88	0.24	5
			5.50	8.50	3.00	SiltyClay	8	8	1.88	0.24	5
			8.50	11.50	3.00	SandySilt	19	17	1.85	0.21	24
			11.50	14.50	3.00	SiltyClay	34	34	1.99	1.16	4
			14.50	17.50	3.00	SiltyClay	40	40	2.00	1.35	4
			17.50	20.50	3.00	SandySilt	92	45	1.94	0.22	27
			20.50	30.00	9.50	SiltyClay	67	67	2.03	2.15	4
7+256	7+941	BH-CL	0.00	4.00	4.00	SiltySand	16	25	1.82	0.00	30
			4.00	10.00	6.00	SandySilt	30	24	1.89	0.19	26
7+351	8+036	BH-A1	0.00	4.00	4.00	SandySilt	5	8	1.70	0.20	23
			4.00	8.50	4.50	SandySilt	24	22	1.86	0.19	25
			8.50	11.50	3.00	SiltyClay	20	20	1.95	0.70	4
			11.50	14.50	3.00	SandySilt	33	22	1.87	0.22	25
			14.50	17.50	3.00	SiltyClay	39	39	1.99	1.32	5
			17.50	23.50	6.00	SandySilt	67	32	1.93	0.20	28
			23.50	28.00	4.50	SandySilt	100	41	1.94	0.20	28
			28.00	32.50	4.50	SandySilt	49	23	1.89	0.21	27
			32.50	35.50	3.00	SiltyClay	71	71	2.03	2.28	5
			35.50	40.00	4.50	SiltyClay	100	100	2.05	3.15	5
		BH-P1	0.00	4.00	4.00	SandySilt	9	13	1.71	0.18	25
			4.00	7.00	3.00	SiltyClay	11	11	1.91	0.41	4
			7.00	10.00	3.00	SiltyClay	12	12	1.92	0.41	4
			10.00	13.00	3.00	SandySilt	45	29	1.93	0.21	27
			13.00	14.50	1.50	SandySilt	-	-	1.93	0.21	27
			14.50	19.00	4.50	SiltyClay	31	31	1.99	1.02	5
			19.00	25.00	6.00	SandySilt	56	29	1.92	0.22	27
			25.00	28.00	3.00	SandySilt	89	38	1.94	0.20	29
			28.00	31.00	3.00	SiltyClay	41	41	2.00	1.36	5
			31.00	34.00	3.00	SiltyClay	59	59	2.02	1.95	5
			34.00	40.00	6.00	SandySilt	95	35	1.96	0.20	30
		BH-A2	0.00	5.50	5.50	SiltySand	4	7	1.65	0.00	28
			5.50	8.50	3.00	SiltySand	8	10	1.66	0.00	28
			8.50	11.50	3.00	SiltySand	14	15	1.75	0.10	28
			11.50	14.50	3.00	SiltySand	22	19	1.79	0.11	29
			14.50	18.00	3.50	SandySilt	56	34	1.94	0.22	28
			18.00	25.00	7.00	SandySilt	78	40	1.96	0.19	29
			25.00	40.00	15.00	SandySilt	90	39	-	-	-

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
7+457	8+141	BH-CL	0.00	4.00	4.00	SiltySand	12	19	1.78	0.00	29
			4.00	10.00	6.00	SandySilt	25	22	1.90	0.20	25
7+613	8+298	BH-A1	0.00	5.50	5.50	SiltySand	11	16	1.74	0.00	30
			5.50	8.50	3.00	SiltySand	21	20	1.81	0.09	30
			8.50	11.50	3.00	SiltySand	20	18	1.81	0.09	30
			11.50	14.50	3.00	SiltySand	29	22	1.83	0.09	30
			14.50	17.50	3.00	SiltyClay	100	100	2.00	3.15	5
			17.50	20.50	3.00	SiltySand	70	37	1.89	0.00	33
			20.50	23.50	3.00	SiltySand	55	29	1.88	0.00	32
			23.50	27.00	3.50	SiltyClay	72	72	2.04	2.41	5
			27.00	32.50	5.50	SiltyClay	81	81	2.04	2.64	5
			32.50	40.00	7.50	SiltySand	80	30	2.00	0.11	33
		BH-A2	0.00	4.00	4.00	SiltyClay	21	21	1.95	0.72	5
			4.00	7.00	3.00	SiltyClay	22	22	1.95	0.72	5
			7.00	10.00	3.00	SiltyClay	31	31	1.98	1.02	6
			10.00	13.00	3.00	SiltyClay	30	30	1.98	1.02	6
			13.00	16.00	3.00	SiltySand	60	34	1.89	0.11	31
			16.00	19.00	3.00	SiltySand	55	30	1.89	0.11	31
			19.00	22.00	3.00	SiltySand	81	39	1.89	0.00	33
			22.00	25.00	3.00	SiltySand	80	37	1.89	0.00	33
			25.00	28.00	3.00	SiltySand	82	36	1.89	0.00	33
			28.00	31.00	3.00	SiltyClay	56	56	1.98	1.85	4
			31.00	37.00	6.00	SiltyClay	100	100	2.01	3.13	4
			37.00	40.00	3.00	SandySilt	100	42	1.98	0.20	32
7+907	8+592	BH-CL	0.00	2.50	2.50	SiltySand	13	13	1.67	0.00	30
			2.50	8.50	4.50	SiltyClay	16	16	1.93	0.53	5
			8.50	10.0	2.50	SiltySand	39	28	1.86	0.00	30
8+207	8+891	BH-CL	0.00	5.50	5.50	SandySilt	17	21	1.83	0.20	26
			5.50	8.50	3.00	SandySilt	26	22	1.88	0.18	25
			8.50	10.00	1.50	SiltyClay	30	30	1.98	1.02	5
8+610	9+295	BH-CL	0.00	4.00	4.00	SiltySand	19	21	1.77	0.00	30
			4.00	7.00	3.00	SiltySand	17	18	1.80	0.10	29
			7.00	10.00	3.00	SiltySand	35	36	1.85	0.11	29
8+852	9+537	BH-A1	0.00	5.50	5.50	SiltySand	20	23	1.79	0.10	29
			5.50	8.50	3.00	SiltySand	25	22	1.80	0.09	30
			8.50	11.50	3.00	SiltyClay	49	49	2.00	1.49	6
			11.50	14.50	3.00	SiltyClay	41	41	1.99	1.49	6
			14.50	17.50	3.00	SiltyClay	46	46	2.00	1.49	6

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
8+852	9+537	BH-A1	17.50	20.50	3.00	SandySilt	41	24	1.90	0.18	29
			20.50	25.00	4.50	SandySilt	43	24	1.90	0.18	29
			25.00	30.00	5.00	SiltyClay	53	53	2.01	1.65	6
		BH-A2	0.00	4.00	4.00	SiltySand	15	18	1.76	0.11	29
			4.00	7.00	3.00	SiltySand	14	16	1.77	0.11	29
			7.00	10.00	3.00	SiltySand	19	18	1.79	0.11	29
			10.00	13.00	3.00	SandySilt	39	27	1.90	0.21	27
			13.00	16.00	3.00	SiltyClay	57	57	2.02	1.88	5
			16.00	19.00	3.00	SiltyClay	40	40	2.00	1.35	6
			19.00	22.00	3.00	SandySilt	41	24	1.91	0.20	28
			22.00	25.00	3.00	SandySilt	56	28	1.90	0.19	29
			25.00	30.00	5.00	SiltyClay	54	54	2.01	1.72	6
8+907	9+591	BH-CL	0.00	5.50	5.50	SiltySand	11	15	1.70	0.00	29
			5.50	10.00	4.50	SiltySand	25	22	1.81	0.00	30
-	10+340	BH-PLT-08	0.00	4.50	4.50	SiltySand	7	9	1.79	0.15	25
			4.50	7.50	3.00	SiltySand	26	21	1.83	0.19	26
			7.50	12.00	4.50	SandySilt	49	30	1.88	0.21	26
9+200	9+882	BH-CL	0.00	4.00	4.00	SiltyClay	6	6	1.86	0.23	5
			4.00	10.00	6.00	SandySilt	20	19	1.86	0.22	25
9+211	9+894	BH-CL	0.00	4.00	4.00	SiltyClay	7	7	1.86	0.15	5
			4.00	10.00	6.00	SandySilt	21	19	1.88	0.20	26
9+407	10+091	BH-CL	0.00	4.00	4.00	SiltySand	7	11	1.70	0.00	29
			4.00	8.50	4.50	SiltySand	14	17	1.76	0.00	29
			8.50	10.00	1.50	SiltyClay	20	20	1.95	0.70	5
9+726	10+410	BH-A1	0.00	4.00	4.00	SiltySand	4	8	1.66	0.00	27
			4.00	8.50	4.50	SiltySand	21	22	1.79	0.11	27
			8.50	11.50	3.00	SandySilt	41	30	1.92	0.22	26
			11.50	14.50	3.00	SandySilt	48	31	1.92	0.22	26
			14.50	17.50	3.00	SandySilt	33	22	1.91	0.18	26
			17.50	20.50	3.00	SandySilt	33	21	1.91	0.18	26
			20.50	23.50	3.00	SiltyClay	39	39	2.00	1.32	5
			23.50	26.50	3.00	SiltyClay	47	47	2.01	1.55	5
			26.50	28.00	1.50	SiltyClay	100	100	2.00	1.55	5
			28.00	30.00	2.00	SiltySand	100	38	1.93	0.00	32
		BH-A2	0.00	4.50	4.50	SiltySand	5	8	-	-	-
			4.50	10.00	5.50	SiltySand	27	25	1.83	0	30
			10.00	13.00	3.00	SiltyClay	31	31	2.03	2.00	6

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
9+726	10+410	BH-A2	13.00	16.00	3.00	SiltySand	37	25	1.87	0.11	29
			16.00	19.00	3.00	SiltySand	37	24	1.87	0.11	29
			19.00	22.00	3.00	SiltySand	40	24	1.87	0.11	29
			22.00	25.00	3.00	SiltySand	45	25	1.87	0.09	30
			25.00	26.50	1.50	SiltySand	-	-	1.89	0.09	30
			26.50	30.00	3.45	SiltyClay	64	64	2.03	2.00	6
9+772	10+457	BH-CL	0.00	2.25	2.25	SandySilt	5	8	1.74	0.21	22
			2.25	5.25	3.00	SandySilt	16	18	1.84	0.20	24
			5.25	8.25	3.00	SiltySand	22	20	1.84	0.10	27
			8.25	12.00	3.75	SiltySand	40	28	1.91	0.11	29
10+025	10+709	BH-A1	0.00	4.00	4.00	SandySilt	10	16	1.80	0.20	25
			4.00	8.50	4.50	SiltySand	20	20	1.82	0.10	29
			8.50	11.50	3.00	SandySilt	20	18	1.86	0.22	26
			11.50	14.50	3.00	SandySilt	27	20	1.86	0.22	26
			14.50	17.50	3.00	SandySilt	31	21	1.86	0.19	27
			17.50	20.50	3.00	SiltyClay	64	64	2.03	2.02	6
			20.50	26.50	6.00	SiltyClay	48	48	2.04	2.02	6
			26.50	30.00	3.50	SiltyClay	55	55	-	-	-
		BH-A2	0.00	4.00	4.00	SandySilt	13	17	1.73	0.22	26
			4.00	10.00	6.00	SiltySand	34	27	1.84	0.09	30
			10.00	13.00	3.00	SandySilt	55	35	1.91	0.23	28
			13.00	16.00	3.00	SandySilt	54	32	1.92	0.23	28
			16.00	19.00	3.00	SandySilt	59	32	1.92	0.23	28
			19.00	22.00	3.00	SiltyClay	62	62	2.03	2.05	5
			22.00	25.00	3.00	SiltyClay	67	67	2.03	2.05	5
			25.00	28.00	3.00	SiltyClay	63	63	2.03	2.05	5
			28.00	30.00	2.00	SiltyClay	72	72	2.03	2.31	5
10+223	10+908	BH-CL	0.00	2.25	2.25	SandySilt	6	9	1.65	0.18	25
			2.25	5.25	3.00	SandySilt	17	17	1.77	0.20	25
			5.25	8.25	3.00	SandySilt	25	21	1.85	0.19	26
			8.25	10.00	1.75	SiltySand	26	20	1.84	0.10	28
10+519	11+203	BH-CL	0.00	2.25	2.25	SandySilt	8	12	1.70	0.20	25
			2.25	4.50	2.25	SandySilt	18	22	1.78	0.21	25
			4.50	8.25	3.75	SiltySand	42	35	1.87	0.20	27
			8.25	10.00	1.75	SiltySand	51	33	1.88	0.19	28

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
10+658	11+340	BH-CL	0.00	2.25	2.25	SandySilt	6	10	-	-	-
			2.25	3.00	0.75	SandySilt	-	-	1.74	0.19	24
			3.00	5.25	2.25	SiltyClay	13	13	1.80	0.37	5
			5.25	8.25	3.00	SiltySand	24	21	1.81	0.10	27
			8.25	10.00	1.75	SiltySand	33	24	1.81	0.00	30
10+718	11+403	BH-CL	0.00	2.25	2.25	SiltySand	20	32	1.75	0.00	30
			2.25	5.25	3.00	Silty Sand	8	10	1.72	0.10	27
			5.25	8.25	3.00	Silty Sand	23	21	1.83	0.11	28
			8.25	10.00	1.75	SandySilt	27	21	1.87	0.18	26
10+749	11+434	BH-CL	0.00	1.50	1.50	SiltySand	11	20	1.74	0.00	30
			1.50	5.25	3.75	SandySilt	18	21	1.79	0.21	25
			5.25	8.25	3.00	SiltySand	20	19	1.79	0.00	30
			8.25	10.00	1.75	SandySilt	23	19	1.86	0.20	26
10+859	11+543	BH-A1(R)	0.00	5.50	5.50	SiltySand	8	10	1.69	0.11	27
			5.50	11.50	6.00	SiltySand	16	16	1.77	0.09	28
			11.50	14.50	3.00	SiltyClay	31	31	1.98	1.06	6
			14.50	17.50	3.00	SiltyClay	36	36	1.99	1.23	6
			17.50	20.50	3.00	SiltyClay	49	49	2.01	1.62	5
			20.50	28.00	7.50	SiltyClay	77	77	-	-	-
			28.00	40.00	12.00	SandySilt	79	31	1.99	0.20	33
		BH-A1	0.00	4.50	4.50	SiltySand	9	12	1.69	0.00	29
			4.50	10.00	5.50	SiltySand	13	15	1.77	0.08	28
			10.00	16.00	6.00	SiltyClay	30	30	1.99	1.02	6
			16.00	19.00	3.00	SiltyClay	84	84	2.04	2.61	6
			19.00	25.00	6.00	SiltyClay	84	84	2.04	2.61	6
			25.00	31.00	9.00	SiltyClay	92	92	2.05	2.80	4
			31.00	40.00	9.00	SandySilt	93	36	1.97	0.18	31
		BH-P1	0.00	1.00	1.00	Filled up Strata	-	-	-	-	-
			1.00	11.50	10.50	SiltySand	20	22	1.74	0.00	30
			11.50	14.50	3.00	SiltyClay	31	31	1.99	1.06	6
			14.50	17.50	3.00	SiltyClay	32	32	1.99	1.06	6
			17.50	20.50	3.00	SiltyClay	34	34	1.99	1.16	6
			20.50	23.50	3.00	SiltyClay	49	49	2.01	1.65	5
			23.50	25.00	1.50	SiltyClay	100	100	2.01	1.65	5
			25.00	29.50	4.50	SiltyClay	48	48	2.00	1.34	6
			29.50	40.00	10.50	SandySilt	87	34	1.96	0.19	31
		BH-A2	0.00	4.00	4.00	SiltySand	8	10	1.67	0.00	29
			4.00	7.00	3.00	SiltySand	11	11	1.69	0.00	29

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
10+859	11+543	BH-A2	7.00	10.00	3.00	SiltySand	14	13	1.71	0.00	30
			10.00	13.00	3.00	SiltySand	12	11	1.71	0.00	30
			13.00	16.00	3.00	SiltySand	21	16	1.79	0.11	28
			16.00	19.00	3.00	SiltyClay	57	57	2.01	1.88	6
			19.00	25.00	6.00	SiltyClay	55	55	2.01	1.88	6
			25.00	28.00	3.00	SiltyClay	72	72	2.03	2.29	6
			28.00	40.00	12.00	Sandy Silt	84	39	1.95	0.21	30
17+625	18+310	BH-A1	0.00	4.00	4.00	SandySilt	3	4	1.66	0.19	24
			4.00	7.00	3.00	SandySilt	12	14	1.79	0.20	25
			7.00	10.00	3.00	SandySilt	14	15	1.80	0.20	25
			10.00	13.00	3.00	SandySilt	13	12	1.80	0.20	25
			13.00	16.00	3.00	SandySilt	59	34	1.90	0.19	28
			16.00	19.00	3.00	SandySilt	52	29	1.90	0.19	28
			19.00	25.00	6.00	SiltyClay	76	76	2.04	2.41	5
			25.00	28.00	3.00	SiltyClay	55	55	2.02	1.76	6
			28.00	30.00	2.00	SiltyClay	100	100	2.04	2.05	5
		BH-A2	0.00	5.50	5.50	SandySilt	11	14	1.74	0.21	25
			5.50	8.50	3.00	SandySilt	20	18	1.83	0.22	27
			8.50	11.50	3.00	SandySilt	36	25	1.88	0.21	27
			11.50	14.50	3.00	SandySilt	45	28	1.90	0.21	28
			14.50	17.50	3.00	SandySilt	46	27	1.91	0.21	28
			17.50	20.50	3.00	SandySilt	52	28	1.91	0.18	29
			20.50	23.50	3.00	SandySilt	49	26	1.91	0.18	29
			23.50	26.50	3.00	SiltyClay	69	69	2.03	2.21	5
			26.50	30.00	3.50	SiltyClay	83	83	2.04	2.58	6
17+872	18+558	BH-A1	0.00	5.50	5.50	SiltyClay	7	7	1.87	0.26	5
			5.50	8.50	3.00	SandySilt	22	20	1.88	0.21	24
			8.50	11.50	3.00	SandySilt	30	23	1.89	0.21	24
			11.50	14.50	3.00	SandySilt	39	26	1.91	0.19	25
			14.50	17.50	3.00	SandySilt	42	26	1.92	0.19	25
			17.50	30.00	12.50	SiltyClay	100	100	2.06	3.16	4
		BH-A2	0.00	4.00	4.00	SiltyClay	16	16	1.92	0.56	5
			4.00	7.00	3.00	SiltyClay	22	22	1.96	0.75	4
			7.00	13.00	6.00	SandySilt	23	19	1.88	0.21	24
			13.00	16.00	3.00	SandySilt	38	25	1.91	0.22	25
			16.00	19.00	3.00	SiltyClay	63	63	2.03	2.02	5
			19.00	30.00	11.00	SiltyClay	100	100	2.05	3.15	4

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
-	19+010	BH-PLT-07	0.00	3.00	3.00	SiltyClay	8	8	1.80	0.19	7
			3.00	7.50	4.50	SandySilt	23	23	1.82	0.12	23
			7.50	12.00	4.50	SandySilt	38	28	1.89	0.18	26
18+750	19+435	BH-A1	0.00	4.00	4.00	SiltyClay	7	7	1.88	0.25	5
			4.00	8.50	4.50	SiltySand	27	24	1.84	0.00	30
			8.50	13.00	5.50	SiltyClay	14	14	1.92	0.49	5
			13.00	14.50	3.00	SiltySand	66	38	-	-	-
			14.50	20.50	3.00	SiltyClay	36	36	1.98	1.15	6
			20.50	23.50	3.00	SiltyClay	46	46	1.99	1.52	5
			23.50	26.50	3.00	SiltyClay	65	65	2.01	2.03	6
			26.50	30.00	3.50	SiltyClay	78	78	2.03	2.52	5
		BH-A2	0.00	4.00	4.00	SiltyClay	13	13	1.91	0.45	5
			4.00	7.00	3.00	SiltyClay	17	17	1.93	0.45	5
			7.00	10.00	3.00	SiltyClay	11	11	1.91	0.45	5
			10.00	13.00	3.00	SiltyClay	20	20	1.95	0.69	5
			13.00	16.00	3.00	SiltyClay	32	32	1.98	1.03	6
			16.00	22.00	6.00	SiltyClay	49	49	2.00	1.36	5
			22.00	25.00	3.00	SiltyClay	52	52	2.02	1.75	5
			25.00	30.00	5.00	SiltyClay	67	67	2.04	2.20	6
19+500	20+185	BH-A1	0.00	4.00	4.00	SiltyClay	14	14	1.86	0.29	5
			4.00	10.00	6.00	SiltySand	17	17	1.78	0.00	30
			10.00	13.00	3.00	SiltyClay	20	20	1.95	0.70	5
			13.00	16.00	3.00	SiltyClay	21	21	1.95	0.70	5
			16.00	19.00	3.00	SiltyClay	33	33	1.99	1.12	4
			19.00	22.00	3.00	SiltyClay	48	48	2.01	1.58	5
			22.00	25.00	3.00	SiltyClay	63	63	2.02	2.02	4
			25.00	31.00	6.00	SiltyClay	84	84	2.03	2.58	4
			31.00	40.00	9.00	SiltySand	100	39	1.98	0.13	32
		BH-P1	0.00	4.00	4.00	SiltyClay	6	6	1.86	0.22	5
			4.00	8.50	4.50	SiltyClay	15	15	1.93	0.52	5
			8.50	11.50	3.00	SiltyClay	17	17	1.94	0.60	4
			11.50	14.50	3.00	SiltyClay	22	22	1.96	0.76	4
			14.50	17.50	3.00	SiltyClay	32	32	1.99	1.12	5
			17.50	20.50	3.00	SiltyClay	35	35	2.00	1.12	5
			20.50	23.50	3.00	SiltyClay	75	75	2.04	2.41	4
			23.50	29.50	6.00	SiltyClay	76	76	2.04	2.41	4
			29.50	32.50	3.00	SandySilt	100	40	1.96	0.18	30
			32.50	40.00	7.50	SiltyClay	75	75	2.04	2.52	4

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
19+500	20+185	BH-A2	0.00	4.00	4.00	SiltyClay	18	18	1.95	0.63	5
			4.00	7.00	3.00	SiltyClay	19	19	1.95	0.63	5
			7.00	10.00	3.00	SiltyClay	8	8	1.87	0.30	5
			10.00	13.00	3.00	SiltyClay	58	58	2.02	1.85	4
			13.00	16.00	3.00	SiltyClay	56	56	2.02	1.85	4
			16.00	37.00	21.00	SiltyClay	86	76	2.03	3.12	4
			37.00	40.00	3.00	SiltyClay	100	100	2.03	3.12	4
19+715	20+400	BH-A1	0.00	5.50	5.50	SiltyClay	6	6	1.85	0.22	5
			5.50	9.00	3.50	SiltySand	18	18	1.76	0.00	30
			9.00	14.50	5.50	SiltyClay	22	22	1.96	0.75	5
			14.50	17.50	3.00	SiltyClay	27	27	1.97	0.92	5
			17.50	20.50	3.00	SandySilt	41	25	1.89	0.21	28
			20.50	25.00	4.50	SandySilt	57	30	1.91	0.19	29
			25.00	30.00	5.00	SiltyClay	84	84	2.04	2.59	6
		BH-P1	0.00	4.00	4.00	SiltyClay	5	5	1.85	0.18	5
			4.00	10.00	6.00	SiltySand	13	15	1.74	0.00	30
			10.00	14.50	4.50	SandySilt	36	25	1.89	0.22	27
			14.50	19.00	4.50	SandySilt	40	26	1.89	0.20	28
			19.00	26.50	7.50	SiltyClay	60	60	2.02	1.83	6
			26.50	30.00	3.50	SiltyClay	80	80	2.03	2.41	5
		BH-A2	0.00	5.50	5.50	SiltyClay	8	8	1.87	0.31	5
			5.50	8.50	3.00	SiltyClay	14	14	1.92	0.49	4
			8.50	12.00	3.50	SiltySand	25	21	1.81	0.00	31
			12.00	17.50	5.50	SandySilt	33	23	1.88	0.21	27
			17.50	20.50	3.00	SiltyClay	45	45	2.01	1.48	5
			20.50	23.50	3.00	SiltyClay	56	56	2.01	1.85	4
			23.50	30.00	6.50	SiltyClay	74	74	2.02	2.24	5
20+300	20+985	BH-A1	0.00	5.50	5.50	SandySilt	19	23	1.87	0.21	26
			5.50	8.50	3.00	SiltySand	38	30	1.87	0.11	30
			8.50	11.50	3.00	SiltyClay	46	46	2.00	1.52	5
			11.50	14.50	3.00	SiltyClay	53	53	2.02	1.70	6
			14.50	17.50	3.00	SiltyClay	53	53	2.02	1.70	6
			17.50	20.50	3.00	SiltyClay	54	54	2.02	1.70	6
			20.50	26.50	6.00	SiltyClay	63	63	2.02	1.97	5
			26.50	32.50	6.00	SiltyClay	61	61	2.02	1.97	5
			32.50	40.00	7.50	SiltyClay	75	75	2.03	2.35	6

ChainageOld (km)	ChainageNew (km)	BH.No.	Layer depth below EGL(m)		Thicknessofstrata(m)	Stratadescription	SPT'N'		BulkDensity(gm/cc)	Cohesion(C)(kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
20+300	20+985	BH-P1	0.00	4.00	4.00	SiltyClay	8	8	1.87	0.30	5
			4.00	7.00	3.00	SandySilt	19	19	1.85	0.21	26
			7.00	10.00	3.00	SandySilt	22	19	1.85	0.21	26
			10.00	13.00	3.00	SandySilt	33	24	1.90	0.22	27
			13.00	17.50	4.50	SandySilt	40	25	1.91	0.22	27
			17.50	22.00	4.50	SiltyClay	53	53	2.01	1.65	4
			22.00	25.00	3.00	SiltyClay	68	68	2.02	2.18	5
			25.00	40.00	15.00	SiltyClay	100	100	2.05	3.14	4
		BH-P2	0.00	4.00	4.00	SiltyClay	8	8	1.87	0.29	5
			4.00	8.50	4.50	SandySilt	16	17	1.84	0.21	25
			8.50	11.50	3.00	SandySilt	24	20	1.86	0.20	26
			11.50	14.50	3.00	SandySilt	33	23	1.87	0.19	28
			14.50	19.00	4.50	SandySilt	45	27	1.89	0.20	28
			19.00	23.50	4.50	SiltyClay	57	57	2.02	1.82	5
			23.50	40.00	16.50	SiltyClay	100	100	2.08	3.14	4
		BH-A2	0.00	4.00	4.00	SiltyClay	10	10	1.88	0.37	5
			4.00	7.00	3.00	SiltyClay	18	18	1.94	0.70	4
			7.00	10.00	3.00	SiltyClay	21	21	1.94	0.70	4
			10.00	13.00	3.00	SiltyClay	28	28	1.98	0.95	5
			13.00	16.00	3.00	SiltyClay	32	32	1.98	1.16	5
			16.00	19.00	3.00	SiltyClay	36	36	1.98	1.16	5
			19.00	22.00	3.00	SandySilt	43	23	1.91	0.21	28
			22.00	28.00	6.00	SandySilt	59	27	1.91	0.21	28
			28.00	34.00	6.00	SandySilt	82	33	1.93	0.18	30
			34.00	40.00	6.00	SiltyClay	100	100	2.05	3.18	4
			0.00	5.50	5.50	SiltyClay	5	5	1.68	0.20	6
			5.50	8.50	3.00	SiltySand	11	13	1.67	0.00	28
			8.50	11.50	3.00	SiltySand	18	17	1.75	0.00	29

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-in-situ RCC pile in compression & uplift are attached vide **Appendix C-3.**

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-4.**

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 (km)	Chainage New (km)	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)
-	0+000	BH-PLT-09	2.0 x 2.0	1.0	16.1	10.3	10.3
			2.0 x 2.0	2.7	27.6	13.0	13.0
			2.0 x 2.0	3.0	29.8	13.3	13.3
-	0+000	PLT-09	2.0 x 2.0	2.7	20.4	22.8	20.4
(-)0+627	0+057	BH-CL	7.2 x 7.2	1.0	42.5	26.1	26.1
			7.2 x 7.2	2.0	53.4	25.9	25.9
			7.2 x 7.2	3.0	64.8	24.9	24.9
(-)0+529	0+158	BH-CL	4.8 x 4.8	1.0	24.0	25.2	24.0
			4.8 x 4.8	2.0	32.1	25.8	25.8
			4.8 x 4.8	3.0	40.7	26.1	26.1
(-)0+319	0+371	BH-CL	5.5 x 5.5	1.0	40.6	16.3	16.3
			5.5 x 5.5	2.0	52.5	14.7	14.7
			5.5 x 5.5	3.0	64.9	14.1	14.1
0+273	0+958	BH-CL	4.8 x 4.8	1.0	49.4	23.8	23.8
			4.8 x 4.8	2.0	61.4	25.8	25.8
			4.8 x 4.8	3.0	74.1	27.9	27.9
1+006	1+696	BH-A1	7.2 x 7.2	2.0	38.1	21.6	21.6
			7.2 x 7.2	3.0	47.2	25.3	25.3
			7.2 x 7.2	4.0	56.6	30.3	30.3
		BH-A2	7.2 x 7.2	2.0	43.2	11.1	11.1
			7.2 x 7.2	3.0	53.4	17.4	17.4
			7.2 x 7.2	4.0	63.9	38.9	38.9
1+333	2+018	BH-CL	4.8 x 4.8	1.0	50.2	40.7	40.7
			4.8 x 4.8	2.0	68.7	42.1	42.1
			4.8 x 4.8	3.0	88.4	44.3	44.3
1+811	2+493	BH-CL	12.5 x 12.5	1.0	41.8	28.9	28.9
			12.5 x 12.5	2.0	49.6	29.6	29.6
			12.5 x 12.5	3.0	57.6	30.2	30.2

Chainage Old (km)	Chainage New (km)	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+472	3+160	BH-CL	2.7 x 2.7	1.0	18.2	16.5	16.5
			2.7 x 2.7	2.0	25.9	22.1	22.1
			2.7 x 2.7	3.0	33.4	31.9	31.9
2+788	3+476	BH-A1	7.2 x 7.2	2.0	87.9	26.0	26.0
			7.2 x 7.2	3.0	107.3	29.9	29.9
			7.2 x 7.2	4.0	127.5	34.1	34.1
		BH-A2	7.2 x 7.2	2.0	88.7	21.6	21.6
			7.2 x 7.2	3.0	108.3	25.3	25.3
			7.2 x 7.2	4.0	128.7	30.3	30.3
3+497	4+242	BH-A1	7.2 x 7.2	2.0	22.1	7.2	7.2
			7.2 x 7.2	3.0	23.0	10.2	10.2
			7.2 x 7.2	4.0	23.9	17.3	17.3
		BH-P1	7.2 x 7.2	2.0	62.5	44.2	44.2
			7.2 x 7.2	3.0	73.0	45.7	45.7
			7.2 x 7.2	4.0	83.9	46.5	46.5
		BH-P2	7.2 x 7.2	2.0	41.5	14.1	14.1
			7.2 x 7.2	3.0	51.2	14.5	14.5
			7.2 x 7.2	4.0	61.4	14.8	14.8
		BH-P3	7.2 x 7.2	2.0	48.9	14.9	14.9
			7.2 x 7.2	3.0	60.2	15.6	15.6
			7.2 x 7.2	4.0	72.0	16.6	16.6
		BH-A2	7.2 x 7.2	2.0	71.1	29.0	29.0
			7.2 x 7.2	3.0	87.1	30.2	30.2
			7.2 x 7.2	4.0	103.7	31.6	31.6
3+691	4+376	BH-A1	7.2 x 7.2	2.0	41.7	15.9	15.9
			7.2 x 7.2	3.0	49.1	16.8	16.8
			7.2 x 7.2	4.0	56.8	17.5	17.5
		BH-A2	7.2 x 7.2	2.0	41.7	10.1	10.1
			7.2 x 7.2	3.0	49.1	12.5	12.5
			7.2 x 7.2	4.0	56.8	15.9	15.9
4+174	4+858	BH-CL	4.8 x 4.8	1.0	15.1	16.2	15.1
			4.8 x 4.8	2.0	16.0	17.2	16.0
			4.8 x 4.8	3.0	17.0	21.2	17.0
4+207	4+892	BH-CL	1.5 x 1.5	1.0	26.6	47.1	26.6
			1.5 x 1.5	2.0	38.0	55.8	38.0
			1.5 x 1.5	3.0	50.7	60.6	50.7
4+655	5+340	BH-CL	4.8 x 4.8	1.0	15.1	16.2	15.1
			4.8 x 4.8	2.0	16.0	17.2	16.0
			4.8 x 4.8	3.0	17.0	21.2	17.0

Chainage Old (km)	Chainage New (km)	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)
5+119	5+804	BH-CL	4.8 x 4.8	1.0	14.0	21.7	14.0
			4.8 x 4.8	2.0	19.9	23.5	19.9
			4.8 x 4.8	3.0	26.2	25.4	25.4
5+730	6+415	BH-CL	3.7 x 3.7	1.0	15.3	17.5	15.3
			3.7 x 3.7	2.0	22.8	19.4	19.4
			3.7 x 3.7	3.0	30.8	21.3	21.3
6+197	6+881	BH-CL	4.8 x 4.8	1.0	16.2	9.5	9.5
			4.8 x 4.8	2.0	18.9	10.3	10.3
			4.8 x 4.8	3.0	21.8	11.1	11.1
6+877	7+559	BH-CL	4.8 x 4.8	1.0	16.0	10.2	10.2
			4.8 x 4.8	2.0	19.9	11.0	11.0
			4.8 x 4.8	3.0	24.0	11.9	11.9
7+078	7+759	BH-A1	7.2 x 7.2	2.0	16.9	7.4	7.4
			7.2 x 7.2	3.0	19.1	7.9	7.9
			7.2 x 7.2	4.0	21.5	8.5	8.5
		BH-A2	7.2 x 7.2	2.0	23.5	4.3	NR
			7.2 x 7.2	3.0	26.7	4.7	NR
			7.2 x 7.2	4.0	29.9	5.3	NR
7+256	7+941	BH-CL	2.7 x 2.7	1.0	11.9	13.5	11.9
			2.7 x 2.7	2.0	18.3	15.5	15.5
			2.7 x 2.7	3.0	25.4	17.1	17.1
7+351	8+036	BH-A1	7.2 x 7.2	2.0	19.5	7.3	NR*
			7.2 x 7.2	3.0	22.1	8.1	NR*
			7.2 x 7.2	4.0	24.9	9.1	NR*
		BH-P1	7.2 x 7.2	2.0	9.3	6.2	NR
			7.2 x 7.2	3.0	11.4	7.2	NR
			7.2 x 7.2	4.0	13.6	8.4	NR
		BH-A2	7.2 x 7.2	2.0	9.3	12.8	NR
			7.2 x 7.2	3.0	11.4	13.5	NR
			7.2 x 7.2	4.0	13.6	14.3	NR
7+457	8+141	BH-CL	2.7 x 2.7	1.0	17.6	10.8	10.8
			2.7 x 2.7	2.0	21.3	12.3	12.3
			2.7 x 2.7	3.0	25.4	13.7	13.7
7+613	8+298	BH-A1	7.2 x 7.2	2.0	16.4	7.5	NR*
			7.2 x 7.2	3.0	20.0	7.9	NR*
			7.2 x 7.2	4.0	23.8	8.4	NR*
		BH-A2	7.2 x 7.2	2.0	18.2	14.9	14.9
			7.2 x 7.2	3.0	18.8	15.7	15.7
			7.2 x 7.2	4.0	19.5	16.7	16.7

Chainage Old (km)	Chainage New (km)	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)
7+907	8+592	BH-CL	4.8 x 4.8	1.0	11.9	7.2	7.2
			4.8 x 4.8	2.0	12.5	7.8	7.8
			4.8 x 4.8	3.0	13.2	8.4	8.4
8+207	8+891	BH-CL	4.8 x 4.8	1.0	18.5	9.2	9.2
			4.8 x 4.8	2.0	21.8	9.9	9.9
			4.8 x 4.8	3.0	25.3	10.6	10.6
8+610	9+295	BH-CL	7.2 x 7.2	1.0	17.3	9.3	9.3
			7.2 x 7.2	2.0	21.8	9.7	9.7
			7.2 x 7.2	3.0	26.5	10.2	10.2
8+852	9+537	BH-A1	7.2 x 7.2	2.0	21.7	10.5	10.5
			7.2 x 7.2	3.0	25.3	13.1	13.1
			7.2 x 7.2	4.0	29.1	15.1	15.1
		BH-A2	7.2 x 7.2	2.0	11.7	6.9	6.9
			7.2 x 7.2	3.0	14.2	8.1	8.1
			7.2 x 7.2	4.0	16.9	9.2	9.2
8+907	9+591	BH-CL	2.7 x 2.7	1.0	4.0	8.3	NR*
			2.7 x 2.7	2.0	6.2	9.6	NR*
			2.7 x 2.7	3.0	8.7	10.6	NR*
-	10+340	BH-PLT-08	4.8 x 4.8	1.0	15.8	3.3	NR*
			4.8 x 4.8	2.0	18.8	4.7	NR*
			4.8 x 4.8	3.0	22.0	7.9	NR*
9+200	9+882	BH-CL	2.7 x 2.7	1.0	4.0	8.3	NR
			2.7 x 2.7	2.0	6.2	9.6	NR
			2.7 x 2.7	3.0	8.7	10.6	NR
9+211	9+894	BH-CL	6.0 x 6.0	1.0	3.6	3.5	NR*
			6.0 x 6.0	2.0	3.9	4.5	NR*
			6.0 x 6.0	3.0	4.1	6.0	NR*
9+407	10+091	BH-CL	3.7 x 3.7	1.0	3.6	5.6	NR
			3.7 x 3.7	2.0	3.9	6.2	NR
			3.7 x 3.7	3.0	4.3	6.7	NR
9+726	10+410	BH-A1	7.2 x 7.2	2.0	24.6	7.6	NR*
			7.2 x 7.2	3.0	30.0	8.6	NR*
			7.2 x 7.2	4.0	35.6	9.8	NR*
		BH-A2	7.2 x 7.2	2.0	21.6	7.3	NR
			7.2 x 7.2	3.0	26.4	8.0	NR
			7.2 x 7.2	4.0	31.5	9.0	NR
9+772	10+457	BH-CL	7.2 x 7.2	1.0	18.8	4.9	NR*
			7.2 x 7.2	2.0	21.5	8.5	NR*
			7.2 x 7.2	3.0	24.4	10.9	NR*

Chainage Old (km)	Chainage New (km)	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)
10+025	10+709	BH-A1	7.2 x 7.2	2.0	14.5	8.0	8.0
			7.2 x 7.2	3.0	16.3	8.4	8.4
			7.2 x 7.2	4.0	18.2	8.9	8.9
		BH-A2	7.2 x 7.2	2.0	17.5	12.8	12.8
			7.2 x 7.2	3.0	19.5	13.5	13.5
			7.2 x 7.2	4.0	21.6	14.3	14.3
10+223	10+908	BH-CL	2.7 x 2.7	1.0	13.1	4.4	NR*
			2.7 x 2.7	2.0	15.9	8.4	NR*
			2.7 x 2.7	3.0	18.8	11.3	NR*
10+519	11+203	BH-CL	4.8 x 4.8	1.0	18.8	7.8	NR*
			4.8 x 4.8	2.0	21.8	8.5	NR*
			4.8 x 4.8	3.0	25.0	9.2	NR*
10+658	11+340	BH-CL	2.7 x 2.7	1.0	12.2	5.0	NR*
			2.7 x 2.7	2.0	14.9	8.4	NR*
			2.7 x 2.7	3.0	17.7	13.4	NR*
10+718	11+403	BH-CL	4.8 x 4.8	1.0	9.9	8.9	NR
			4.8 x 4.8	2.0	12.1	9.6	NR
			4.8 x 4.8	3.0	14.5	10.4	NR
10+749	11+434	BH-CL	2.7 x 2.7	1.0	16.8	9.5	9.5
			2.7 x 2.7	2.0	20.4	10.9	10.9
			2.7 x 2.7	3.0	24.2	12.0	12.0
10+859	11+543	BH-A1(R)	7.2 x 7.2	2.0	11.7	5.4	NR*
			7.2 x 7.2	3.0	13.4	5.8	NR*
			7.2 x 7.2	4.0	15.2	6.3	NR*
		BH-A1	7.2 x 7.2	2.0	9.1	10.7	NR
			7.2 x 7.2	3.0	11.2	11.5	NR
			7.2 x 7.2	4.0	13.3	12.7	NR
		BH-P1	7.2 x 7.2	2.0	9.1	7.0	NR
			7.2 x 7.2	3.0	11.3	7.3	NR
			7.2 x 7.2	4.0	13.4	7.6	NR
		BH-A2	7.2 x 7.2	2.0	9.7	3.8	NR
			7.2 x 7.2	3.0	12.0	3.9	NR
			7.2 x 7.2	4.0	14.3	4.1	NR
17+625	18+310	BH-A1	7.2 x 7.2	2.0	17.8	7.5	NR
			7.2 x 7.2	3.0	20.1	7.9	NR
			7.2 x 7.2	4.0	22.5	8.4	NR
		BH-A2	7.2 x 7.2	2.0	16.8	10.4	NR*
			7.2 x 7.2	3.0	18.8	10.9	NR*
			7.2 x 7.2	4.0	20.9	11.5	NR*

Chainage Old (km)	Chainage New (km)	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)
17+872	18+558	BH-A1	7.2 x 7.2	2.0	6.3	6.4	NR
			7.2 x 7.2	3.0	6.6	8.2	NR
			7.2 x 7.2	4.0	6.9	12.3	NR
		BH-A2	7.2 x 7.2	2.0	18.4	11.8	11.8
			7.2 x 7.2	3.0	19.0	10.9	10.9
			7.2 x 7.2	4.0	19.7	10.6	10.6
-	19+010	BH-PLT-07	4.8 x 4.8	1.0	4.9	6.3	NR*
			4.8 x 4.8	2.0	5.3	8.9	NR*
			4.8 x 4.8	3.0	5.7	14.0	NR*
18+750	19+435	BH-A1	7.2 x 7.2	2.0	6.3	9.4	NR*
			7.2 x 7.2	3.0	6.6	15.5	NR*
			7.2 x 7.2	4.0	6.9	18.3	NR*
		BH-A2	7.2 x 7.2	2.0	10.5	8.9	NR
			7.2 x 7.2	3.0	11.0	8.4	NR
			7.2 x 7.2	4.0	11.4	9.3	NR
19+500	20+185	BH-A1	7.2 x 7.2	2.0	7.0	6.8	NR
			7.2 x 7.2	3.0	7.3	8.4	NR
			7.2 x 7.2	4.0	7.6	11.0	NR
		BH-P1	7.2 x 7.2	2.0	5.4	5.4	NR*
			7.2 x 7.2	3.0	5.7	5.7	NR*
			7.2 x 7.2	4.0	6.0	6.1	NR*
		BH-A2	7.2 x 7.2	2.0	15.0	30.9	NR
			7.2 x 7.2	3.0	15.5	32.6	NR
			7.2 x 7.2	4.0	16.1	34.4	NR
19+715	20+400	BH-A1	7.2 x 7.2	2.0	17.8	4.5	NR
			7.2 x 7.2	3.0	21.7	5.3	NR
			7.2 x 7.2	4.0	25.8	6.6	NR
		BH-P1	7.2 x 7.2	2.0	13.0	4.7	NR
			7.2 x 7.2	3.0	16.0	6.3	NR
			7.2 x 7.2	4.0	19.0	10.1	NR
		BH-A2	7.2 x 7.2	2.0	10.9	6.1	NR
			7.2 x 7.2	3.0	11.4	6.7	NR
			7.2 x 7.2	4.0	11.8	7.3	NR
20+300	20+985	BH-A1	7.2 x 7.2	2.0	28.1	15.1	15.1
			7.2 x 7.2	3.0	31.9	17.4	17.4
			7.2 x 7.2	4.0	35.7	20.7	20.7
		BH-P1	7.2 x 7.2	2.0	22.3	8.5	NR
			7.2 x 7.2	3.0	25.2	10.2	NR
			7.2 x 7.2	4.0	28.2	10.8	NR

Chainage Old (km)	Chainage New (km)	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)
20+300	20+985	BH-P2	7.2 x 7.2	2.0	7.0	7.2	NR*
			7.2 x 7.2	3.0	7.3	9.2	NR*
			7.2 x 7.2	4.0	7.6	13.5	NR*
		BH-A2	7.2 x 7.2	2.0	16.4	13.8	13.8
			7.2 x 7.2	3.0	17.0	14.5	14.5
			7.2 x 7.2	4.0	17.6	15.3	15.3

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.

Note:-

- NR* - BH's as Liquefible depth less than or equal to 4m (SBC is recommended after replacement/compaction).
- NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm

Chainage Old (km)	Chainage New (km)	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)
-	0+000	BH-PLT-09	2.0 x 2.0	1.0	16.1	20.6	16.1
			2.0 x 2.0	2.7	27.6	26.0	26.0
			2.0 x 2.0	3.0	29.8	26.6	26.6
(-)0+627	0+057	BH-CL	7.2 x 7.2	1.0	42.5	52.2	42.5
			7.2 x 7.2	2.0	53.4	51.8	51.8
			7.2 x 7.2	3.0	64.8	49.8	49.8
(-)0+529	0+158	BH-CL	4.8 x 4.8	1.0	24.0	50.4	24.0
			4.8 x 4.8	2.0	32.1	51.6	32.1
			4.8 x 4.8	3.0	40.7	52.3	40.7
(-)0+319	0+371	BH-CL	5.5 x 5.5	1.0	40.6	32.6	32.6
			5.5 x 5.5	2.0	52.5	29.4	29.4
			5.5 x 5.5	3.0	64.9	28.3	28.3
0+273	0+958	BH-CL	4.8 x 4.8	1.0	49.4	47.7	47.7
			4.8 x 4.8	2.0	61.4	51.5	51.5
			4.8 x 4.8	3.0	74.1	55.8	55.8
1+006	1+696	BH-A1	7.2 x 7.2	2.0	38.1	43.2	38.1
			7.2 x 7.2	3.0	47.2	50.6	47.2
			7.2 x 7.2	4.0	56.6	60.7	56.6

Chainage Old (km)	Chainage New (km)	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)
1+006	1+696	BH-A2	7.2 x 7.2	2.0	43.2	22.2	22.2
			7.2 x 7.2	3.0	53.4	34.9	34.9
			7.2 x 7.2	4.0	63.9	77.9	63.9
1+333	2+018	BH-CL	4.8 x 4.8	1.0	50.2	81.3	50.2
			4.8 x 4.8	2.0	68.7	84.2	68.7
			4.8 x 4.8	3.0	88.4	88.5	88.4
1+811	2+493	BH-CL	12.5 x 12.5	1.0	41.8	57.8	41.8
			12.5 x 12.5	2.0	49.6	59.3	49.6
			12.5 x 12.5	3.0	57.6	60.5	57.6
2+472	3+160	BH-CL	2.7 x 2.7	1.0	18.2	32.9	18.2
			2.7 x 2.7	2.0	25.9	44.1	25.9
			2.7 x 2.7	3.0	33.4	63.8	33.4
2+788	3+476	BH-A1	7.2 x 7.2	2.0	87.9	52.0	52.0
			7.2 x 7.2	3.0	107.3	59.9	59.9
			7.2 x 7.2	4.0	127.5	68.2	68.2
		BH-A2	7.2 x 7.2	2.0	88.7	43.2	43.2
			7.2 x 7.2	3.0	108.3	50.6	50.6
			7.2 x 7.2	4.0	128.7	60.7	60.7
3+497	4+242	BH-A1	7.2 x 7.2	2.0	22.1	14.3	14.3
			7.2 x 7.2	3.0	23.0	20.5	20.5
			7.2 x 7.2	4.0	23.9	34.6	23.9
		BH-P1	7.2 x 7.2	2.0	62.5	88.3	62.5
			7.2 x 7.2	3.0	73.0	91.4	73.0
			7.2 x 7.2	4.0	83.9	93.0	83.9
		BH-P2	7.2 x 7.2	2.0	41.5	28.2	28.2
			7.2 x 7.2	3.0	51.2	29.0	29.0
			7.2 x 7.2	4.0	61.4	29.5	29.5
		BH-P3	7.2 x 7.2	2.0	48.9	29.8	29.8
			7.2 x 7.2	3.0	60.2	31.2	31.2
			7.2 x 7.2	4.0	72.0	33.1	33.1
		BH-A2	7.2 x 7.2	2.0	71.1	58.0	58.0
			7.2 x 7.2	3.0	87.1	60.3	60.3
			7.2 x 7.2	4.0	103.7	63.3	63.3
3+691	4+376	BH-A1	7.2 x 7.2	2.0	41.7	31.9	31.9
			7.2 x 7.2	3.0	49.1	33.6	33.6
			7.2 x 7.2	4.0	56.8	35.0	35.0
		BH-A2	7.2 x 7.2	2.0	41.7	20.2	20.2
			7.2 x 7.2	3.0	49.1	25.1	25.1
			7.2 x 7.2	4.0	56.8	31.7	31.7
4+174	4+858	BH-CL	4.8 x 4.8	1.0	15.1	32.4	15.1
			4.8 x 4.8	2.0	16.0	34.4	16.0
			4.8 x 4.8	3.0	17.0	42.4	17.0

Chainage Old (km)	Chainage New (km)	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)
4+207	4+892	BH-CL	1.5 x 1.5	1.0	26.6	94.2	26.6
			1.5 x 1.5	2.0	38.0	111.7	38.0
			1.5 x 1.5	3.0	50.7	121.1	50.7
4+655	5+340	BH-CL	4.8 x 4.8	1.0	15.1	32.4	15.1
			4.8 x 4.8	2.0	16.0	34.4	16.0
			4.8 x 4.8	3.0	17.0	42.4	17.0
5+119	5+804	BH-CL	4.8 x 4.8	1.0	14.0	43.4	14.0
			4.8 x 4.8	2.0	19.9	46.9	19.9
			4.8 x 4.8	3.0	26.2	50.8	26.2
5+730	6+415	BH-CL	3.7 x 3.7	1.0	15.3	35.0	15.3
			3.7 x 3.7	2.0	22.8	38.9	22.8
			3.7 x 3.7	3.0	30.8	42.5	30.8
6+197	6+881	BH-CL	4.8 x 4.8	1.0	16.2	19.0	16.2
			4.8 x 4.8	2.0	18.9	20.6	18.9
			4.8 x 4.8	3.0	21.8	22.3	21.8
6+877	7+559	BH-CL	4.8 x 4.8	1.0	16.0	20.4	16.0
			4.8 x 4.8	2.0	19.9	22.0	19.9
			4.8 x 4.8	3.0	24.0	23.8	23.8
7+078	7+759	BH-A1	7.2 x 7.2	2.0	16.9	14.9	14.9
			7.2 x 7.2	3.0	19.1	15.8	15.8
			7.2 x 7.2	4.0	21.5	17.0	17.0
		BH-A2	7.2 x 7.2	2.0	23.5	8.6	NR
			7.2 x 7.2	3.0	26.7	9.5	NR
			7.2 x 7.2	4.0	29.9	10.6	NR
7+256	7+941	BH-CL	2.7 x 2.7	1.0	11.9	26.9	11.9
			2.7 x 2.7	2.0	18.3	30.9	18.3
			2.7 x 2.7	3.0	25.4	34.2	25.4
7+351	8+036	BH-A1	7.2 x 7.2	2.0	19.5	14.5	NR*
			7.2 x 7.2	3.0	22.1	16.1	NR*
			7.2 x 7.2	4.0	24.9	18.2	NR*
		BH-P1	7.2 x 7.2	2.0	9.3	12.3	NR
			7.2 x 7.2	3.0	11.4	14.4	NR
			7.2 x 7.2	4.0	13.6	16.7	NR
		BH-A2	7.2 x 7.2	2.0	9.3	25.7	NR
			7.2 x 7.2	3.0	11.4	27.0	NR
			7.2 x 7.2	4.0	13.6	28.6	NR
7+457	8+141	BH-CL	2.7 x 2.7	1.0	17.6	21.5	17.6
			2.7 x 2.7	2.0	21.3	24.7	21.3
			2.7 x 2.7	3.0	25.4	27.3	25.4
7+613	8+298	BH-A1	7.2 x 7.2	2.0	16.4	15.0	NR*
			7.2 x 7.2	3.0	20.0	15.9	NR*
			7.2 x 7.2	4.0	23.8	16.8	NR*

Chainage Old (km)	Chainage New (km)	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)
7+613	8+298	BH-A2	7.2 x 7.2	2.0	18.2	29.8	18.2
			7.2 x 7.2	3.0	18.8	31.5	18.8
			7.2 x 7.2	4.0	19.5	33.4	19.5
7+907	8+592	BH-CL	4.8 x 4.8	1.0	11.9	14.4	11.9
			4.8 x 4.8	2.0	12.5	15.5	12.5
			4.8 x 4.8	3.0	13.2	16.8	13.2
8+207	8+891	BH-CL	4.8 x 4.8	1.0	18.5	18.3	18.3
			4.8 x 4.8	2.0	21.8	19.7	19.7
			4.8 x 4.8	3.0	25.3	21.3	21.3
8+610	9+295	BH-CL	7.2 x 7.2	1.0	17.3	18.5	17.3
			7.2 x 7.2	2.0	21.8	19.4	19.4
			7.2 x 7.2	3.0	26.5	20.4	20.4
8+852	9+537	BH-A1	7.2 x 7.2	2.0	21.7	23.3	21.7
			7.2 x 7.2	3.0	25.3	26.3	25.3
			7.2 x 7.2	4.0	29.1	30.2	29.1
		BH-A2	7.2 x 7.2	2.0	11.7	14.7	11.7
			7.2 x 7.2	3.0	14.2	16.2	14.2
			7.2 x 7.2	4.0	16.9	18.3	16.9
8+907	9+591	BH-CL	2.7 x 2.7	1.0	4.0	16.7	NR*
			2.7 x 2.7	2.0	6.2	19.2	NR*
			2.7 x 2.7	3.0	8.7	21.2	NR*
-	10+340	BH-PLT-08	4.8 x 4.8	1.0	15.8	6.6	NR*
			4.8 x 4.8	2.0	18.8	9.4	NR*
			4.8 x 4.8	3.0	22.0	15.9	NR*
9+200	9+882	BH-CL	2.7 x 2.7	1.0	4.0	16.7	NR
			2.7 x 2.7	2.0	6.2	19.2	NR
			2.7 x 2.7	3.0	8.7	21.2	NR
9+211	9+894	BH-CL	6.0 x 6.0	1.0	3.6	7.0	NR*
			6.0 x 6.0	2.0	3.9	9.0	NR*
			6.0 x 6.0	3.0	4.1	12.0	NR*
9+407	10+091	BH-CL	3.7 x 3.7	1.0	3.6	11.1	NR
			3.7 x 3.7	2.0	3.9	12.4	NR
			3.7 x 3.7	3.0	4.3	13.4	NR
9+726	10+410	BH-A1	7.2 x 7.2	2.0	24.6	15.9	NR*
			7.2 x 7.2	3.0	30.0	15.9	NR*
			7.2 x 7.2	4.0	35.6	16.8	NR*
		BH-A2	7.2 x 7.2	2.0	21.6	15.1	NR
			7.2 x 7.2	3.0	26.4	15.9	NR
			7.2 x 7.2	4.0	31.5	16.8	NR
9+772	10+457	BH-CL	7.2 x 7.2	1.0	18.8	12.7	NR*
			7.2 x 7.2	2.0	21.5	38.5	NR*
			7.2 x 7.2	3.0	24.4	21.8	NR*

Chainage Old (km)	Chainage New (km)	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)
10+025	10+709	BH-A1	7.2 x 7.2	2.0	14.5	15.9	14.5
			7.2 x 7.2	3.0	16.3	16.8	16.3
			7.2 x 7.2	4.0	18.2	17.7	17.7
		BH-A2	7.2 x 7.2	2.0	17.5	25.7	17.5
			7.2 x 7.2	3.0	19.5	27.0	19.5
			7.2 x 7.2	4.0	21.6	28.6	21.6
10+223	10+908	BH-CL	2.7 x 2.7	1.0	13.1	8.7	NR*
			2.7 x 2.7	2.0	15.9	16.8	NR*
			2.7 x 2.7	3.0	18.8	22.5	NR*
10+519	11+203	BH-CL	4.8 x 4.8	1.0	18.8	15.6	NR*
			4.8 x 4.8	2.0	21.8	16.9	NR*
			4.8 x 4.8	3.0	25.0	18.3	NR*
10+658	11+340	BH-CL	2.7 x 2.7	1.0	12.2	9.6	NR*
			2.7 x 2.7	2.0	14.9	14.9	NR*
			2.7 x 2.7	3.0	17.7	26.9	NR*
10+718	11+403	BH-CL	4.8 x 4.8	1.0	9.9	17.7	NR
			4.8 x 4.8	2.0	12.1	19.2	NR
			4.8 x 4.8	3.0	14.5	20.8	NR
10+749	11+434	BH-CL	2.7 x 2.7	1.0	16.8	19.0	16.8
			2.7 x 2.7	2.0	20.4	21.8	20.4
			2.7 x 2.7	3.0	24.2	24.1	24.1
10+859	11+543	BH-A1(R)	7.2 x 7.2	2.0	11.7	10.7	NR*
			7.2 x 7.2	3.0	13.4	11.5	NR*
			7.2 x 7.2	4.0	15.2	12.7	NR*
		BH-A1	7.2 x 7.2	2.0	11.7	10.7	NR
			7.2 x 7.2	3.0	13.4	11.5	NR
			7.2 x 7.2	4.0	15.2	12.7	NR
		BH-P1	7.2 x 7.2	2.0	9.1	14.0	NR
			7.2 x 7.2	3.0	11.3	15.0	NR
			7.2 x 7.2	4.0	13.4	16.3	NR
		BH-A2	7.2 x 7.2	2.0	9.7	7.6	NR
			7.2 x 7.2	3.0	12.0	8.0	NR
			7.2 x 7.2	4.0	14.3	8.4	NR
17+625	18+310	BH-A1	7.2 x 7.2	2.0	17.8	15.0	NR
			7.2 x 7.2	3.0	20.1	15.9	NR
			7.2 x 7.2	4.0	22.5	16.8	NR
		BH-A2	7.2 x 7.2	2.0	16.8	20.7	NR*
			7.2 x 7.2	3.0	18.8	21.8	NR*
			7.2 x 7.2	4.0	20.9	23.1	NR*
17+872	18+558	BH-A1	7.2 x 7.2	2.0	6.3	12.7	NR
			7.2 x 7.2	3.0	6.6	16.4	NR
			7.2 x 7.2	4.0	6.9	24.6	NR

Chainage Old (km)	Chainage New (km)	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)
17+872	18+558	BH-A2	7.2 x 7.2	2.0	18.4	21.2	18.4
			7.2 x 7.2	3.0	19.0	21.7	19.0
			7.2 x 7.2	4.0	19.7	22.1	19.7
-	19+010	BH-PLT-07	4.8 x 4.8	1.0	4.9	12.7	NR*
			4.8 x 4.8	2.0	5.3	17.7	NR*
			4.8 x 4.8	3.0	5.7	27.9	NR*
18+750	19+435	BH-A1	7.2 x 7.2	2.0	6.3	18.8	NR*
			7.2 x 7.2	3.0	6.6	31.1	NR*
			7.2 x 7.2	4.0	6.9	36.5	NR*
		BH-A2	7.2 x 7.2	2.0	10.5	15.5	NR
			7.2 x 7.2	3.0	11.0	16.8	NR
			7.2 x 7.2	4.0	11.4	18.6	NR
19+500	20+185	BH-A1	7.2 x 7.2	2.0	7.0	13.5	NR
			7.2 x 7.2	3.0	7.3	16.8	NR
			7.2 x 7.2	4.0	7.6	22.0	NR
		BH-P1	7.2 x 7.2	2.0	5.4	10.9	NR*
			7.2 x 7.2	3.0	5.7	11.5	NR*
			7.2 x 7.2	4.0	6.0	12.1	NR*
		BH-A2	7.2 x 7.2	2.0	15.0	61.9	NR
			7.2 x 7.2	3.0	15.5	65.2	NR
			7.2 x 7.2	4.0	16.1	68.9	NR
19+715	20+400	BH-A1	7.2 x 7.2	2.0	17.8	8.9	NR
			7.2 x 7.2	3.0	21.7	10.5	NR
			7.2 x 7.2	4.0	25.8	13.2	NR
		BH-P1	7.2 x 7.2	2.0	13.0	9.5	NR
			7.2 x 7.2	3.0	16.0	12.5	NR
			7.2 x 7.2	4.0	19.0	20.1	NR
		BH-A2	7.2 x 7.2	2.0	10.9	12.2	NR
			7.2 x 7.2	3.0	11.4	13.3	NR
			7.2 x 7.2	4.0	11.8	14.6	NR
20+300	20+985	BH-A1	7.2 x 7.2	2.0	28.1	30.2	28.1
			7.2 x 7.2	3.0	31.9	34.9	31.9
			7.2 x 7.2	4.0	35.7	41.4	35.7
		BH-P1	7.2 x 7.2	2.0	22.3	16.9	NR
			7.2 x 7.2	3.0	25.2	20.4	NR
			7.2 x 7.2	4.0	28.2	21.6	NR
		BH-P2	7.2 x 7.2	2.0	7.0	14.4	NR*
			7.2 x 7.2	3.0	7.3	18.3	NR*
			7.2 x 7.2	4.0	7.6	27.0	NR*
		BH-A2	7.2 x 7.2	2.0	16.4	27.5	16.4
			7.2 x 7.2	3.0	17.0	29.0	17.0
			7.2 x 7.2	4.0	17.6	30.6	17.6

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.

Note:-

- NR* - BH's as Liquefible depth less than or equal to 4m (SBC is recommended after replacement/compaction).
- NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Table 4.3: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm (Replaced or Compacted Soil)

Chainage Old (km)	Chainage New (km)	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)
7+351	8+036	BH-A1	7.2 x 7.2	2.0	16.1	13.6	13.6
			7.2 x 7.2	3.0	17.6	14.2	14.2
			7.2 x 7.2	4.0	19.1	14.0	14.0
7+613	8+298	BH-A1	7.2 x 7.2	2.0	22.3	11.0	11.0
			7.2 x 7.2	3.0	26.5	10.6	10.6
			7.2 x 7.2	4.0	30.7	9.9	9.9
8+907	9+591	BH-CL	2.7 x 2.7	1.0	8.8	13.4	8.8
			2.7 x 2.7	2.0	13.6	16.0	13.6
			2.7 x 2.7	3.0	18.9	17.1	17.1
-	10+340	BH-PLT-08	4.8 x 4.8	1.0	28.5	11.9	11.9
			4.8 x 4.8	2.0	34.3	12.9	12.9
			4.8 x 4.8	3.0	40.5	14.0	14.0
9+211	9+894	BH-CL	6.0 x 6.0	1.0	22.6	9.3	9.3
			6.0 x 6.0	2.0	26.5	9.9	9.9
			6.0 x 6.0	3.0	30.5	10.6	10.6
9+726	10+410	BH-A1	7.2 x 7.2	2.0	36.1	11.7	11.7
			7.2 x 7.2	3.0	41.9	12.3	12.3
			7.2 x 7.2	4.0	48.0	13.0	13.0
9+772	10+457	BH-CL	7.2 x 7.2	1.0	17.7	10.5	10.5
			7.2 x 7.2	2.0	20.4	11.0	11.0
			7.2 x 7.2	3.0	23.2	11.6	11.6
10+223	10+908	BH-CL	2.7 x 2.7	1.0	14.2	10.8	10.8
			2.7 x 2.7	2.0	17.6	12.3	12.3
			2.7 x 2.7	3.0	21.2	13.7	13.7
10+519	11+203	BH-CL	4.8 x 4.8	1.0	22.6	12.3	12.3
			4.8 x 4.8	2.0	27.0	13.2	13.2
			4.8 x 4.8	3.0	31.5	14.3	14.3
10+658	11+340	BH-CL	2.7 x 2.7	1.0	10.6	13.9	10.6
			2.7 x 2.7	2.0	13.6	18.7	13.6
			2.7 x 2.7	3.0	16.9	23.9	16.9
10+859	11+543	BH-A1(R)	7.2 x 7.2	2.0	15.8	8.4	8.4
			7.2 x 7.2	3.0	18.5	9.0	9.0
			7.2 x 7.2	4.0	21.2	9.8	9.8

Chainage Old (km)	Chainage New (km)	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)
17+625	18+310	BH-A2	7.2 x 7.2	2.0	37.1	13.5	13.5
			7.2 x 7.2	3.0	42.7	13.5	13.5
			7.2 x 7.2	4.0	48.6	13.0	13.0
-	19+010	BH-PLT-07	4.8 x 4.8	1.0	11.2	11.5	11.2
			4.8 x 4.8	2.0	12.3	12.5	12.3
			4.8 x 4.8	3.0	13.4	13.5	13.4
18+750	19+435	BH-A1	7.2 x 7.2	2.0	17.8	23.5	17.8
			7.2 x 7.2	3.0	21.2	24.8	21.2
			7.2 x 7.2	4.0	24.8	26.2	24.8
19+500	20+185	BH-P1	7.2 x 7.2	2.0	21.7	7.0	7.0
			7.2 x 7.2	3.0	23.8	6.9	6.9
			7.2 x 7.2	4.0	26.1	6.9	6.9
20+300	20+985	BH-P2	7.2 x 7.2	2.0	17.1	13.9	13.9
			7.2 x 7.2	3.0	19.2	14.5	14.5
			7.2 x 7.2	4.0	21.5	14.7	14.7

Table 4.4: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm (Replaced or Compacted Soil)

Chainage Old (km)	Chainage New (km)	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)
7+351	8+036	BH-A1	7.2 x 7.2	2.0	16.1	27.2	16.1
			7.2 x 7.2	3.0	17.6	28.4	17.6
			7.2 x 7.2	4.0	19.1	28.0	19.1
7+613	8+298	BH-A1	7.2 x 7.2	2.0	22.3	21.9	21.9
			7.2 x 7.2	3.0	26.5	21.2	21.2
			7.2 x 7.2	4.0	30.7	19.8	19.8
8+907	9+591	BH-CL	2.7 x 2.7	1.0	8.8	26.9	8.8
			2.7 x 2.7	2.0	13.6	32.1	13.6
			2.7 x 2.7	3.0	18.9	34.2	18.9
-	10+340	BH-PLT-08	4.8 x 4.8	1.0	28.5	23.8	23.8
			4.8 x 4.8	2.0	34.3	25.8	25.8
			4.8 x 4.8	3.0	40.5	27.9	27.9
9+211	9+894	BH-CL	6.0 x 6.0	1.0	22.6	18.7	18.7
			6.0 x 6.0	2.0	26.5	19.8	19.8
			6.0 x 6.0	3.0	30.5	21.2	21.2

Chainage Old (km)	Chainage New (km)	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)
9+726	10+410	BH-A1	7.2 x 7.2	2.0	36.1	23.4	23.4
			7.2 x 7.2	3.0	41.9	24.7	24.7
			7.2 x 7.2	4.0	48.0	26.1	26.1
9+772	10+457	BH-CL	7.2 x 7.2	1.0	17.7	21.1	17.7
			7.2 x 7.2	2.0	20.4	22.1	20.4
			7.2 x 7.2	3.0	23.2	23.3	23.2
10+223	10+908	BH-CL	2.7 x 2.7	1.0	14.2	21.5	14.2
			2.7 x 2.7	2.0	17.6	24.7	17.6
			2.7 x 2.7	3.0	21.2	27.3	21.2
10+519	11+203	BH-CL	4.8 x 4.8	1.0	22.6	24.5	22.6
			4.8 x 4.8	2.0	27.0	26.5	26.5
			4.8 x 4.8	3.0	31.5	28.7	28.7
10+658	11+340	BH-CL	2.7 x 2.7	1.0	10.6	25.0	10.6
			2.7 x 2.7	2.0	13.6	28.9	13.6
			2.7 x 2.7	3.0	16.9	26.9	16.9
10+859	11+543	BH-A1(R)	7.2 x 7.2	2.0	15.8	16.8	15.8
			7.2 x 7.2	3.0	18.5	18.0	18.0
			7.2 x 7.2	4.0	21.2	19.7	19.7
17+625	18+310	BH-A2	7.2 x 7.2	2.0	37.1	27.0	27.0
			7.2 x 7.2	3.0	42.7	27.0	27.0
			7.2 x 7.2	4.0	48.6	26.1	26.1
-	19+010	BH-PLT-07	4.8 x 4.8	1.0	11.2	23.0	11.2
			4.8 x 4.8	2.0	12.3	24.9	12.3
			4.8 x 4.8	3.0	13.4	27.0	13.4
18+750	19+435	BH-A1	7.2 x 7.2	2.0	17.8	47.0	17.8
			7.2 x 7.2	3.0	21.2	49.5	21.2
			7.2 x 7.2	4.0	24.8	52.3	24.8
19+500	20+185	BH-P1	7.2 x 7.2	2.0	21.7	14.0	14.0
			7.2 x 7.2	3.0	23.8	13.9	13.9
			7.2 x 7.2	4.0	26.1	13.7	13.7
20+300	20+985	BH-P2	7.2 x 7.2	2.0	17.1	27.8	17.1
			7.2 x 7.2	3.0	19.2	29.1	19.2
			7.2 x 7.2	4.0	21.5	29.3	21.5

Note:- Table 4.1& 4.2 Show that most of the boreholes are liquefiable up to certain depth. Therefore before laying the open foundation it is recommended to replace & compact the soil up to liquefaction depth, Replaced/ Compacted SBC are presented in Table 4.3 & 4.4. For the strata liquefying for more than 4m depth from EGL, Ground Improvement Techniques such as Dynamic Compaction or Vibro Compaction are recommended.

Note:-

- The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.
- As per the Morth guidelines the gradation of fill soil shall be as per following limits. The effective angle of friction not less than 30º. The gradation of fill soil shall be as per following limits.

Sieve Size	Percentage Passing
75 mm	100%
425 micron	0-60%
75 micron	less than 15 %
PI	≤6

1. *The density of backfill soil should be more than 95% of proctor density. The replaced /compacted soil should be lay down layer wise for each 300mm.*
2. *The design parameters considered for replaced/compacted Soil for calculating the SBC from shear criteria are as follows;*

C=0, Phi = 32 degree, Sp. Gravity= 2.63 Moisture content= 8%, bulk density= 1.84 g/cc, N = 25.

- Based on the method of analysis given under Para 7.2 above, The values of Safe Load Carrying Capacity of piles in compression, uplift and lateral under static conditions have been tabulated below:-

Table 4.5: Safe Load Carrying Capacity of normal bored cast in-situ RCC Pile in Soil

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
1+006	1+696	BH-A1	1.0	18.0	2.0	365.0	240.0	22.0
				20.0		404.0	276.0	
				22.0		443.0	313.0	
				24.0		501.0	350.0	
				26.0		460.0	388.0	
				28.0		494.0	420.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
1+006	1+696	BH-A1	1.2	18.0	2.0	519.0	311.0	30.0
				20.0		574.0	363.0	
				22.0		630.0	415.0	
				24.0		719.0	468.0	
				26.0		623.0	522.0	
				28.0		671.0	567.0	
		BH-A2	1.0	18.0		305.0	249.0	15.0
				20.0		348.0	289.0	
				22.0		370.0	311.0	
				24.0		397.0	337.0	
				26.0		456.0	373.0	
				28.0		488.0	404.0	
			1.2	18.0		400.0	323.0	20.0
				20.0		462.0	381.0	
				22.0		492.0	411.0	
				24.0		529.0	448.0	
				26.0		614.0	498.0	
				28.0		660.0	542.0	
2+788	3+476	BH-A1	1.0	18.0	2.0	331.0	234.0	24.0
				20.0		368.0	269.0	
				22.0		406.0	304.0	
				24.0		443.0	339.0	
				26.0		482.0	375.0	
				28.0		551.0	412.0	
			1.2	18.0		431.0	295.0	32.0
				20.0		485.0	340.0	
				22.0		533.0	386.0	
				24.0		581.0	431.0	
				26.0		631.0	479.0	
				28.0		729.0	527.0	
		BH-A2	1.0	18.0		326.0	232.0	24.0
				20.0		361.0	266.0	
				22.0		428.0	302.0	
				24.0		467.0	338.0	
				26.0		505.0	374.0	
				28.0		544.0	410.0	
			1.2	18.0		430.0	292.0	32.0
				20.0		476.0	336.0	
				22.0		526.0	384.0	
				24.0		622.0	431.0	
				26.0		672.0	478.0	
				28.0		722.0	526.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
3+497	4+242	BH-A1	1.0	22.0	2.0	338.0	255.0	28.0
				24.0		376.0	291.0	
				26.0		414.0	327.0	
				28.0		436.0	349.0	
				30.0		458.0	371.0	
				32.0		482.0	395.0	
			1.2	22.0		441.0	329.0	38.0
				24.0		492.0	376.0	
				26.0		542.0	424.0	
				28.0		569.0	452.0	
				30.0		596.0	480.0	
				32.0		625.0	510.0	
		BH-P1	1.0	20.0	2.0	351.0	276.0	41.0
				22.0		369.0	295.0	
				24.0		387.0	314.0	
				26.0		405.0	332.0	
				28.0		423.0	351.0	
				30.0		441.0	370.0	
			1.2	20.0		451.0	351.0	55.0
				22.0		474.0	375.0	
				24.0		496.0	399.0	
				26.0		518.0	423.0	
				28.0		540.0	447.0	
				30.0		562.0	471.0	
		BH-P2	1.0	20.0	2.0	277.0	226.0	22.0
				22.0		307.0	255.0	
				24.0		324.0	273.0	
				26.0		340.0	290.0	
				28.0		357.0	308.0	
				30.0		390.0	327.0	
			1.2	20.0		356.0	288.0	30.0
				22.0		396.0	327.0	
				24.0		417.0	350.0	
				26.0		437.0	373.0	
				28.0		458.0	395.0	
				30.0		502.0	420.0	
		BH-P3	1.0	22.0	2.0	317.0	250.0	24.0
				24.0		336.0	270.0	
				26.0		354.0	289.0	
				28.0		373.0	309.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
3+497	4+242	BH-P3	1.0	30.0	2.0	392.0	329.0	24.0
				32.0		411.0	348.0	
			1.2	22.0		414.0	323.0	32.0
				24.0		437.0	348.0	
				26.0		461.0	374.0	
				28.0		484.0	399.0	
				30.0		508.0	424.0	
				32.0		531.0	449.0	
		BH-A2	1.0	22.0		391.0	315.0	32.0
				24.0		409.0	334.0	
				26.0		433.0	359.0	
				28.0		497.0	385.0	
				30.0		524.0	411.0	
				32.0		551.0	437.0	
			1.2	22.0		502.0	402.0	43.0
				24.0		525.0	426.0	
				26.0		555.0	457.0	
				28.0		642.0	490.0	
				30.0		675.0	523.0	
				32.0		708.0	556.0	
3+691	4+376	BH-A1	1.0	20.0	2.0	391.0	247.0	26.0
				22.0		429.0	283.0	
				24.0		467.0	318.0	
				26.0		505.0	354.0	
				28.0		543.0	390.0	
				30.0		581.0	425.0	
			1.2	20.0		538.0	315.0	35.0
				22.0		588.0	363.0	
				24.0		639.0	410.0	
				26.0		689.0	458.0	
				28.0		739.0	505.0	
				30.0		789.0	553.0	
		BH-A2	1.0	22.0		379.0	257.0	21.0
				24.0		416.0	292.0	
				26.0		452.0	326.0	
				28.0		489.0	361.0	
				30.0		526.0	395.0	
				32.0		562.0	430.0	
			1.2	22.0		516.0	329.0	28.0
				24.0		565.0	375.0	
				26.0		614.0	422.0	
				28.0		662.0	468.0	
				30.0		710.0	514.0	
				32.0		759.0	560.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
7+078	7+759	BH-A1	1.0	22.0	2.0	254.0	189.0	17.0
				24.0		267.0	212.0	
				26.0		290.0	234.0	
				28.0		312.0	257.0	
				30.0		334.0	279.0	
				32.0		353.0	299.0	
			1.2	22.0		365.0	251.0	23.0
				24.0		380.0	283.0	
				26.0		412.0	315.0	
				28.0		443.0	347.0	
				30.0		458.0	379.0	
				32.0		483.0	405.0	
		BH-A2	1.0	22.0		220.0	162.0	8.0
				24.0		239.0	182.0	
				26.0		259.0	202.0	
				28.0		278.0	222.0	
				30.0		297.0	242.0	
				32.0		316.0	262.0	
			1.2	22.0		328.0	220.0	12.0
				24.0		356.0	249.0	
				26.0		384.0	278.0	
				28.0		412.0	307.0	
				30.0		440.0	336.0	
				32.0		468.0	365.0	
7+351	8+036	BH-A1	1.0	22.0	2.0	247.0	183.0	13.0
				24.0		260.0	205.0	
				26.0		282.0	228.0	
				28.0		305.0	251.0	
				30.0		327.0	273.0	
				32.0		346.0	293.0	
			1.2	22.0		357.0	243.0	18.0
				24.0		371.0	276.0	
				26.0		403.0	308.0	
				28.0		435.0	340.0	
				30.0		449.0	371.0	
				32.0		474.0	398.0	
		BH-P1	1.0	22.0	2.0	204.0	175.0	9.0
				24.0		228.0	199.0	
				26.0		251.0	223.0	
				28.0		267.0	239.0	
				30.0		282.0	256.0	
				32.0		315.0	273.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
7+351	8+036	BH-P1	1.2	22.0	2.0	271.0	232.0	13.0
				24.0		304.0	265.0	
				26.0		338.0	299.0	
				28.0		357.0	320.0	
				30.0		377.0	342.0	
				32.0		421.0	365.0	
		BH-A2	1.0	22.0	2.0	220.0	162.0	8.0
				24.0		239.0	182.0	
				26.0		259.0	202.0	
				28.0		278.0	222.0	
				30.0		297.0	242.0	
				32.0		316.0	262.0	
			1.2	22.0		328.0	220.0	12.0
				24.0		356.0	249.0	
				26.0		384.0	278.0	
				28.0		412.0	307.0	
				30.0		440.0	336.0	
				32.0		468.0	365.0	
7+613	8+298	BH-A1	1.0	22.0	2.0	241.0	182.0	11.0
				24.0		260.0	201.0	
				26.0		280.0	222.0	
				28.0		306.0	243.0	
				30.0		327.0	264.0	
				32.0		349.0	286.0	
			1.2	22.0		328.0	244.0	16.0
				24.0		351.0	269.0	
				26.0		376.0	295.0	
				28.0		411.0	322.0	
				30.0		436.0	349.0	
				32.0		468.0	381.0	
		BH-A2	1.0	22.0	2.0	268.0	217.0	18.0
				24.0		292.0	241.0	
				26.0		316.0	265.0	
				28.0		331.0	282.0	
				30.0		351.0	302.0	
				32.0		411.0	325.0	
			1.2	22.0		357.0	287.0	21.0
				24.0		392.0	321.0	
				26.0		426.0	356.0	
				28.0		445.0	377.0	
				30.0		469.0	403.0	
				32.0		551.0	433.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
8+852	9+537	BH-A1	1.0	20.0	2.0	197.0	159.0	25.0
				22.0		220.0	182.0	
				24.0		239.0	201.0	
				26.0		254.0	218.0	
				28.0		269.0	234.0	
				30.0		283.0	250.0	
			1.2	20.0		264.0	209.0	33.0
				22.0		296.0	242.0	
				24.0		322.0	269.0	
				26.0		340.0	290.0	
				28.0		359.0	312.0	
				30.0		378.0	333.0	
		BH-A2	1.0	20.0		194.0	155.0	18.0
				22.0		216.0	177.0	
				24.0		235.0	196.0	
				26.0		249.0	212.0	
				28.0		264.0	229.0	
				30.0		278.0	245.0	
			1.2	20.0		257.0	202.0	21.0
				22.0		289.0	234.0	
				24.0		314.0	261.0	
				26.0		332.0	282.0	
				28.0		351.0	303.0	
				30.0		369.0	324.0	
9+726	10+410	BH-A1	1.0	20.0	2.0	180.0	153.0	14.0
				22.0		195.0	169.0	
				24.0		215.0	185.0	
				26.0		229.0	200.0	
				28.0		316.0	220.0	
				30.0		335.0	240.0	
			1.2	20.0		237.0	201.0	20.0
				22.0		255.0	221.0	
				24.0		282.0	241.0	
				26.0		300.0	262.0	
				28.0		328.0	291.0	
				30.0		488.0	320.0	
		BH-A2	1.0	20.0	2.0	189.0	152.0	13.0
				22.0		213.0	176.0	
				24.0		232.0	196.0	
				26.0		246.0	212.0	
				28.0		262.0	229.0	
				30.0		348.0	253.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
9+726	10+410	BH-A2	1.2	20.0	2.0	249.0	199.0	18.0
				22.0		284.0	233.0	
				24.0		310.0	261.0	
				26.0		327.0	280.0	
				28.0		348.0	304.0	
				30.0		504.0	338.0	
10+025	10+709	BH-A1	1.0	20.0	2.0	212.0	163.0	18.0
				22.0		229.0	180.0	
				24.0		245.0	198.0	
				26.0		262.0	216.0	
				28.0		278.0	233.0	
				30.0		295.0	251.0	
			1.2	20.0		276.0	208.0	24.0
				22.0		297.0	231.0	
				24.0		317.0	254.0	
				26.0		338.0	277.0	
				28.0		359.0	299.0	
				30.0		379.0	322.0	
		BH-A2	1.0	20.0	2.0	220.0	169.0	23.0
				22.0		237.0	187.0	
				24.0		253.0	204.0	
				26.0		270.0	223.0	
				28.0		295.0	241.0	
				30.0		313.0	260.0	
			1.2	20.0		289.0	218.0	31.0
				22.0		309.0	241.0	
				24.0		329.0	263.0	
				26.0		351.0	287.0	
				28.0		383.0	311.0	
				30.0		405.0	335.0	
10+859	11+543	BH-A1(R)	1.0	20.0	2.0	161.0	130.0	11.0
				22.0		175.0	146.0	
				24.0		189.0	161.0	
				26.0		203.0	177.0	
				28.0		317.0	201.0	
				30.0		341.0	225.0	
			1.2	20.0		210.0	168.0	15.0
				22.0		228.0	188.0	
				24.0		245.0	208.0	
				26.0		262.0	228.0	
				28.0		297.0	263.0	
				30.0		509.0	298.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
10+859	11+543	BH-A1	1.0	22.0	2.0	227.0	165.0	10.0
				24.0		248.0	186.0	
				26.0		268.0	207.0	
				28.0		288.0	228.0	
				30.0		309.0	249.0	
				32.0		329.0	270.0	
			1.2	22.0		298.0	212.0	14.0
				24.0		324.0	239.0	
				26.0		349.0	266.0	
				28.0		374.0	292.0	
				30.0		400.0	319.0	
				32.0		425.0	346.0	
		BH-P1	1.0	20.0	2.0	141.0	124.0	9.0
				22.0		160.0	139.0	
				24.0		175.0	155.0	
				26.0		190.0	172.0	
				28.0		207.0	190.0	
				30.0		292.0	213.0	
			1.2	20.0		184.0	160.0	13.0
				22.0		209.0	180.0	
				24.0		227.0	201.0	
				26.0		246.0	223.0	
				28.0		268.0	247.0	
				30.0		422.0	281.0	
		BH-A2	1.0	22.0	2.0	167.0	133.0	5.0
				24.0		184.0	151.0	
				26.0		213.0	170.0	
				28.0		241.0	191.0	
				30.0		262.0	212.0	
				32.0		283.0	233.0	
			1.2	22.0		221.0	173.0	8.0
				24.0		241.0	196.0	
				26.0		280.0	220.0	
				28.0		310.0	251.0	
				30.0		376.0	281.0	
				32.0		406.0	312.0	
17+625	18+310	BH-A1	1.0	18.0	2.0	181.0	133.0	12.0
				20.0		209.0	152.0	
				22.0		210.0	171.0	
				24.0		226.0	189.0	
				26.0		241.0	205.0	
				28.0		264.0	222.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
17+625	18+310	BH-A1	1.2	18.0	2.0	255.0	173.0	18.0
				20.0		277.0	197.0	
				22.0		275.0	222.0	
				24.0		295.0	245.0	
				26.0		313.0	266.0	
				28.0		333.0	288.0	
		BH-A2	1.0	18.0	2.0	206.0	150.0	14.0
				20.0		228.0	172.0	
				22.0		248.0	193.0	
				24.0		265.0	211.0	
				26.0		285.0	231.0	
				28.0		316.0	252.0	
			1.2	18.0		274.0	195.0	20.0
				20.0		304.0	226.0	
				22.0		333.0	255.0	
				24.0		354.0	279.0	
				26.0		378.0	304.0	
				28.0		419.0	331.0	
17+872	18+558	BH-A1	1.0	14.0	2.0	123.0	89.0	9.0
				16.0		144.0	111.0	
				18.0		214.0	134.0	
				20.0		237.0	157.0	
				22.0		260.0	180.0	
				24.0		283.0	203.0	
			1.2	14.0		164.0	114.0	13.0
				16.0		200.0	142.0	
				18.0		284.0	172.0	
				20.0		312.0	201.0	
				22.0		341.0	230.0	
				24.0		369.0	259.0	
		BH-A2	1.0	14.0	2.0	159.0	117.0	18.0
				16.0		188.0	135.0	
				18.0		208.0	155.0	
				20.0		262.0	178.0	
				22.0		285.0	201.0	
				24.0		308.0	224.0	
			1.2	14.0		208.0	148.0	24.0
				16.0		237.0	170.0	
				18.0		268.0	196.0	
				20.0		342.0	225.0	
				22.0		370.0	254.0	
				24.0		398.0	283.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
18+750	19+435	BH-A1	1.0	18.0	2.0	137.0	117.0	9.0
				20.0		152.0	133.0	
				22.0		177.0	149.0	
				24.0		209.0	167.0	
				26.0		227.0	187.0	
				28.0		260.0	207.0	
			1.2	18.0		179.0	150.0	11.0
				20.0		197.0	171.0	
				22.0		229.0	192.0	
				24.0		273.0	215.0	
				26.0		296.0	240.0	
				28.0		339.0	266.0	
		BH-A2	1.0	18.0		107.0	86.0	8.0
				20.0		121.0	103.0	
				22.0		147.0	119.0	
				24.0		163.0	136.0	
				26.0		195.0	155.0	
				28.0		213.0	174.0	
			1.2	18.0		143.0	113.0	11.0
				20.0		161.0	134.0	
				22.0		179.0	155.0	
				24.0		216.0	178.0	
				26.0		258.0	202.0	
				28.0		280.0	227.0	
19+500	20+185	BH-A1	1.0	18.0	2.0	132.0	114.0	11.0
				20.0		160.0	130.0	
				22.0		188.0	147.0	
				24.0		205.0	165.0	
				26.0		240.0	185.0	
				28.0		259.0	205.0	
			1.2	18.0		171.0	147.0	13.0
				20.0		209.0	167.0	
				22.0		228.0	189.0	
				24.0		266.0	212.0	
				26.0		313.0	238.0	
				28.0		336.0	263.0	
		BH-P1	1.0	18.0	2.0	145.0	124.0	10.0
				20.0		162.0	142.0	
				22.0		216.0	161.0	
				24.0		234.0	180.0	
				26.0		252.0	199.0	
				28.0		272.0	219.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
19+500	20+185	BH-P1	1.2	18.0	2.0	186.0	158.0	13.0
				20.0		208.0	181.0	
				22.0		282.0	206.0	
				24.0		304.0	230.0	
				26.0		326.0	255.0	
				28.0		352.0	281.0	
		BH-A2	1.0	18.0	2.0	172.0	100.0	11.0
				20.0		195.0	123.0	
				22.0		218.0	146.0	
				24.0		241.0	169.0	
				26.0		264.0	192.0	
				28.0		287.0	215.0	
			1.2	18.0		233.0	130.0	15.0
				20.0		261.0	159.0	
				22.0		289.0	188.0	
				24.0		317.0	217.0	
				26.0		346.0	246.0	
				28.0		374.0	275.0	
19+715	20+400	BH-A1	1.0	18.0	2.0	168.0	115.0	8.0
				20.0		191.0	139.0	
				22.0		223.0	162.0	
				24.0		244.0	184.0	
				26.0		265.0	205.0	
				28.0		285.0	226.0	
			1.2	18.0		246.0	152.0	12.0
				20.0		279.0	185.0	
				22.0		304.0	217.0	
				24.0		333.0	247.0	
				26.0		359.0	274.0	
				28.0		384.0	301.0	
		BH-P1	1.0	18.0	2.0	142.0	105.0	6.0
				20.0		158.0	122.0	
				22.0		173.0	138.0	
				24.0		188.0	155.0	
				26.0		206.0	174.0	
				28.0		240.0	193.0	
			1.2	18.0		193.0	140.0	9.0
				20.0		212.0	161.0	
				22.0		231.0	183.0	
				24.0		250.0	204.0	
				26.0		272.0	228.0	
				28.0		318.0	253.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
19+715	20+400	BH-A2	1.0	18.0	2.0	157.0	125.0	9.0
				20.0		171.0	141.0	
				22.0		196.0	158.0	
				24.0		225.0	176.0	
				26.0		243.0	195.0	
				28.0		260.0	213.0	
			1.2	18.0		205.0	162.0	13.0
				20.0		222.0	182.0	
				22.0		255.0	203.0	
				24.0		294.0	227.0	
				26.0		316.0	251.0	
				28.0		337.0	275.0	
20+300	20+985	BH-A1	1.0	18.0	2.0	173.0	133.0	21.0
				20.0		189.0	150.0	
				22.0		212.0	168.0	
				24.0		228.0	185.0	
				26.0		244.0	202.0	
				28.0		260.0	219.0	
			1.2	18.0		226.0	170.0	26.0
				20.0		245.0	192.0	
				22.0		275.0	214.0	
				24.0		295.0	237.0	
				26.0		315.0	259.0	
				28.0		335.0	281.0	
		BH-P1	1.0	18.0	2.0	176.0	138.0	9.0
				20.0		190.0	153.0	
				22.0		222.0	172.0	
				24.0		242.0	192.0	
				26.0		292.0	215.0	
				28.0		315.0	238.0	
			1.2	18.0		229.0	177.0	14.0
				20.0		246.0	196.0	
				22.0		267.0	220.0	
				24.0		314.0	246.0	
				26.0		380.0	275.0	
				28.0		408.0	304.0	
		BH-P2	1.0	18.0	2.0	194.0	148.0	12.0
				20.0		209.0	165.0	
				22.0		225.0	183.0	
				24.0		285.0	205.0	
				26.0		308.0	228.0	
				28.0		330.0	251.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
20+300	20+985	BH-P2	1.2	18.0	2.0	254.0	192.0	17.0
				20.0		273.0	213.0	
				22.0		293.0	235.0	
				24.0		374.0	264.0	
				26.0		402.0	293.0	
				28.0		430.0	322.0	
		BH-A2	1.0	18.0	2.0	162.0	137.0	15.0
				20.0		223.0	161.0	
				22.0		248.0	185.0	
				24.0		272.0	209.0	
				26.0		296.0	233.0	
				28.0		248.0	258.0	
			1.2	18.0		210.0	176.0	18.0
				20.0		316.0	210.0	
				22.0		350.0	243.0	
				24.0		384.0	277.0	
				26.0		417.0	311.0	
				28.0		328.0	346.0	

Notes : -

1. Permissible lateral deflection has been taken as 5 mm.
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.

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Abbreviations

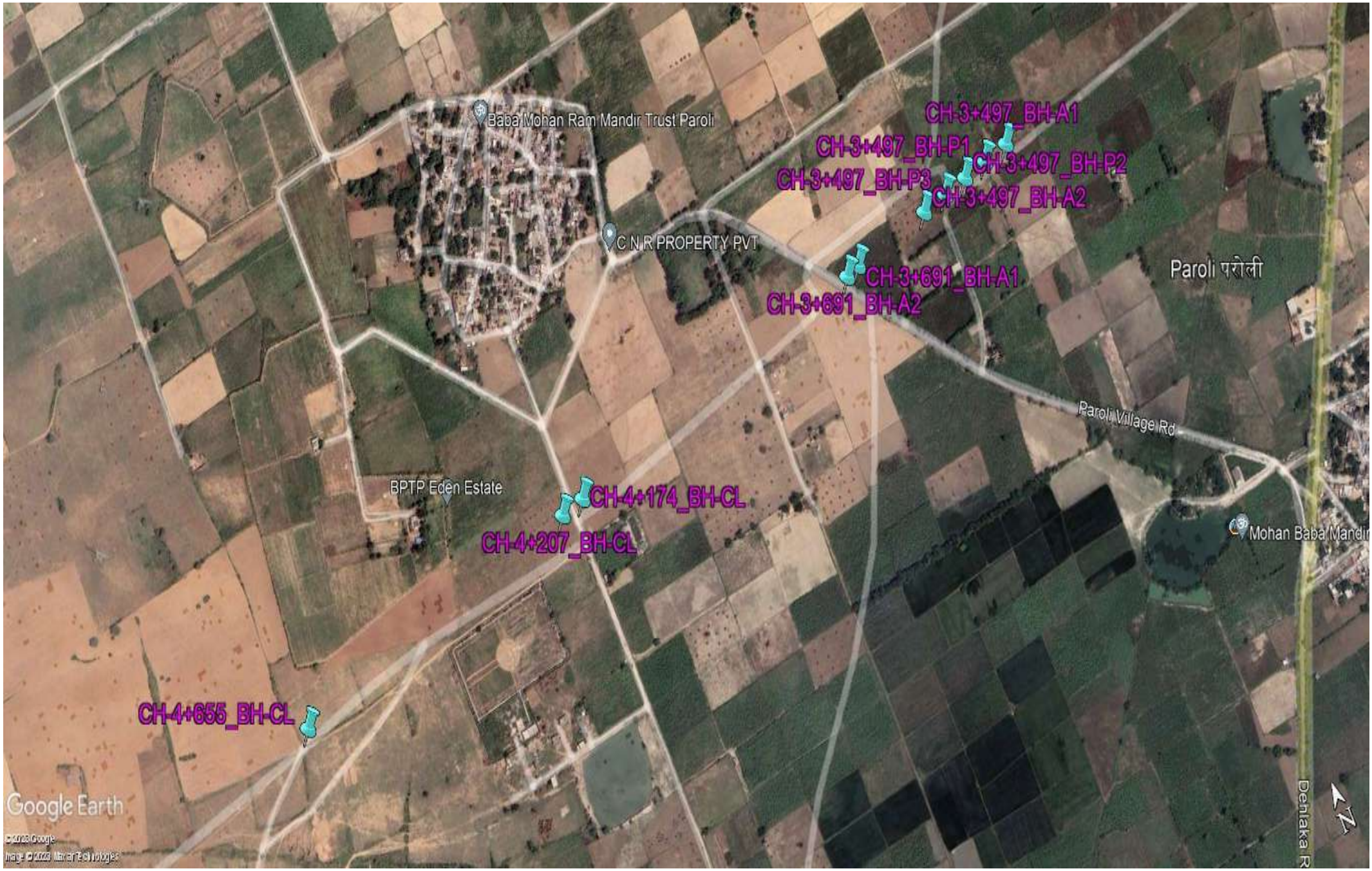
BH	Borehole
ERT	Electrical Resistivity Test
EGL	Existing Ground Level
GWT	Ground Water Table
IS	Indian Standards
SPT	Standard Penetration Test
DS	Disturbed Soil
R.L.	Reduced Level
m	Metre
sp. gr.	Specific Gravity
%	Percentage
mg /l	Milligram per litre
mg /kg	Milligram per kilogram

APPENDIX – A (FIELD DATA RESULTS)

Appendix No.	ITEMS
A-1	LOCATION PLAN
A-2	FIELD BORE HOLE LOGS
A-3	SUB SOIL PROFILE DIAGRAM
A-4	PLT TEST CURVE

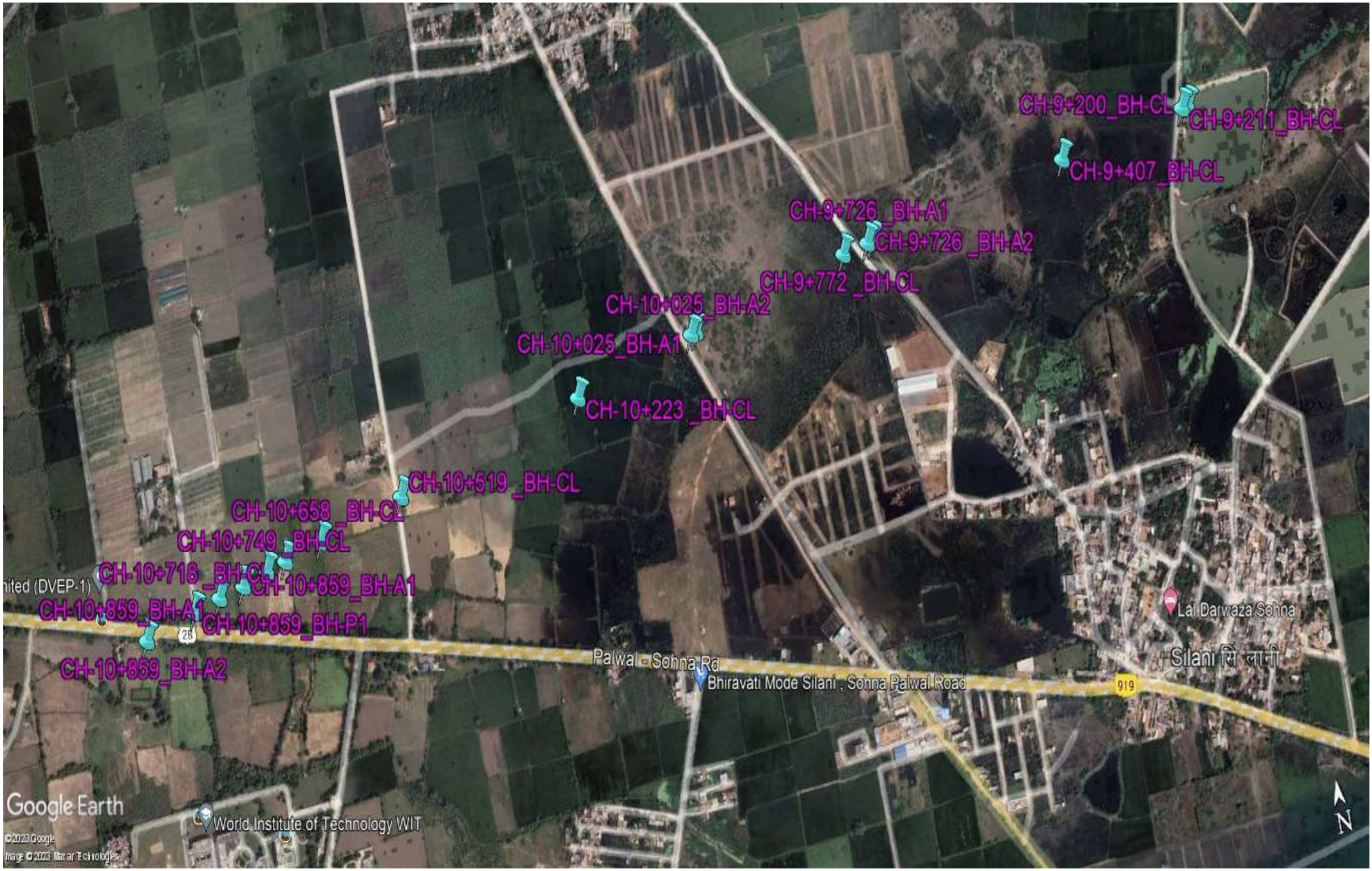

CH-(-)0+627_BH-CL
NCH 0+000_BH-PLT-09
CH-(-)0+529_BH-CL
CH-(-)0+319_BH-CL
Chhaprola छापरोला
CH-0+273_BH-CL
राजकीय प्राथमिक पाठशाला
Chhavi garment
CH-1+006_BH-A1
CH-1+006_BH-A2
Google Earth
©2023 Google
Image © 2023 Maxar Technologies
N


CH-1+333_BH-CL
CH-1+811_BH-CL
Chaudhary Poultry Farm
CH-2+788_BH-A1
CH-2+788_BH-A2
CH-2+472_BH-CL
Google Earth
©2023 Google
Image © 2023 Maxar Technologies
N


Baba Mohan Ram Mandir Trust Paroli
CH-3+497_BH-A1
CH-3+497_BH-P1
CH-3+497_BH-P2
CH-3+497_BH-P3
CH-3+497_BH-A2
C N R PROPERTY PVT
CH-3+691_BH-A1
CH-3+691_BH-A2
Paroli परोली
Paroli Village Rd
BPTP Eden Estate
CH-4+174_BH-CL
CH-4+207_BH-CL
Mohan Baba Mandir
CH-4+655_BH-CL
Google Earth
Dehlaka R


CH-5+119_BH-CL
CH-5+730_BH-CL
CH-6+197_BH-CL
CH-6+877_BH-CL
CH-7+078_BH-A1
CH-7+078_BH-A2
CH-7+256_BH-CL
CH-7+351_BH-P1
CH-7+351_BH-A1
CH-7+351_BH-A2
KHOONTPURI खुनतपरी
Government school
Ratika Noabad रतिका नोवाद
Google Earth
©2023 Google
Image © 2023 Maxar Technologies
N


CH-7+457_BH-CL
CH-7+613_BH-A1
CH-7+613_BH-A2
HARENDER POSWAL
CH-7+907_BH-A1
Aranyak farm
Ahara Farms
CH-8+207_BH-CL
CH-8+610_BH-CL
CH-8+852_BH-A1
CH-8+852_BH-A2
CH-8+907_BH-CL
Google Earth
NCH-10+340_BH-PLT-08
33KV Substation Silani
N


CH-9+200_BH-CL
CH-9+211_BH-CL
CH-9+407_BH-CL
CH-9+726_BH-A1
CH-9+726 _BH-A2
CH-9+772 _BH-CL
CH-10+025_BH-A2
CH-10+025_BH-A1
CH-10+223 _BH-CL
CH-10+619 _BH-CL
CH-10+658 _BH-CL
CH-10+749 _BH-CL
CH-10+718 _BH-CL
CH-10+859_BH-A1
CH-10+859_BH-A1
CH-10+859_BH-P1
CH-10+859_BH-A2
Palwal - Sohna Rd
Bhiravati Mode Silani , Sohna Palwal Road
Lal Darwaza Sohna
Silani सिलानी
919
28
Google Earth
World Institute of Technology WIT
N


Mughlai Food
Fly time India
CH-17+625_BH-A2
CH-17+625_BH-A1
Indari इन्दरी
HSK CONCRETE
CH-17+872_BH-A2
CH-17+872_BH-A1
NCH-19+010_BH-PLT-07
248A
CH-18+750_BH-A2
CH-18+750_BH-A1
Google Earth
N


Sonel Fast Food
220KV Substation Rojka Meo
CH-20+300_BH-P2
CH-20+300_BH-A2
CH-20+300_BH-A1
CH-20+300_BH-P1
Junaid General Store
Western Peripheral Expy
CH-19+715_BH-P1
CH-19+715_BH-A2
CH-19+715_BH-A1
CH-19+500_BH-A1
CH-19+500_BH-P1
CH-19+500_BH-A2
S K Hard Were
Nizam Kirana Store
Google Earth
©2023 Google
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N

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*New Ch. 0+000 km_Prithla Station	*Northing :*3126079 m	*Easting :*720981 m
Reduced Level (m):(+)195.456	*BH. No. :*BH-PLT-09	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-12-2021	*Date of Completion :*23-12-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
	0.75	UDS-1									
1.0											
1.5	1.5	SPT-1	1	1	2	3					
2.0											
	2.25	SPT-2	1	2	3	5					
2.5											
3.0	3	SPT-3	3	5	7	12	Brownish, Medium dnese, Sandy Silt	ML-CL			
3.5											
	3.75	SPT-4	5	7	10	17					
4.0											
4.5	4.5	UDS-2									
5.0											
5.5											
6.0	6	SPT-5	7	10	12	22					
6.5											
7.0											
7.5	7.5	UDS-3									
8.0							Brownish, Medium dense to Dense, Silty Sand	SM			
8.5											
9.0	9	SPT-6	10	12	15	27					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*New Ch. 0+000 km_Prithla Station	*Northing :*3126079 m	*Easting :*720981 m
Reduced Level (m):(+)195.456	*BH. No. :*BH-PLT-09	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-12-2021	*Date of Completion :*23-12-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5	10.5	UDS-4					Brownish, Medium dense to Dense, Silty Sand	SM			
11.0											
11.5											
12.0	12	SPT-7	18	24	29	53					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)0+627 km	*Northing :*3126081.947 m	*Easting :*720920.89 m
Reduced Level (m):(+)196.408	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*8.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-10-2021	*Date of Completion :*14-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	7	8	12	20					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	9	11	17	28					
4.5											
5.0							Brown, Medium dense to very dense, Silty sand	SM			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	12	17	24	41					
7.5											
8.0											
8.5	8.5	UDS-3							8.50m		
9.0											
9.5											
10.0	10	SPT-4	16	22	29	51					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)0+529 km	*Northing :*3126042.507 m	*Easting :*720826.915 m
Reduced Level (m):(+)195.851	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*8.15	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-10-2021	*Date of Completion :*14-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	6	7	11	18					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Silty sand with gravel	SM			
5.5	5.5	SPT-2	7	15	22	37					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0									8.15m		
8.5	8.5	SPT-3	10	18	25	43					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
BH Location/Chainage :(-)0+319 km	*Northing :*3125962.572 m	*Easting :*720635.657 m
Reduced Level (m):(+)197.352	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*8.10	*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 :*15-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	7	12	15	27	Brown, Medium dense, Silty sand	SM			
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	5	9	14	23					
6.0											
6.5											
7.0	7	UDS-3					Brown, Very stiff, Silty clay of low plasticity with gravel	CL			
7.5											
8.0									8.10m		
8.5	8.5	SPT-3	8	14	22	36					
9.0											
9.5							Brown, Dense, Silty sand with gravel	SM			
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*0+273 km	*Northing :*3125734.325 m	*Easting :*720089.535 m
Reduced Level (m):(+)195.008	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*8.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-10-2021	*Date of Completion :*14-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	5	7	12	Brown, Medium dense, Silty sand	SM			
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	15	16	23	39					
4.5											
5.0											
5.5	5.5	UDS-2					Brown, Medium dense to dense, Sandy silt of low with gravel	ML-CL			
6.0											
6.5											
7.0	7	SPT-3	6	9	13	22					
7.5											
8.0									8.25m		
8.5	8.5	UDS-3									
9.0							Brown, Dense, Silty sand with gravel	SM			
9.5											
10.0	10	SPT-4	7	12	20	32					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1+006 km	*Northing :*3125461.869 m	*Easting :*719415.302 m
Reduced Level (m):(+)202.730	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*24.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*04-10-2021	*Date of Completion :*05-10-2021	

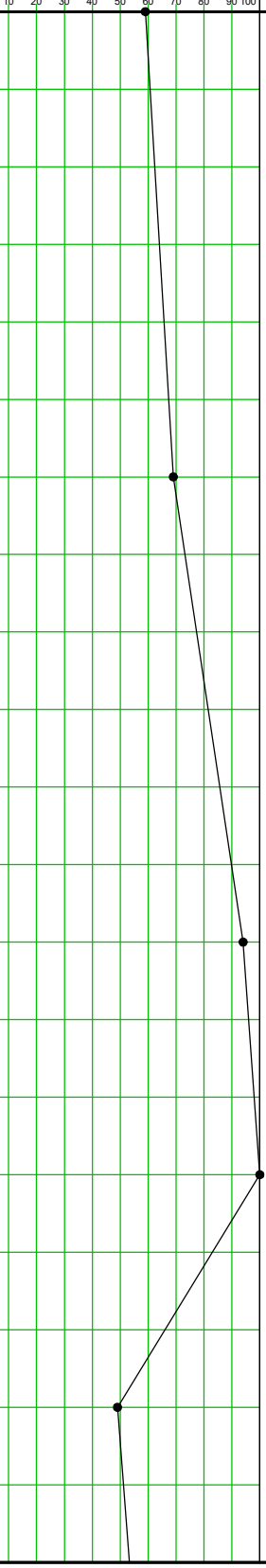
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	5	9					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	10	12	22					
4.5											
5.0											
5.5	5.5	UDS-2					Brown, Medium dense, Silty sand	SM			
6.0											
6.5											
7.0	7	SPT-3	12	18	26	44					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Dense to very dense, Silty sand with gravel	SM			
9.0											
9.5											
10.0	10	SPT-4	14	27	32	59					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1+006 km	*Northing :*3125461.869 m	*Easting :*719415.302 m
Reduced Level (m):(+)202.730	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*24.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*04-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	18	30	39	69					
13.5											
14.0											
14.5	14.5	UDS-5					Brown, Dense to very dense, Silty sand with gravel	SM			
15.0											
15.5											
16.0	16	SPT-6	26	34	60	94					
16.5											
17.0											
17.5	17.5	SPT-7	17	36	64	100					
18.0											
18.5											
19.0	19	SPT-8	18	22	27	49					
19.5							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.0											

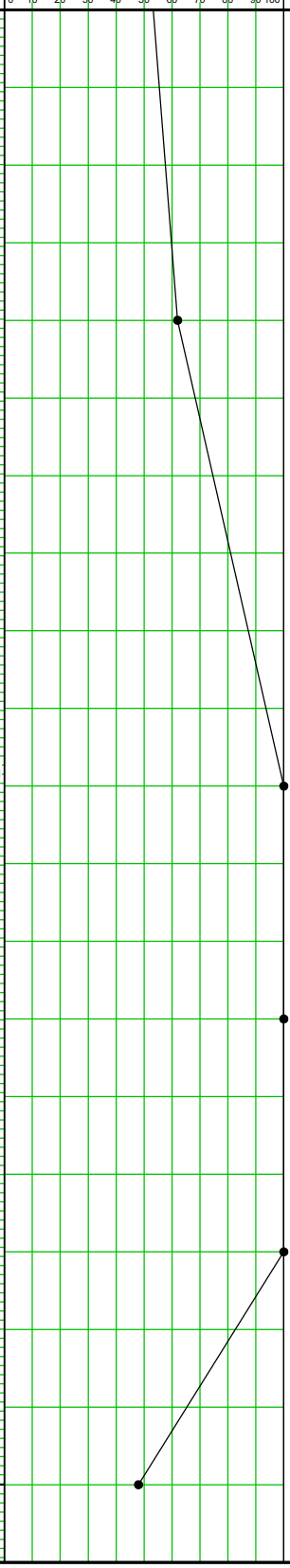


UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1+006 km	*Northing :*3125461.869 m	*Easting :*719415.302 m
Reduced Level (m):(+)202.730	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*24.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*04-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-9	20	28	34	62					
22.5											
23.0											
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-10	36	76	24 (2cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL	▼24.90m		
25.5											
26.0											
26.5	26.5	SPT-11	22	45	55 (11cm)	>100					
27.0											
27.5											
28.0	28	SPT-12	26	62	38 (5cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-13	16	20	28	48					
30.0	30	DS-2					Brown, Hard, Silty clay of low plasticity with gravel	CL			



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1+006 km	*Northing :*3125454.226 m	*Easting :*719396.82 m
Reduced Level (m):(+)203.271	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*24.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*04-10-2021	*Date of Completion :*04-10-2021	

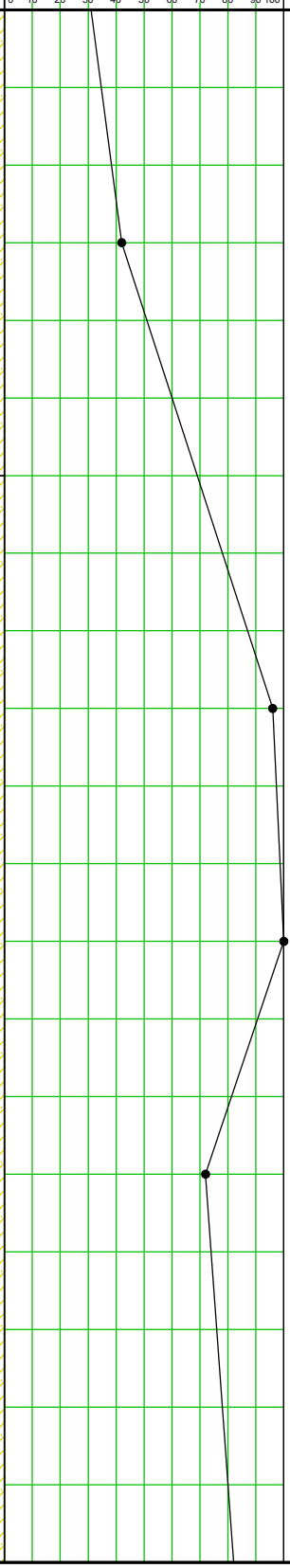
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	SPT-1	2	3	4	7					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	6	8	14					
6.0											
6.5											
7.0	7	UDS-3					Brown, Medium dense, Silty sand with clay	SM-SC			
7.5											
8.0											
8.5	8.5	SPT-3	5	9	11	20					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1+006 km	*Northing :*3125454.226 m	*Easting :*719396.82 m
Reduced Level (m):(+)203.271	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*24.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*04-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	12	19	23	42	Brown, Dense, Silty sand with clay	SM-SC			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	23	36	60	96					
15.0											
15.5											
16.0	16	SPT-6	23	37	63	100					
16.5							Brown, Very dense, Silty sand with clay with gravel	SM-SC			
17.0											
17.5	17.5	SPT-7	17	29	43	72					
18.0											
18.5											
19.0	19	UDS-6									
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1+006 km	*Northing :*3125454.226 m	*Easting :*719396.82 m
Reduced Level (m):(+)203.271	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*24.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*04-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	14	30	54	84	Brown, Very dense, Silty sand with clay with gravel	SM-SC			
21.0											
21.5											
22.0	22	UDS*									
22.5	22.45	SPT-9	10	13	22	35					
23.0											
23.5	23.5	SPT-10	12	16	27	43	Brown, Hard, Silty clay of low plasticity with gravel	CL			
24.0											
24.5									24.80m		
25.0	25	UDS*									
25.5	25.45	SPT-11	15	21	33	54	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
26.0											
26.5	26.5	SPT-12	16	26	50	76					
27.0											
27.5											
28.0	28	UDS*									
28.5	28.45	SPT-13	20	45	55 (12cm)	>100					
29.0											
29.5	29.5	SPT-14	17	28	36	64					
30.0	30	DS-2					Brown, Hard, Silty clay of low plasticity with gravel	CL			

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1+333 km	*Northing :*3125351.606 m	*Easting :*719094.132 m
Reduced Level (m):(+)202.117	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-10-2021	*Date of Completion :*15-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	12	14	21	35					
3.0											
3.5											
4.0	4	UDS-2					Brown, Dense, Silty sand with gravel	SM			
4.5											
5.0											
5.5	5.5	SPT-2	10	17	24	41					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	13	19	29	48					
9.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1+811 km	*Northing :*3125172.851 m	*Easting :*718661.831 m
Reduced Level (m):(+)197.587	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*9.10	*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 :*15-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	6	7	13					
1.5											
2.0							Brown, Medium dense, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	9	15	18	33					
4.5											
5.0											
5.5	5.5	UDS-2					Brown, Dense, Silty sand with gravel	SM			
6.0											
6.5											
7.0	7	SPT-3	7	10	20	30					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Medium dense, Sandy silt of low plasticity with gravel	ML-CL			
9.0									9.10m		
9.5											
10.0	10	SPT-4	13	25	29	54					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2+472 km	*Northing :*3124979.104 m	*Easting :*718027.804 m
Reduced Level (m):(+)197.568	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*7.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	5	6	11					
1.5											
2.0							Brown, Medium dense, Silty sand with clay	SM-SC			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	9	12	15	27					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	16	20	36	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5									7.50m		
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	12	27	33	60					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2+788 km	*Northing :*3124953.799 m	*Easting :*717723.179 m
Reduced Level (m):(+)195.987	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*18.24	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	5	6	11					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Silty sand	SM			
3.0											
3.5											
4.0	4	SPT-2	6	8	10	18					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	15	24	30	54					
7.5											
8.0							Brown, Very dense, Silty sand with gravel	SM			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	25	40	44	84					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2+788 km	*Northing :*3124953.799 m	*Easting :*717723.179 m
Reduced Level (m):(+)195.987	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*18.24	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Very dense, Silty sand with gravel	SM			
13.0	13	SPT-5	17	33	38	71					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	12	14	17	31					
16.5											
17.0											
17.5	17.5	UDS*					Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
18.0	18	SPT-7	17	20	23	43					
18.5									18.24m		
19.0	19	SPT-8	19	21	25	46					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2+788 km	*Northing :*3124953.799 m	*Easting :*717723.179 m
Reduced Level (m):(+)195.987	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*18.24	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-9	20	25	30	55					
22.5											
23.0											
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-10	18	21	27	48	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-8									
27.0	27	SPT-11	16	25	40	65					
27.5											
28.0	28	SPT-12	22	34	41	75					
28.5											
29.0											
29.5	29.5	SPT-13	20	35	45	80					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2+788 km	*Northing :*3124952.116 m	*Easting :*717703.27 m
Reduced Level (m):(+)196.902	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*17.68	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	6	9	13	22					
3.0											
3.5							Brown, Medium dense, Silty sand	SM			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	7	13	17	30					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	14	25	34	59	Brown, Very dense, Silty sand with gravel	SM			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2+788 km	*Northing :*3124952.116 m	*Easting :*717703.27 m
Reduced Level (m):(+)196.902	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*17.68	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	16	26	38	64	Brown, Very dense, Silty sand with gravel	SM			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	12	14	19	33					
15.0											
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	17.5	SPT-6	12	14	18	32			17.68m		
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2+788 km	*Northing :*3124952.116 m	*Easting :*717703.27 m
Reduced Level (m):(+)196.902	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*17.68	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	14	17	19	36					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	35	40	43	83					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5	25.5	SPT-9	22	33	37	70					
26.0											
26.5	26.5	SPT-10	24	36	40	76					
27.0											
27.5											
28.0	28	SPT-11	32	45	55 (12cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-12	29	36	42	78					
30.0	29.95	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124900.291 m	*Easting :*717079.294 m
Reduced Level (m):(+)196.752	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	2	3	5					
1.5											
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	8	10	11	21					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
7.0	7	SPT-3	8	14	17	31					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Very dense, Silty sand with gravel	SM			
10.0	10	SPT-4	12	25	28	53					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124900.291 m	*Easting :*717079.294 m
Reduced Level (m):(+)196.752	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

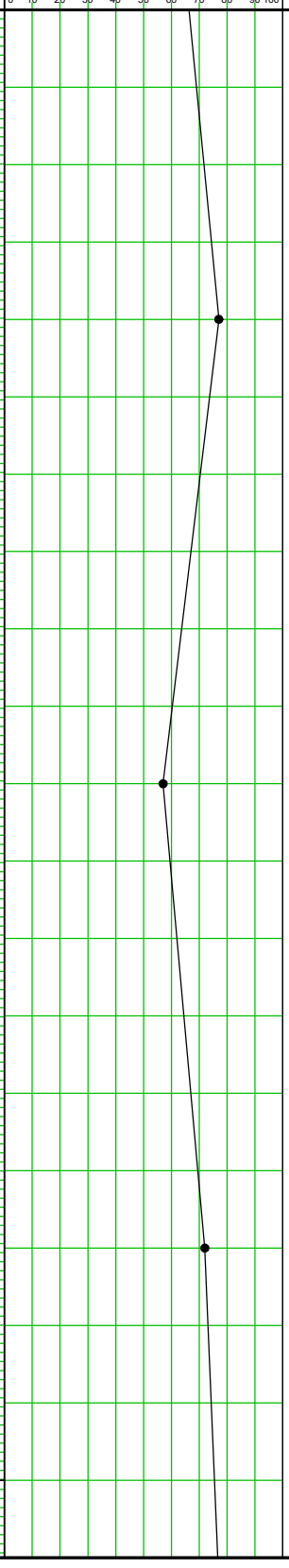
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Very dense, Silty sand with gravel	SM			
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	8	9	12	21					
13.5											
14.0											
14.5	14.5	UDS-5					Brown, Very stiff to hard, Silty clay of low plasticity	CL			
15.0											
15.5											
16.0	16	SPT-6	12	14	19	33			16.25m		
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	21	27	34	61	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124900.291 m	*Easting :*717079.294 m
Reduced Level (m):(+)196.752	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	19	34	43	77					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	13	24	33	57	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	18	29	43	72					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			

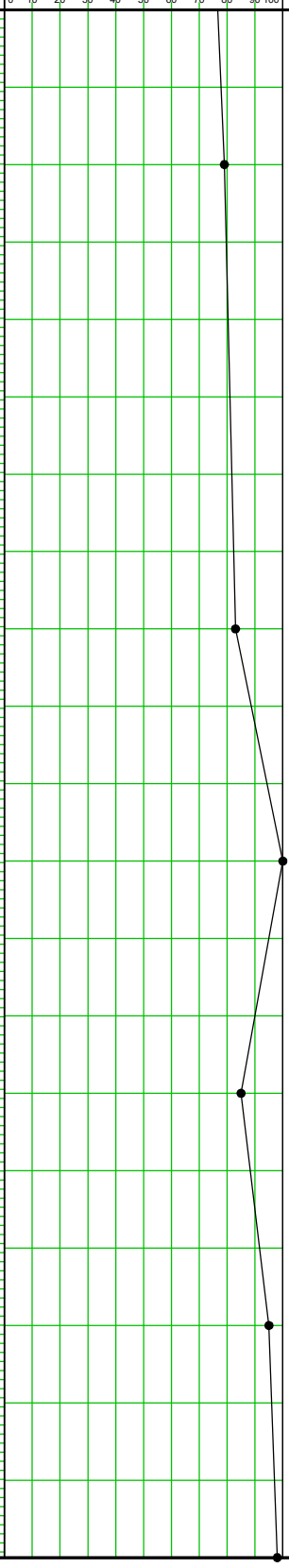


UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124900.291 m	*Easting :*717079.294 m
Reduced Level (m):(+)196.752	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	19	34	45	79					
31.5											
32.0											
32.5	32.5	UDS-11									
33.0											
33.5											
34.0	34	SPT-12	17	36	47	83					
34.5											
35.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
35.5	35.5	SPT-13	65	35 (6cm)	-	>100					
36.0											
36.5											
37.0	37	SPT-14	24	38	47	85					
37.5											
38.0											
38.5	38.5	SPT-15	27	40	55	95					
39.0											
39.5											
40.0	40	SPT-16	23	45	53	98					

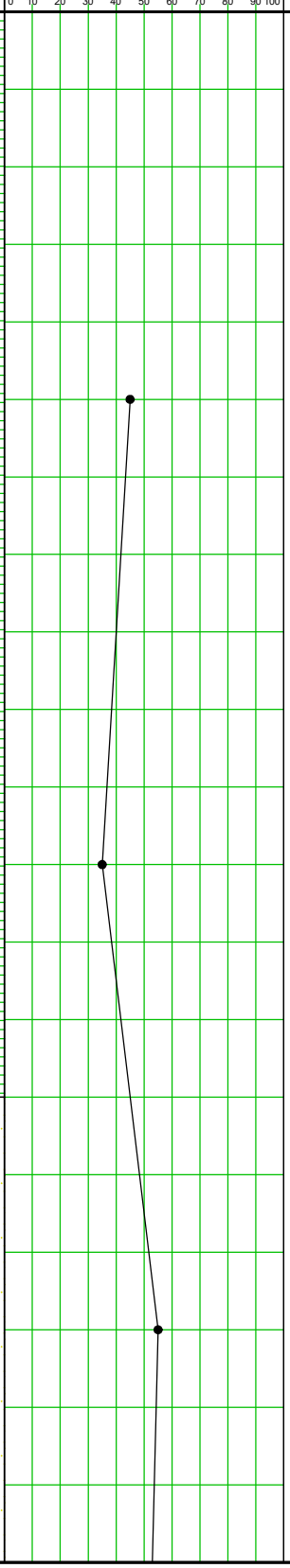


UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124897.227 m	*Easting :*717042.421 m
Reduced Level (m):(+)195.783	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.32	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	7	22	23	45					
3.0											
3.5							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	7	15	20	35					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	20	25	30	55	Brown, Very dense, Silty sand with gravel	SM			
9.0											
9.5											
10.0	10	UDS-4									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124897.227 m	*Easting :*717042.421 m
Reduced Level (m):(+)195.783	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.32	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	12	21	30	51	Brown, Very dense, Silty sand with gravel	SM			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	10	16	24	40	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL	▼15.32m		
15.0											
15.5											
16.0											
16.5	16.5	UDS*									
17.0											
17.5	17.5	SPT-6	10	28	40	68					
18.0											
18.5											
19.0	19	UDS-6					Brown, Very dense, Silty sand with gravel	SM			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124897.227 m	*Easting :*717042.421 m
Reduced Level (m):(+)195.783	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.32	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	22	27	32	59	Brown, Very dense, Silty sand with gravel	SM			
21.0											
21.5											
22.0	22	UDS-7									
22.5											
23.0											
23.5	23.5	SPT-8	19	26	31	57					
24.0											
24.5											
25.0	25	UDS-8									
25.5											
26.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
26.5	26.5	SPT-9	19	27	34	61					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0											
29.5	29.5	SPT-10	17	24	26	50					
30.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124897.227 m	*Easting :*717042.421 m
Reduced Level (m):(+)195.783	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.32	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	UDS-10									
31.5											
32.0											
32.5	32.5	SPT-11	25	30	35	65					
33.0											
33.5											
34.0	34	UDS-11									
34.5											
35.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
35.5	35.5	SPT-12	18	33	43	76					
36.0											
36.5											
37.0	37	UDS*									
37.5											
38.0											
38.5	38.5	SPT-13	25	40	55	95					
39.0											
39.5											
40.0	40	SPT-14	35	49	51	100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124894.329 m	*Easting :*717007.541 m
Reduced Level (m):(+)195.847	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	4	7					
1.5											
2.0							Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	6	8	9	17					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	9	10	19	Brown, Medium dense, Silty sand	SM			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	7	10	13	23					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124894.329 m	*Easting :*717007.541 m
Reduced Level (m):(+)195.847	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4					Brown, Medium dense, Silty sand	SM			
12.0											
12.5											
13.0	13	SPT-5	5	9	11	20					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5							Brown, Very stiff, Silty clay of low plasticity	CL	15.30m		
16.0	16	SPT-6	6	11	13	24					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	22	25	35	60	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124894.329 m	*Easting :*717007.541 m
Reduced Level (m):(+)195.847	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	10	17	21	38	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	9	17	25	42					
25.5											
26.0											
26.5	26.5	UDS-9					Brown, Hard, Silty clay of low plasticity with gravel	CL			
27.0											
27.5											
28.0	28	SPT-10	10	20	28	48					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124894.329 m	*Easting :*717007.541 m
Reduced Level (m):(+)195.847	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	15	29	34	63					
31.5											
32.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
32.5	32.5	UDS-11									
33.0											
33.5											
34.0	34	SPT-12	24	42	55	97					
34.5											
35.0											
35.5	35.5	SPT-13	40	100 (13cm)	-	>100					
36.0											
36.5											
37.0	37	SPT-14	20	38	52	90	Brown, Very dense, Silty sand with clay & gravel	SM-SC			
37.5											
38.0											
38.5	38.5	SPT-15	40	60	40 (7cm)	>100					
39.0											
39.5											
40.0	40	SPT-16	38	68	32 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124891.431 m	*Easting :*716972.661 m
Reduced Level (m):(+)195.759	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.31	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	5	6	11					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Silty sand	SM			
5.5	5.5	SPT-2	7	10	12	22					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	11	14	25					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124891.431 m	*Easting :*716972.661 m
Reduced Level (m):(+)195.759	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.31	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	9	12	16	28					
12.0											
12.5											
13.0	13	UDS-5					Brown, Very stiff to hard, Silty clay of low plasticity	CL			
13.5											
14.0											
14.5	14.5	SPT-5	10	17	25	42					
15.0											
15.5									15.31m		
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	12	25	31	56					
18.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124891.431 m	*Easting :*716972.661 m
Reduced Level (m):(+)195.759	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.31	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	14	28	39	67	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	11	26	35	61					
24.0											
24.5											
25.0	25	UDS-9									
25.5											
26.0											
26.5	26.5	SPT-9	16	25	33	58	Brown, Hard, Silty clay of low plasticity with gravel	CL			
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	19	31	39	70					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124891.431 m	*Easting :*716972.661 m
Reduced Level (m):(+)195.759	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.31	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*22-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
31.0	31	UDS*									
31.5	31.5	SPT-11	22	36	44	80					
32.0											
32.5	32.5	SPT-12	25	42	49	91					
33.0											
33.5											
34.0	34	SPT-13	22	38	50	88					
34.5											
35.0											
35.5	35.5	SPT-14	35	100 (14cm)	-	>100	Brown, Very Dense, Sandy silt of low plasticity with gravel	ML-CL			
36.0											
36.5											
37.0	37	SPT-15	33	88	12 (5cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	40	100 (15cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-17	42	60	40 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124888.367 m	*Easting :*716935.788 m
Reduced Level (m):(+)195.643	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.30	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-10-2021	*Date of Completion :*23-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	6	8	8	16					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	9	12	14	26					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	17	21	26	47					
7.5											
8.0							Brown, Dense to Very dense, Silty sand with gravel	SM			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	10	16	20	36					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124888.367 m	*Easting :*716935.788 m
Reduced Level (m):(+)195.643	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.30	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-10-2021	*Date of Completion :*23-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Dense to Very dense, Silty sand with gravel	SM			
13.0	13	SPT-5	18	24	36	60					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5									15.30m		
16.0	16	SPT-6	12	19	24	43					
16.5											
17.0											
17.5	17.5	UDS-6					Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
18.0	18	SPT-7	18	25	40	65					
18.5											
19.0	19	SPT-8	12	33	50	83					
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124888.367 m	*Easting :*716935.788 m
Reduced Level (m):(+)195.643	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.30	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-10-2021	*Date of Completion :*23-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	20	38	55	93	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
21.0											
21.5											
22.0	22	SPT-10	25	40	57	97					
22.5											
23.0											
23.5	23.5	SPT-11	22	25	33	58					
24.0											
24.5											
25.0	25	UDS-7									
25.5											
26.0											
26.5	26.5	SPT-12	21	23	27	50	Brown, Hard, Silty clay of low plasticity with gravel	CL			
27.0											
27.5											
28.0	28	SPT-13	24	31	45	76					
28.5											
29.0											
29.5	29.5	UDS-8									
30.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+497 km	*Northing :*3124888.367 m	*Easting :*716935.788 m
Reduced Level (m):(+)195.643	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.30	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-10-2021	*Date of Completion :*23-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-14	42	100 (9cm)	-	>100					
31.5											
32.0											
32.5	32.5	SPT-15	41	72	28 (10cm)	>100					
33.0											
33.5											
34.0	34	SPT-16	38	80	20 (5cm)	>100					
34.5											
35.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
35.5	35.5	SPT-17	46	75	25 (5cm)	>100					
36.0											
36.5											
37.0	37	SPT-18	36	82	18 (2cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-19	48	100 (8cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-20	27	67	33 (9cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+691 km	*Northing :*3124880.556 m	*Easting :*716820.675 m
Reduced Level (m):(+)196.163	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.40	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	SPT-1	2	2	3	5					
1.5											
2.0							Brown, Loose, Silty sand with clay	SM-SC			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	10	12	22					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	11	13	24	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	9	12	15	27					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+691 km	*Northing :*3124880.556 m	*Easting :*716820.675 m
Reduced Level (m):(+)196.163	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.40	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
13.0	13	SPT-5	7	10	12	22					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5									15.40m		
16.0	16	SPT-6	10	18	22	40	Brown, Hard, Silty clay of low plasticity with gravel	CL			
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	17	31	46	77	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+691 km	*Northing :*3124880.556 m	*Easting :*716820.675 m
Reduced Level (m):(+)196.163	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.40	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	18	33	48	81					
21.0											
21.5											
22.0	22	SPT-9	13	28	39	67					
22.5											
23.0											
23.5	23.5	SPT-10	15	31	40	71					
24.0											
24.5											
25.0	25	SPT-11	12	24	37	61	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-7									
27.0											
27.5											
28.0	28	SPT-12	17	32	41	73					
28.5											
29.0											
29.5	29.5	SPT-13	21	43	57	100					
30.0	29.95	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+691 km	*Northing :*3124877.143 m	*Easting :*716800.7 m
Reduced Level (m):(+)196.124	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.25	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Very stiff, Silty clay of low plasticity	CL			
2.5	2.5	SPT-1	3	5	7	12					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	7	9	16					
6.0											
6.5											
7.0	7	UDS-3					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	SPT-3	7	9	11	20					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+691 km	*Northing :*3124877.143 m	*Easting :*716800.7 m
Reduced Level (m):(+)196.124	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.25	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	9	12	15	27	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	6	9	13	22					
15.0									15.25m		
15.5											
16.0	16	UDS-6					Brown, Very stiff, Silty clay of low plasticity with gravel	CL			
16.5											
17.0											
17.5	17.5	SPT-6	9	13	17	30					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*3+691 km	*Northing :*3124877.143 m	*Easting :*716800.7 m
Reduced Level (m):(+)196.124	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.25	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	15	21	27	48					
21.0											
21.5											
22.0	22	UDS*									
22.5	22.5	SPT-8	14	19	24	43					
23.0											
23.5	23.5	SPT-9	16	22	31	53					
24.0											
24.5											
25.0	25	UDS-8					Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-10	19	21	25	46					
27.0											
27.5											
28.0	28	UDS*									
28.5	28.5	SPT-11	18	31	38	69					
29.0											
29.5	29.5	SPT-12	20	42	58 (7cm)	>100					
30.0	29.95	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*4+174 km	*Northing :*3124838.454 m	*Easting :*716335.062 m
Reduced Level (m):(+)196.256	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1					Brown, Silty sand	SM			
1.5											
2.0											
2.5	2.5	SPT-1	5	6	8	14					
3.0											
3.5											
4.0	4	UDS-2					Brown, Very stiff, Silty clay of low plasticity	CL			
4.5											
5.0											
5.5	5.5	SPT-2	8	12	17	29					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0							Brown, Medium dense to very dense, Silty sand with gravel	SM			
8.5	8.5	SPT-3	17	24	31	55					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*4+207 km	*Northing :*3124835.546 m	*Easting :*716300.074 m
Reduced Level (m):(+)196.348	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	6	9	15					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	9	12	14	26					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	17	24	41					
7.5											
8.0							Brown, Dense to very dense, Silty sand with gravel	SM			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	17	24	32	56					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*4+655 km	*Northing :*3124798.666 m	*Easting :*715855.211 m
Reduced Level (m):(+)200.573	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	6	8	14	Brown, Medium dense, Silty sand	SM			
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	11	17	24	41					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Brown, Dense to very dense, Silty sand with gravel	SM			
7.0	7	SPT-3	14	23	30	53					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	16	26	36	62					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*5+119 km	*Northing :*3124750.566 m	*Easting :*715393.751 m
Reduced Level (m):(+)202.713	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	SPT-1	4	4	6	10					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	7	12	16	28					
6.0											
6.5											
7.0	7	UDS-3					Brown, Medium dense to dense, Silty sand with gravel	SM			
7.5											
8.0											
8.5	8.5	SPT-3	12	14	19	33					
9.0											
9.5											
10.0	10	UDS-4									

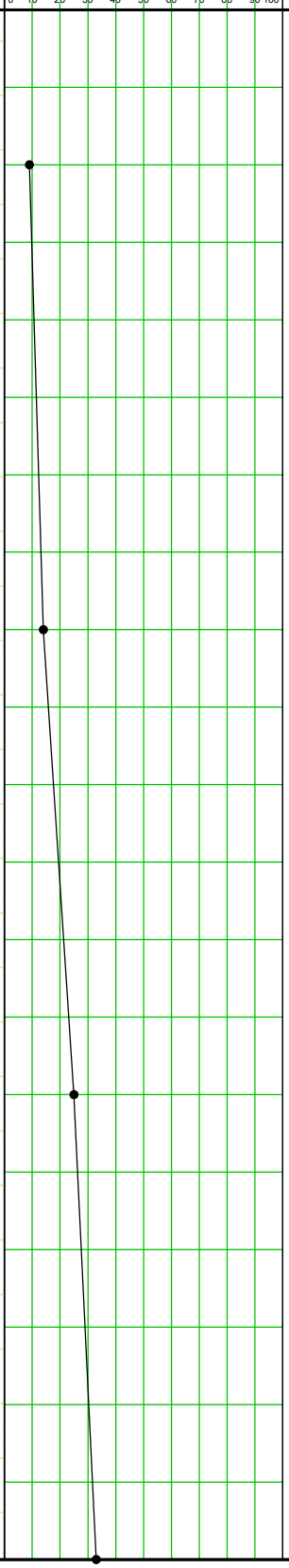
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*5+730 km	*Northing :*3124685.263 m	*Easting :*714786.103 m
Reduced Level (m):(+)198.287	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-10-2021	*Date of Completion :*17-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	3	6	9					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	5	9	14					
4.5											
5.0							Brown, Loose to dense, Silty sand	SM			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	9	16	25					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	12	14	19	33					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*6+197 km	*Northing :*3124636.752 m	*Easting :*714320.102 m
Reduced Level (m):(+)198.287	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*2.52	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-10-2021	*Date of Completion :*17-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	5	8	13			2.52m		
3.0											
3.5											
4.0	4	UDS-2					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.5											
5.0											
5.5	5.5	SPT-2	7	9	12	21					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	15	19	28	47					
9.0							Brown, Dense, Silty sand with gravel	SM			
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*6+877 km	*Northing :*3124570.057 m	*Easting :*713641.709 m
Reduced Level (m):(+)196.702	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-10-2021	*Date of Completion :*17-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	6	6	7	13					
1.5											
2.0									1.85m		
2.5	2.5	UDS-1					Brown, Medium dense, Silty sand with clay	SM-SC			
3.0											
3.5											
4.0	4	SPT-2	7	8	10	18					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	12	21	33					
7.5											
8.0							Brown, Dense, Silty sand	SM			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	12	14	24	38					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+078 km	*Northing :*3124551.638 m	*Easting :*713455.57 m
Reduced Level (m):(+)195.221	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.70	*Inclination :* Vertical
*Boring type :*Shell & Augar	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0									1.70m		
2.5	2.5	SPT-1	4	5	8	13					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	4	5	9	14					
6.0											
6.5											
7.0	7	UDS*									
7.5	7.5	SPT-3	6	8	9	17					
8.0											
8.5	8.5	SPT-4	9	11	12	23					
9.0											
9.5											
10.0	10	UDS-3									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+078 km	*Northing :*3124551.638 m	*Easting :*713455.57 m
Reduced Level (m):(+)195.221	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.70	*Inclination :* Vertical
*Boring type :*Shell & Augar	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
11.0											
11.5	11.5	SPT-5	7	11	16	27					
12.0											
12.5											
13.0	13	UDS-4									
13.5											
14.0							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
14.5	14.5	SPT-6	9	14	21	35					
15.0											
15.5											
16.0	16	UDS-5									
16.5											
17.0											
17.5	17.5	SPT-7	18	41	47	88					
18.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
18.5											
19.0	19	SPT-8	20	36	50	86					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+078 km	*Northing :*3124551.638 m	*Easting :*713455.57 m
Reduced Level (m):(+)195.221	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.70	*Inclination :* Vertical
*Boring type :*Shell & Augar	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	22	32	40	72	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
21.0											
21.5											
22.0	22	SPT-10	20	34	50	84					
22.5											
23.0											
23.5	23.5	SPT-11	18	33	53	86					
24.0											
24.5											
25.0	25	SPT-12	21	33	35	68	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5											
27.0											
27.5	27.5	SPT-13	15	28	48	76					
28.0	28	SPT-14	16	24	45	69					
28.5											
29.0											
29.5	29.5	SPT-15	15	22	48	70					
30.0	29.95	DS-2									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+078 km	*Northing :*3124549.896 m	*Easting :*713435.595 m
Reduced Level (m):(+)194.815	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.25	*Inclination :* Vertical
*Boring type :*Shell & Augar	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	1	2	3	5					
1.5									1.25m		
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	2	3	4	7	Brown, Medium stiff, Silty clay of low plasticity	CL			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	3	3	5	8					
7.5											
8.0											
8.5	8.5	UDS*									
9.0	9	SPT-4	6	8	10	18	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-5	5	7	12	19					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+078 km	*Northing :*3124549.896 m	*Easting :*713435.595 m
Reduced Level (m):(+)194.815	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.25	*Inclination :* Vertical
*Boring type :*Shell & Augar	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
11.0											
11.5	11.5	UDS-3									
12.0											
12.5											
13.0	13	SPT-6	12	15	19	34					
13.5											
14.0											
14.5	14.5	UDS-4					Brown, Hard, Silty clay of low plasticity with gravel	CL			
15.0											
15.5											
16.0	16	SPT-7	13	18	22	40					
16.5											
17.0											
17.5	17.5	UDS*									
18.0	18	SPT-8	30	45	50	95					
18.5							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
19.0	19	SPT-9	18	34	55	89					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+078 km	*Northing :*3124549.896 m	*Easting :*713435.595 m
Reduced Level (m):(+)194.815	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.25	*Inclination :* Vertical
*Boring type :*Shell & Augar	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*03-10-2021	*Date of Completion :*04-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.5	20.5	SPT-10	21	28	30	58					
21.0											
21.5											
22.0	22	SPT-11	18	35	39	74					
22.5											
23.0											
23.5	23.5	UDS-5									
24.0											
24.5											
25.0	25	SPT-12	10	19	32	51	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0	26	UDS*									
26.5											
27.0	27	SPT-13	15	29	50	79					
27.5											
28.0	28	SPT-14	15	24	46	70					
28.5											
29.0											
29.5	29.5	SPT-15	14	25	45	70					
30.0	29.95	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+256 km	*Northing :*3124532.969 m	*Easting :*713264.533 m
Reduced Level (m):(+)193.947	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.59	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	7	9	16					
1.5									1.59m		
2.0							Brown, Medium dense, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	9	11	16	27					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	12	18	30	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	10	13	20	33					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124525.765 m	*Easting :*713206.08 m
Reduced Level (m):(+)194.037	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-10-2021	*Date of Completion :*26-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	3	6					
1.5											
2.0							Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0									3.00m		
3.5											
4.0	4	SPT-2	10	14	18	32					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
6.5											
7.0	7	SPT-3	5	7	8	15					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Very stiff, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	7	9	11	20					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124525.765 m	*Easting :*713206.08 m
Reduced Level (m):(+)194.037	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-10-2021	*Date of Completion :*26-10-2021	

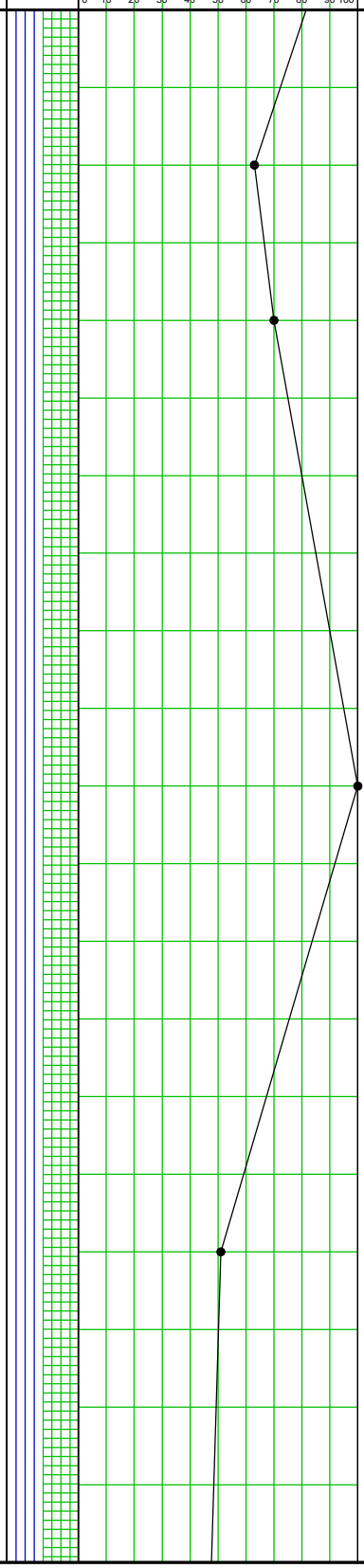
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5							Brown, Very stiff, Silty clay of low plasticity	CL			
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	10	14	19	33	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	13	18	21	39	Brown, Hard, Silty clay of low plasticity with gravel	CL			
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	35	65	35 (11cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124525.765 m	*Easting :*713206.08 m
Reduced Level (m):(+)194.037	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-10-2021	*Date of Completion :*26-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5											
21.0	21	SPT-8	20	29	34	63					
21.5											
22.0	22	SPT-9	23	33	37	70					
22.5											
23.0											
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-10	27	66	34 (12cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	UDS*									
27.0											
27.5											
28.0	28	SPT-11	20	24	27	51					
28.5											
29.0											
29.5	29.5	UDS-8									
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124525.765 m	*Easting :*713206.08 m
Reduced Level (m):(+)194.037	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-10-2021	*Date of Completion :*26-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-12	18	21	25	46	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
31.5											
32.0											
32.5	32.5	UDS-9									
33.0											
33.5											
34.0	34	SPT-13	22	32	39	71					
34.5											
35.0											
35.5	35.5	UDS-10									
36.0											
36.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
37.0	37	SPT-14	32	58	42 (8cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-15	45	70	30 (13cm)	>100					
39.0											
39.5											
40.0	40	SPT-16	40	54	46 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124522.342 m	*Easting :*713171.257 m
Reduced Level (m):(+)196.827	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Loose, Sandy silt of low plasticity	ML-CL	2.10m		
2.5	2.5	SPT-1	3	4	5	9					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	3	4	7	11					
6.0											
6.5											
7.0	7	UDS-3					Brown, Very stiff, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	SPT-3	5	5	7	12					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124522.342 m	*Easting :*713171.257 m
Reduced Level (m):(+)196.827	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	10	17	28	45	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	9	12	16	28					
15.0											
15.5											
16.0	16	UDS-6					Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
16.5											
17.0											
17.5	17.5	SPT-6	9	14	19	33					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124522.342 m	*Easting :*713171.257 m
Reduced Level (m):(+)196.827	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	19	43	57 (8cm)	>100					
21.0											
21.5											
22.0	22	SPT-8	18	30	39	69					
22.5											
23.0											
23.5	23.5	SPT-9	11	19	24	43					
24.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
24.5											
25.0	25	UDS-8									
25.5											
26.0											
26.5	26.5	SPT-10	18	38	51	89					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
29.5	29.5	SPT-11	12	18	23	41					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124522.342 m	*Easting :*713171.257 m
Reduced Level (m):(+)196.827	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*25-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	UDS-10									
31.5											
32.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
32.5	32.5	SPT-12	18	27	32	59					
33.0											
33.5											
34.0	34	UDS*									
34.5	34.5	SPT-13	19	35	55	90					
35.0											
35.5	35.5	SPT-14	20	38	60	98					
36.0											
36.5											
37.0	37	SPT-15	26	39	57	96	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
37.5											
38.0											
38.5	38.5	SPT-16	31	45	55 (12cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	35	50	50 (4cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124522.342 m	*Easting :*713136.399 m
Reduced Level (m):(+)193.680	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.70	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	1	2	2	4					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	2	2	2	4	Brown, Loose, Silty sand	SM			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	2	3	5	8					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Medium dense, Silty sand with clay	SM-SC			
9.5											
10.0	10	SPT-4	4	6	8	14					

0.70m

0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124522.342 m	*Easting :*713136.399 m
Reduced Level (m):(+)193.680	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.70	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Medium dense, Silty sand with clay	SM-SC			
13.0	13	SPT-5	7	9	13	22					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	13	25	31	56					
16.5											
17.0											
17.5	17.5	UDS*					Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
18.0	18	SPT-7	16	29	35	64					
18.5											
19.0	19	SPT-8	19	32	39	71					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124522.342 m	*Easting :*713136.399 m
Reduced Level (m):(+)193.680	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.70	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	23	36	42	78					
21.0											
21.5											
22.0	22	SPT-10	25	39	46	85					
22.5											
23.0											
23.5	23.5	SPT-11	27	42	49	91					
24.0											
24.5											
25.0	25	SPT-12	29	45	50	95	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-13	32	55	45 (12cm)	>100					
27.0											
27.5											
28.0	28	SPT-14	35	61	39 (7cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-15	33	58	42 (9cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+351 km	*Northing :*3124522.342 m	*Easting :*713136.399 m
Reduced Level (m):(+)193.680	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.70	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-16	37	70	30 (5cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-17	15	38	47	85					
33.0											
33.5											
34.0	34	SPT-18	19	41	50	91					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-19	27	60	40 (13cm)	>100					
36.0											
36.5											
37.0	37	SPT-20	30	64	36 (9cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-21	32	62	38 (7cm)	>100					
39.0											
39.5											
40.0	40	SPT-22	34	69	31 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+457 km	*Northing :*3124513.592 m	*Easting :*713067.448 m
Reduced Level (m):(+)193.671	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*0.59	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-10-2021	*Date of Completion :*24-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5									0.59m		
1.0	1	SPT-1	4	5	7	12					
1.5											
2.0							Brown, Medium dense, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	7	12	19					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	10	15	25	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	12	14	18	32					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+613 km	*Northing :*3124499.906 m	*Easting :*712928.25 m
Reduced Level (m):(+)195.453	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-10-2021	*Date of Completion :*27-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5									0.50m		
1.0	1	SPT-1	4	4	5	9					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Loose to medium dense, Silty sand	SM			
3.0											
3.5											
4.0	4	SPT-2	4	5	7	12					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	10	11	21					
7.5											
8.0							Brown, Medium dense, Silty sand with clay	SM-SC			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	10	10	20					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+613 km	*Northing :*3124499.906 m	*Easting :*712928.25 m
Reduced Level (m):(+)195.453	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-10-2021	*Date of Completion :*27-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Medium dense, Silty sand with clay	SM-SC			
13.0	13	SPT-5	9	13	16	29					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	26	62	38 (7cm)	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5							Brown, Very dense, Silty sand with gravel	SM			
19.0	19	SPT-7	14	28	42	70					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+613 km	*Northing :*3124499.906 m	*Easting :*712928.25 m
Reduced Level (m):(+)195.453	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-10-2021	*Date of Completion :*27-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	12	23	32	55	Brown, Very dense, Silty sand with gravel	SM			
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	12	30	42	72					
25.5											
26.0											
26.5	26.5	UDS*					Brown, Hard, Silty clay of low plasticity with gravel	CL			
27.0	27	SPT-10	19	35	47	82					
27.5											
28.0	28	SPT-11	16	32	43	75					
28.5											
29.0											
29.5	29.5	UDS-9									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+613 km	*Northing :*3124499.906 m	*Easting :*712928.25 m
Reduced Level (m):(+)195.453	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-10-2021	*Date of Completion :*27-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-12	22	37	48	85	Brown, Hard, Silty clay of low plasticity with gravel	CL			
31.5											
32.0											
32.5	32.5	UDS-10									
33.0											
33.5											
34.0	34	SPT-13	24	57	43 (8cm)	>100					
34.5											
35.0											
35.5	35.5	SPT-14	22	63	37 (6cm)	>100					
36.0							Brown, Very dense, Silty sand with clay & gravel	SM-SC			
36.5											
37.0	37	SPT-15	26	67	33 (5cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	28	72	28 (3cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	24	38	42	80					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+613 km	*Northing :*3124496.873 m	*Easting :*712897.399 m
Reduced Level (m):(+)193.923	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1							0.85m		
1.5											
2.0											
2.5	2.5	SPT-1	5	6	15	21					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Very stiff, Silty clay of low plasticity	CL			
5.5	5.5	SPT-2	6	9	13	22					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	14	17	31					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+613 km	*Northing :*3124496.873 m	*Easting :*712897.399 m
Reduced Level (m):(+)193.923	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	10	12	18	30	Brown, Very stiff, Silty clay of low plasticity	CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	13	22	38	60					
15.0											
15.5											
16.0	16	UDS-6					Brown, Very dense, Silty sand with clay & gravel	SM-SC			
16.5											
17.0											
17.5	17.5	SPT-6	10	25	30	55					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Very dense, Silty sand with gravel	SM-SC			
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+613 km	*Northing :*3124496.873 m	*Easting :*712897.399 m
Reduced Level (m):(+)193.923	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	SPT-7	17	35	46	81					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	16	36	44	80					
24.0							Brown, Very dense, Silty sand with gravel	SM-SC			
24.5											
25.0	25	UDS-9									
25.5											
26.0											
26.5	26.5	SPT-9	18	34	48	82					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
29.5	29.5	SPT-10	14	28	38	66					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+613 km	*Northing :*3124496.873 m	*Easting :*712897.399 m
Reduced Level (m):(+)193.923	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*28-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	22	57	43 (8cm)	>100					
33.0											
33.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
34.0	34	SPT-12	23	55	45 (11cm)	>100					
34.5											
35.0											
35.5	35.5	SPT-13	21	56	44 (5cm)	>100					
36.0											
36.5											
37.0	37	SPT-14	27	70	30 (5cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-15	29	69	31 (6cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
39.0											
39.5											
40.0	40	SPT-16	23	42	51 (10cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*7+907 km	*Northing :*3124469.642 m	*Easting :*712620.43 m
Reduced Level (m):(+)193.872	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-10-2021	*Date of Completion :*26-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1					Brown, Silty sand	SM			
1.5											
2.0									1.90m		
2.5	2.5	SPT-1	4	6	7	13					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	6	8	11	19	Brown, Very stiff, Silty clay of low plasticity	CL			
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	14	25	39					
9.0											
9.5							Brown, Dense, Silty sand with gravel	SM			
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+207 km	*Northing :*3124437.243 m	*Easting :*712317.987 m
Reduced Level (m):(+)193.686	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*2.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-10-2021	*Date of Completion :*26-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	5	7	12					
1.5											
2.0									2.00m		
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	8	14	22	Brownish grey, Medium dense, Sandy silt of low plasticity	ML-CL			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	10	16	26					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Hard, Silty clay of medium plasticity	CI			
9.5											
10.0	10	SPT-4	6	12	18	30					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+610 km	*Northing :*3124401.078 m	*Easting :*711923.004 m
Reduced Level (m):(+)194.123	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.95	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-10-2021	*Date of Completion :*20-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Medium dense, Silty sand	SM	▼1.95m		
2.5	2.5	SPT-1	5	7	12	19					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	6	7	10	17					
6.0											
6.5											
7.0	7	UDS-3					Brown, Medium dense to dense, Silty sand with clay	SM-SC			
7.5											
8.0											
8.5	8.5	SPT-3	8	15	20	35					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+852 km	*Northing :*3124377.983 m	*Easting :*711688.17 m
Reduced Level (m):(+)193.689	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.75	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*18-10-2021	*Date of Completion :*19-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	SPT-1	4	5	7	12			0.75m		
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	12	16	28	Brown, Medium dense, Silty sand with clay	SM-SC			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	10	15	25					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
9.5											
10.0	10	SPT-4	12	19	30	49					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+852 km	*Northing :*3124377.983 m	*Easting :*711688.17 m
Reduced Level (m):(+)193.689	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.75	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*18-10-2021	*Date of Completion :*19-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	14	17	24	41					
13.5											
14.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	14	19	27	46					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	13	17	24	41	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+852 km	*Northing :*3124377.983 m	*Easting :*711688.17 m
Reduced Level (m):(+)193.689	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.75	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*18-10-2021	*Date of Completion :*19-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	14	18	25	43					
22.5							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
23.0											
23.5	23.5	UDS*									
24.0											
24.5											
25.0	25	SPT-9	13	19	28	47					
25.5											
26.0											
26.5	26.5	UDS-8									
27.0											
27.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
28.0	28	SPT-10	16	24	35	59					
28.5											
29.0											
29.5	29.5	UDS-9									
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+852 km	*Northing :*3124375.655 m	*Easting :*711664.484 m
Reduced Level (m):(+)194.209	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.35	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*18-10-2021	*Date of Completion :*19-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	UDS-1									
1.5									1.35m		
2.0											
2.5	2.5	SPT-1	4	7	8	15					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Silty sand with clay	SM-SC			
5.5	5.5	SPT-2	4	7	7	14					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	5	8	11	19					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+852 km	*Northing :*3124375.655 m	*Easting :*711664.484 m
Reduced Level (m):(+)194.209	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.35	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*18-10-2021	*Date of Completion :*19-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	10	17	22	39	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	13	24	33	57					
15.0											
15.5											
16.0	16	UDS-6					Brown, Hard, Silty clay of low plasticity with gravel	CL			
16.5											
17.0											
17.5	17.5	SPT-6	11	17	23	40					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+852 km	*Northing :*3124375.655 m	*Easting :*711664.484 m
Reduced Level (m):(+)194.209	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.35	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*18-10-2021	*Date of Completion :*19-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	12	19	22	41					
21.0											
21.5											
22.0	22	UDS-8									
22.5							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
23.0											
23.5	23.5	SPT-8	17	24	32	56					
24.0											
24.5											
25.0	25	UDS-9									
25.5											
26.0											
26.5	26.5	SPT-9	14	22	30	52					
27.0											
27.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	16	21	35	56					
30.0	29.95	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*8+907 km	*Northing :*3124371.601 m	*Easting :*711623.253 m
Reduced Level (m):(+)193.708	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*0.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-10-2021	*Date of Completion :*26-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5									0.55m		
1.0	1	SPT-1	2	3	3	6					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	7	9	16					
4.5											
5.0							Brown, Loose to medium dense, Silty sand	SM			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	10	12	22					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	9	12	15	27					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*New Ch. 10+340 km_Silani Station	*Northing :*3124346.49 m	*Easting :*711500.031 m
Reduced Level (m):(+)194.158	*BH. No. :*BH-PLT-08	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*4.03	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-12-2021	*Date of Completion :*21-12-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
	0.75	UDS-1									
1.0											
1.5	1.5	SPT-1	1	1	2	3					
2.0											
	2.25	SPT-2	1	2	3	5					
2.5											
3.0	3	SPT-3	2	3	5	8					
3.5											
	3.75	SPT-4	3	5	8	13	Brown, Loose/Very loose, Silty sand with gravles	SM-SC	4.03m		
4.0											
4.5	4.5	UDS-2									
5.0											
5.5											
6.0	6	SPT-5	9	12	14	26					
6.5											
7.0											
7.5	7.5	UDS-3									
8.0											
8.5											
9.0	9	SPT-6	14	19	21	40	Brown, Medium dense, Sandy silt with clay	ML-CL			
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*New Ch. 10+340 km_Silani Station	*Northing :*3124346.49 m	*Easting :*711500.031 m
Reduced Level (m):(+)194.158	*BH. No. :*BH-PLT-08	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*4.03	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-12-2021	*Date of Completion :*21-12-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5	10.5	UDS-4					Brown, Medium dense, Sandy silt with clay	ML-CL			
11.0											
11.5											
12.0	12	SPT-7	23	27	30	57					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+200 km	*Northing :*3124343.215 m	*Easting :*711334.58 m
Reduced Level (m):(+)194.672	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*05-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5									1.25m		
2.0							Grey, Medium stiff, Silty clay of low plasticity	CL			
2.5	2.5	SPT-1	2	3	3	6					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	6	8	14					
6.0											
6.5											
7.0	7	UDS*					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
7.5	7.45	SPT-3	5	9	11	20					
8.0											
8.5	8.5	SPT-4	8	11	14	25					
9.0											
9.5											
10.0	10	UDS-3									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+211 km	*Northing :*3124342.307 m	*Easting :*711325.206 m
Reduced Level (m):(+)194.649	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.36	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification
0.0		DS						
1.0	1	SPT-1	2	3	4	7		
2.0							Brown, Soft, Silty clay of low plasticity	CL
2.5	2.5	UDS-1						
4.0	4	SPT-2	6	6	5	11		
5.5	5.5	UDS-2						
7.0	7	SPT-3	5	8	9	17	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL
8.5	8.5	UDS-3						
10.0	10	SPT-4	9	12	22	34		

Graphic Log: 1.36m

(Depth v/s SPT N Value): 0 10 20 30 40 50 60 70 80 90 100

Special Observations

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+407 km	*Northing :*3124322.695 m	*Easting :*711125.831 m
Reduced Level (m):(+)193.387	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-10-2021	*Date of Completion :*27-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5									0.60m		
1.0	1	UDS-1									
1.5											
2.0							Brown, Loose to medium dense, Silty sand	SM			
2.5	2.5	SPT-1	2	3	4	7					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	6	8	14	Brown, Loose to medium dense, Silty sand	SP-SM			
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0							Brown, Loose to medium dense, Silty sand	SM			
8.5	8.5	SPT-3	7	9	11	20					
9.0											
9.5							Brown, Very stiff, Silty clay of low plasticity	CL			
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+726 km	*Northing :*3124291.156 m	*Easting :*710810.84 m
Reduced Level (m):(+)194.097	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*07-10-2021	*Date of Completion :*08-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	2	2	4			0.85m		
1.5											
2.0							Yellowish brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	8	12	20					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0							Brown, Medium dense, Silty sand with clay	SM-SC			
6.5											
7.0	7	SPT-3	6	10	12	22					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
9.5											
10.0	10	SPT-4	14	18	23	41					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+726 km	*Northing :*3124291.156 m	*Easting :*710810.84 m
Reduced Level (m):(+)194.097	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*07-10-2021	*Date of Completion :*08-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	13	16	32	48					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	SPT-6	11	14	19	33					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	14	15	18	33					
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+726 km	*Northing :*3124291.156 m	*Easting :*710810.84 m
Reduced Level (m):(+)194.097	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*07-10-2021	*Date of Completion :*08-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7					Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
21.0											
21.5											
22.0	22	SPT-8	10	18	21	39					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.0	25	SPT-9	12	21	26	47					
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	48	100 (7cm)	-	>100					
28.5											
29.0							Brown, Very dense, Silty sand with gravel	SM			
29.5	29.5	SPT-11	36	62	38 (6cm)	>100					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+726 km	*Northing :*3124290.194 m	*Easting :*710802.664 m
Reduced Level (m):(+)193.613	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.29	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-10-2021	*Date of Completion :*29-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5									0.29m		
1.0	1	UDS*									
1.5	1.5	SPT-1	1	2	2	4					
2.0											
2.5	2.5	SPT-2	2	2	3	5	Brown, Loose, Silty sand with clay	SM-SC			
3.0											
3.5											
4.0	4	UDS*									
4.5	4.5	SPT-3	8	11	14	25					
5.0											
5.5	5.5	SPT-4	9	12	15	27					
6.0											
6.5											
7.0	7	UDS-1					Brown, Medium dense, Silty sand with gravel	SM			
7.5											
8.0											
8.5	8.5	SPT-5	7	12	18	30					
9.0											
9.5											
10.0	10	UDS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+726 km	*Northing :*3124290.194 m	*Easting :*710802.664 m
Reduced Level (m):(+)193.613	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.29	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-10-2021	*Date of Completion :*29-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-6	9	13	18	31	Brown, Hard, Silty clay of low plasticity with gravel	CL			
12.0											
12.5											
13.0	13	UDS-3									
13.5											
14.0											
14.5	14.5	SPT-7	11	16	21	37					
15.0											
15.5											
16.0	16	UDS-4									
16.5							Brown, Dense, Silty sand with clay & gravel	SM-SC			
17.0											
17.5	17.5	SPT-8	12	15	22	37					
18.0											
18.5											
19.0	19	UDS-5									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+726 km	*Northing :*3124290.194 m	*Easting :*710802.664 m
Reduced Level (m):(+)193.613	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.29	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-10-2021	*Date of Completion :*29-10-2021	

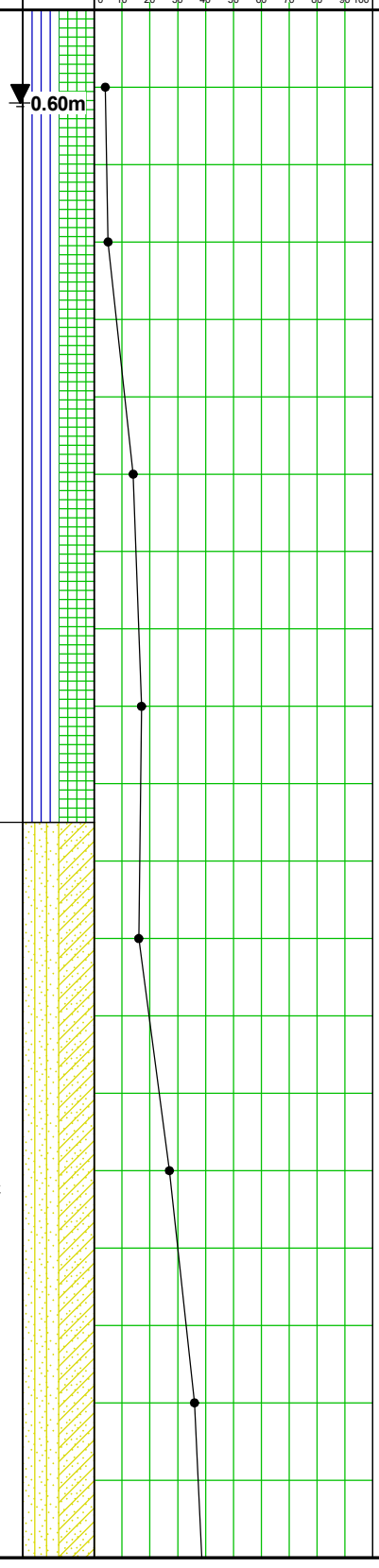
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	13	16	24	40					
21.0											
21.5											
22.0	22	UDS-6									
22.5											
23.0											
23.5	23.5	SPT-10	14	18	27	45	Brown, Dense, Silty sand with clay & gravel	SM-SC			
24.0											
24.5											
25.0	25	UDS-7									
25.5											
26.0											
26.5	26.5	SPT-11	16	22	36	58					
27.0											
27.5											
28.0	28	UDS-8					Brown, Hard, Silty clay of low plasticity with gravel	CL			
28.5											
29.0											
29.5	29.5	SPT-12	21	30	39	69					
30.0	29.95	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+772 km	*Northing :*3124285.182 m	*Easting :*710762.491 m
Reduced Level (m):(+)193.598	*BH. No. :*BH-CL	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-11-2021	*Date of Completion :*10-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	1	2	2	4					
1.0											
1.5	1.5	SPT-2	2	2	3	5					
2.0											
2.5	2.25	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	4	6	8	14					
3.5											
4.0											
4.5	4.5	SPT-4	3	7	10	17					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	5	7	9	16					
6.5											
7.0											
7.5	7.5	SPT-6	8	12	15	27	Brown, Medium dense to dense, Silty sand with clay & gravel	SM-SC			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	12	16	20	36					
9.5											
10.0											

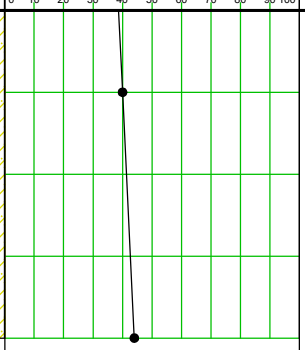


UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*9+772 km	*Northing :*3124285.182 m	*Easting :*710762.491 m
Reduced Level (m):(+)193.598	*BH. No. :*BH-CL	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-11-2021	*Date of Completion :*10-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	14	18	22	40	Brown, Medium dense to dense, Silty sand with clay & gravel	SM-SC			
11.0											
	11.25	UDS-4									
11.5											
12.0	12	SPT-9	16	20	24	44					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+025 km	*Northing :*3124244.432 m	*Easting :*710515.298 m
Reduced Level (m):(+)194.595	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.34	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*05-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	7	10					
1.5									1.34m		
2.0							Yellowish brown, Loose, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	6	11	17					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0							Yellowish brown, Medium dense, Silty sand with clay & gravel	SM-SC			
6.5											
7.0	7	SPT-3	7	10	13	23					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Yellowish brown, Medium dense, Sandy silt of low plasticity	ML-CL			
10.0	10	SPT-4	6	9	11	20					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+025 km	*Northing :*3124244.432 m	*Easting :*710515.298 m
Reduced Level (m):(+)194.595	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.34	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*05-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	8	12	15	27					
13.5							Yellowish brown, Medium dense, Sandy silt of low plasticity	ML-CL			
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	9	14	17	31					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	13	30	34	64	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+025 km	*Northing :*3124244.432 m	*Easting :*710515.298 m
Reduced Level (m):(+)194.595	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.34	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*05-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	14	25	37	62					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	12	14	19	33	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	15	25	30	55					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0	29.95	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+025 km	*Northing :*3124242.99 m	*Easting :*710507.526 m
Reduced Level (m):(+)194.589	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.22	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*05-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	UDS-1									
1.5									1.22m		
2.0							Yellowish brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	SPT-1	4	6	7	13					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	9	12	15	27					
6.0											
6.5											
7.0	7	UDS*					Yellowish brown, Medium dense to dense, Silty sand with clay & gravel	SM-SC			
7.5	7.5	SPT-3	10	15	17	32					
8.0											
8.5	8.5	SPT-4	15	18	25	43					
9.0											
9.5											
10.0	10	UDS-3									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+025 km	*Northing :*3124242.99 m	*Easting :*710507.526 m
Reduced Level (m):(+)194.589	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.22	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*05-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-5	14	25	30	55					
12.0											
12.5											
13.0	13	UDS-4									
13.5											
14.0											
14.5	14.5	SPT-6	13	23	31	54	Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
15.0											
15.5											
16.0	16	UDS-5									
16.5											
17.0											
17.5	17.5	SPT-7	15	24	35	59					
18.0											
18.5											
19.0	19	UDS-6									
19.5							Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+025 km	*Northing :*3124242.99 m	*Easting :*710507.526 m
Reduced Level (m):(+)194.589	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.22	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*05-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	17	25	37	62					
21.0											
21.5											
22.0	22	UDS-7									
22.5											
23.0											
23.5	23.5	SPT-9	18	27	40	67					
24.0											
24.5											
25.0	25	UDS-8					Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-10	20	27	36	63					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0											
29.5	29.5	SPT-11	25	32	40	72					
30.0	29.95	DS-2									

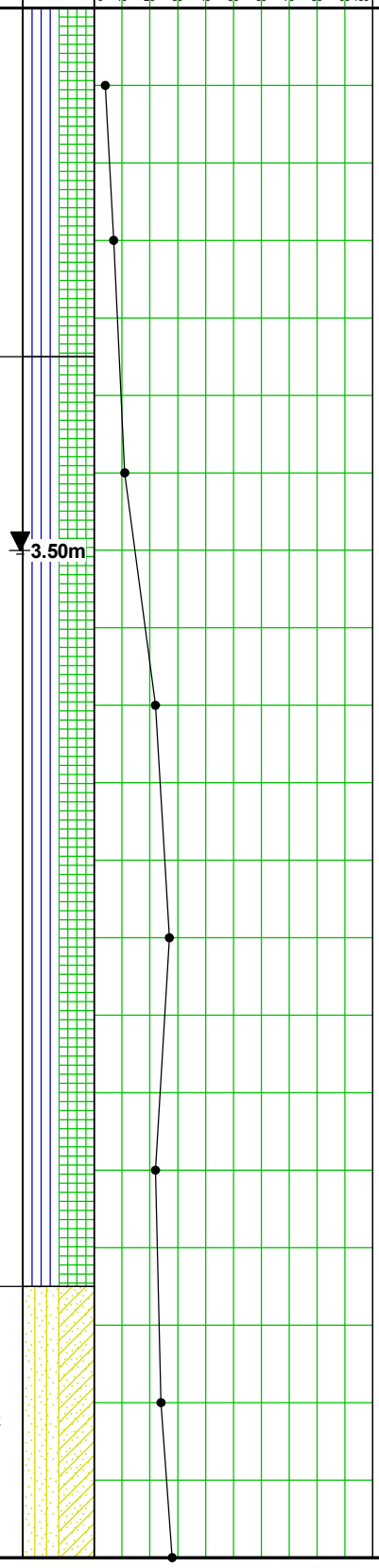
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+223 km	*Northing :*3124207.834 m	*Easting :*710317.973 m
Reduced Level (m):(+)194.116	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*3.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*29-10-2021	*Date of Completion :*29-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification
0.0		DS						
0.5	0.5	SPT-1	2	2	2	4	Brown, Loose, Sandy silt of low plasticity	ML-CL
1.0								
1.5	1.5	SPT-2	2	3	4	7		
2.0								
	2.25	UDS-1						
2.5								
3.0	3	SPT-3	3	5	6	11		
3.5								
4.0								
4.5	4.5	SPT-4	8	10	12	22		
5.0								
	5.25	UDS-2					Brown, Medium dense, Sandy silt of low plasticity	ML-CL
5.5								
6.0	6	SPT-5	10	12	15	27		
6.5								
7.0								
7.5	7.5	SPT-6	7	10	12	22		
8.0								
	8.25	UDS-3						
8.5								
9.0	9	SPT-7	8	11	13	24	Brown, Medium dense, Silty sand with clay	SM-SC
9.5								
10.0	10	SPT-8	10	12	16	28		



Special Observations

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+519 km	*Northing :*3124153.189 m	*Easting :*710023.336 m
Reduced Level (m):(+)194.584	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*4.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*29-10-2021	*Date of Completion :*29-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	3	4	6	10					
2.0											
2.5	2.25	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	5	6	12	18					
3.5											
4.0											
4.5	4.5	SPT-4	7	12	22	34			4.50m		
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	12	20	26	46					
6.5											
7.0											
7.5	7.5	SPT-6	14	22	25	47	Brown, Dense to very dense, Silty sand with clay & gravel	SM-SC			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	12	23	28	51					
9.5											
10.0	10	SPT-8	13	24	27	51					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+658 km	*Northing :*3124128.59 m	*Easting :*709890.704 m
Reduced Level (m):(+)194.898	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*3.20	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*29-10-2021	*Date of Completion :*29-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
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	3	4	6	10					
3.5									3.20m		
4.0							Brown, Stiff to very stiff, Silty clay of low plasticity	CL			
4.5	4.5	SPT-4	5	7	9	16					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	8	10	12	22					
6.5											
7.0							Brown, Medium dense, Silty sand with clay	SM-SC			
7.5	7.5	SPT-6	10	11	14	25					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	12	14	16	30	Brown, Dense, Silty sand	SM			
9.5											
10.0	10	SPT-8	13	17	18	35					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+718 km	*Northing :*3124117.642 m	*Easting :*709831.671 m
Reduced Level (m):(+)193.997	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*2.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*29-10-2021	*Date of Completion :*29-10-2021	

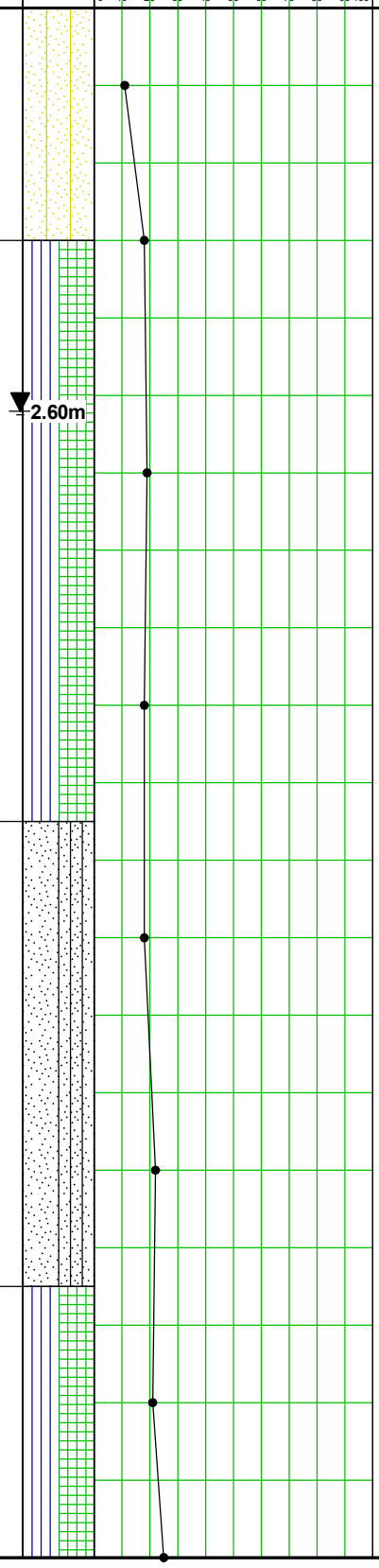
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	4	4	8	12	Brown, Medium dense, Silty sand	SM			
1.0											
1.5	1.5	SPT-2	6	13	15	28					
2.0											
	2.25	UDS-1									
2.5									2.50m		
3.0	3	SPT-3	2	3	4	7	Brown, Loose, Silty sand with clay	SM-SC			
3.5											
4.0											
4.5	4.5	SPT-4	3	3	5	8					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	4	8	12	20	Brown, Medium dense, Silty sand with clay	SM-SC			
6.5											
7.0											
7.5	7.5	SPT-6	5	10	16	26					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	7	11	14	25	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	6	13	16	29					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+749 km	*Northing :*3124111.993 m	*Easting :*709801.215 m
Reduced Level (m):(+)194.893	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*2.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*29-10-2021	*Date of Completion :*29-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification
0.0		DS						
0.5	0.5	SPT-1	4	5	6	11	Brown, Medium dense, Silty sand	SM
1.0								
1.5	1.5	SPT-2	5	8	10	18		
2.0								
	2.25	UDS-1						
2.5								
3.0	3	SPT-3	4	8	11	19	Brown, Medium dense, Sandy silt of low plasticity	ML-CL
3.5								
4.0								
4.5	4.5	SPT-4	5	8	10	18		
5.0								
	5.25	UDS-2						
5.5								
6.0	6	SPT-5	4	7	11	18	Brown, Medium dense, Silty sand	SP-SM
6.5								
7.0								
7.5	7.5	SPT-6	4	8	14	22		
8.0								
	8.25	UDS-3						
8.5								
9.0	9	SPT-7	6	9	12	21	Brown, Medium dense, Sandy silt of low plasticity	ML-CL
9.5								
10.0	10	SPT-8	7	11	14	25		



Special Observations

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124103.149 m	*Easting :*709761.805 m
Reduced Level (m):(+)195.206	*BH. No. :*BH-A1(R)	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.99	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	2	3	5					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0									2.99m		
3.5											
4.0	4	SPT-2	3	4	6	10					
4.5											
5.0							Brown, Loose to medium dense, Silty sand with clay	SM-SC			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	4	6	7	13					
7.5											
8.0											
8.5	8.5	UDS*									
9.0	9	SPT-4	5	7	9	16					
9.5											
10.0	10	SPT-5	6	8	11	19					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124103.149 m	*Easting :*709761.805 m
Reduced Level (m):(+)195.206	*BH. No. :*BH-A1(R)	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.99	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Loose to medium dense, Silty sand with clay	SM-SC			
11.0											
11.5	11.5	UDS-3									
12.0											
12.5											
13.0	13	SPT-6	8	12	19	31					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0											
15.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
16.0	16	SPT-7	9	16	20	36					
16.5											
17.0											
17.5	17.5	UDS-5									
18.0											
18.5											
19.0	19	SPT-8	13	21	28	49					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124103.149 m	*Easting :*709761.805 m
Reduced Level (m):(+)195.206	*BH. No. :*BH-A1(R)	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.99	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-9	16	29	37	66					
22.5											
23.0											
23.5	23.5	SPT-10	19	34	41	75					
24.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
24.5											
25.0	25	SPT-11	31	43	48	91					
25.5											
26.0											
26.5	26.5	SPT-12	33	54	46 (8cm)	>100					
27.0											
27.5											
28.0	28	SPT-13	16	28	33	61					
28.5											
29.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
29.5	29.5	SPT-14	35	61	39 (11cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124103.149 m	*Easting :*709761.805 m
Reduced Level (m):(+)195.206	*BH. No. :*BH-A1(R)	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.99	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-15	30	46	54 (14cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-16	34	50	50 (10cm)	>100					
33.0											
33.5											
34.0	34	SPT-17	37	60	40 (7cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-18	32	66	34 (5cm)	>100					
36.0											
36.5											
37.0	37	SPT-19	25	41	55	96					
37.5											
38.0											
38.5	38.5	SPT-20	31	49	51 (5cm)	>100					
39.0											
39.5											
40.0	40	SPT-21	32	54	46 (8cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124097.508 m	*Easting :*709723.114 m
Reduced Level (m):(+)194.772	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.95	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*07-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
	2.25	SPT-1	3	4	5	9	Brown, Loose, Silty sand	SM			
2.5											
3.0									2.95m		
3.5											
4.0	4	UDS*									
4.5	4.5	SPT-2	4	5	8	13					
5.0											
5.5	5.5	SPT-3	6	6	7	13					
6.0											
6.5											
7.0	7	UDS-2					Brown, Medium dense, Silty sand with clay	SM-SC			
7.5											
8.0											
8.5	8.5	SPT-4	4	5	8	13					
9.0											
9.5											
10.0	10	UDS-3									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124097.508 m	*Easting :*709723.114 m
Reduced Level (m):(+)194.772	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.95	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*07-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-5	11	13	18	31					
12.0											
12.5											
13.0	13	UDS*					Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
13.5	13.5	SPT-6	7	10	16	26					
14.0											
14.5	14.5	SPT-7	8	14	20	34					
15.0											
15.5											
16.0	16	UDS-4									
16.5											
17.0											
17.5	17.5	SPT-8	26	35	49	84					
18.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
18.5											
19.0	19	UDS-5									
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124097.508 m	*Easting :*709723.114 m
Reduced Level (m):(+)194.772	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.95	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*07-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	16	35	49	84					
21.0											
21.5											
22.0	22	SPT-10	41	72	28 (5cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-11	35	48	52 (12cm)	>100					
24.0											
24.5											
25.0	25	SPT-12	30	40	52	92	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-13	15	26	33	59					
27.0											
27.5											
28.0	28	UDS-6									
28.5											
29.0											
29.5	29.5	SPT-14	22	52	38	90					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124097.508 m	*Easting :*709723.114 m
Reduced Level (m):(+)194.772	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.95	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*07-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
31.0	31	UDS*									
31.5	31.5	SPT-15	24	45	52	97					
32.0											
32.5	32.5	SPT-16	22	41	48	89					
33.0											
33.5											
34.0	34	UDS-7									
34.5											
35.0											
35.5	35.5	SPT-17	26	48	52 (13cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
36.0											
36.5											
37.0	37	SPT-18	30	56	44 (9cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-19	28	43	52 (8cm)	>100					
39.0											
39.5											
40.0	40	SPT-20	32	58	47 (6cm)	>100					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124089.603 m	*Easting :*709681.945 m
Reduced Level (m):(+)195.316	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.35	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5							Filled up strata	FILL			
1.0	1	SPT-1	10	14	17	31					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5									3.35m		
4.0	4	SPT-2	3	4	6	10					
4.5											
5.0											
5.5	5.5	UDS*					Brown, Loose to medium dense, Silty sand	SM			
6.0	6	SPT-3	4	5	8	13					
6.5											
7.0	7	SPT-4	6	8	11	19					
7.5											
8.0											
8.5	8.5	UDS*									
9.0	9	SPT-5	6	11	14	25					
9.5											
10.0	10	SPT-6	7	9	12	21					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124089.603 m	*Easting :*709681.945 m
Reduced Level (m):(+)195.316	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.35	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5							Brown, Loose to medium dense, Silty sand	SM			
11.0											
11.5	11.5	UDS-2									
12.0											
12.5											
13.0	13	SPT-7	8	14	17	31					
13.5											
14.0											
14.5	14.5	UDS-3									
15.0											
15.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
16.0	16	SPT-8	10	14	18	32					
16.5											
17.0											
17.5	17.5	UDS-4									
18.0											
18.5											
19.0	19	SPT-9	10	15	19	34					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124089.603 m	*Easting :*709681.945 m
Reduced Level (m):(+)195.316	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.35	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-5									
21.0											
21.5											
22.0	22	SPT-10	14	19	30	49					
22.5											
23.0											
23.5	23.5	UDS-6									
24.0											
24.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.0	25	SPT-11	15	21	33	54					
25.5											
26.0											
26.5	26.5	UDS-7									
27.0											
27.5											
28.0	28	SPT-12	11	17	24	41					
28.5											
29.0											
29.5	29.5	UDS-8					Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124089.603 m	*Easting :*709681.945 m
Reduced Level (m):(+)195.316	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.35	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-13	22	35	40	75					
31.5											
32.0											
32.5	32.5	SPT-14	34	43	52	95					
33.0											
33.5											
34.0	34	SPT-15	38	58	42 (6cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-16	25	30	55	85					
36.0											
36.5											
37.0	37	SPT-17	23	41	52	93					
37.5											
38.0											
38.5	38.5	SPT-18	28	44	55	99					
39.0											
39.5											
40.0	40	SPT-19	33	60	40 (10cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124072.923 m	*Easting :*709602.681 m
Reduced Level (m):(+)195.247	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.60	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2021	*Date of Completion :*21-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	2	3	5	8					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Loose to medium dense, Silty sand	SM			
5.5	5.5	SPT-2	3	4	7	11			5.60m		
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	4	6	8	14					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124072.923 m	*Easting :*709602.681 m
Reduced Level (m):(+)195.247	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.60	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2021	*Date of Completion :*21-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	4	5	7	12	Brown, Loose to medium dense, Silty sand	SM			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	7	9	12	21	Brown, Medium dense, Silty sand with clay	SM-SC			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	18	23	34	57	Brown, Hard, Silty clay of low plasticity with gravel	CL			
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124072.923 m	*Easting :*709602.681 m
Reduced Level (m):(+)195.247	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.60	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2021	*Date of Completion :*21-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	15	20	24	44					
21.0											
21.5											
22.0	22	UDS*									
22.5	22.45	SPT-8	18	23	34	57					
23.0											
23.5	23.5	SPT-9	20	26	38	64					
24.0											
24.5											
25.0	25	SPT-10	21	28	40	68	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-11	17	33	42	75					
27.0											
27.5											
28.0	28	SPT-12	24	34	38	72					
28.5											
29.0											
29.5	29.5	SPT-13	31	37	41	78					
30.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*10+859 km	*Northing :*3124072.923 m	*Easting :*709602.681 m
Reduced Level (m):(+)195.247	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*5.60	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2021	*Date of Completion :*21-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-14	28	40	44	84					
31.5											
32.0											
32.5	32.5	SPT-15	26	38	43	81					
33.0											
33.5											
34.0	34	SPT-16	30	41	46	87					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-17	28	44	49	93					
36.0											
36.5											
37.0	37	SPT-18	26	46	50	96					
37.5											
38.0											
38.5	38.5	SPT-19	34	50	50	100					
39.0											
39.5											
40.0	40	SPT-20	37	56	44 (13cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+625 km	*Northing :*3119823.851 m	*Easting :*704882.319 m
Reduced Level (m):(+)191.597	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*13-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Yellowish brown, Very loose, Sandy silt of low plasticity	ML-CL			
2.5	2.5	SPT-1	1	1	2	3					
3.0									▼3.00m		
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	3	4	8	12					
6.0											
6.5											
7.0	7	UDS-3					Yellowish brown, Medium, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	SPT-3	6	6	8	14					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+625 km	*Northing :*3119823.851 m	*Easting :*704882.319 m
Reduced Level (m):(+)191.597	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*13-11-2021	

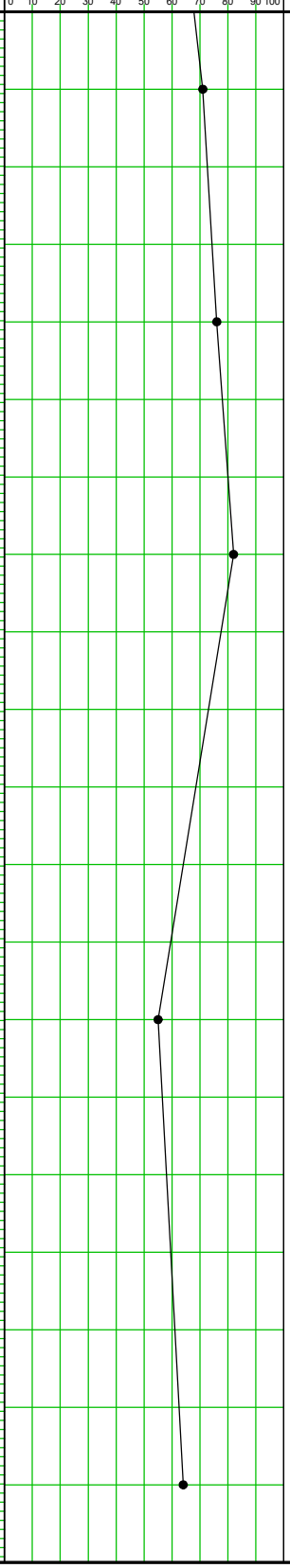
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	4	5	8	13	Yellowish brown, Medium, Sandy silt of low plasticity	ML-CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	13	25	34	59					
15.0											
15.5											
16.0	16	UDS-6					Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
16.5											
17.0											
17.5	17.5	SPT-6	12	22	30	52					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+625 km	*Northing :*3119823.851 m	*Easting :*704882.319 m
Reduced Level (m):(+)191.597	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*13-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	12	30	41	71					
21.0											
21.5											
22.0	22	SPT-8	14	28	48	76					
22.5											
23.0											
23.5	23.5	SPT-9	13	32	50	82					
24.0											
24.5											
25.0	25	UDS-8					Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-10	12	20	35	55					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0											
29.5	29.5	SPT-11	14	24	40	64					
30.0	30	DS-2									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+625 km	*Northing :*3119805.101 m	*Easting :*704873.896 m
Reduced Level (m):(+)191.814	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.05	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	SPT-1	3	4	5	9					
1.5											
2.0											
2.5	2.5	UDS-1					Yellowish brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL	3.05m		
3.0											
3.5											
4.0	4	SPT-2	4	5	7	12					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	8	12	20					
7.5											
8.0							Yellowish brown, Medium dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	10	13	23	36					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+625 km	*Northing :*3119805.101 m	*Easting :*704873.896 m
Reduced Level (m):(+)191.814	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.05	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	12	20	25	45					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Yellowish brown, Medium dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	SPT-6	14	19	27	46					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	12	22	30	52					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+625 km	*Northing :*3119805.101 m	*Easting :*704873.896 m
Reduced Level (m):(+)191.814	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*3.05	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	11	20	29	49	Yellowish brown, Medium dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	18	29	40	69					
25.5											
26.0											
26.5	26.5	UDS-9									
27.0							Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
27.5											
28.0	28	SPT-10	17	38	45	83					
28.5											
29.0											
29.5	29.5	SPT-11	19	42	50	92					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+872 km	*Northing :*3119597.349 m	*Easting :*704759.612 m
Reduced Level (m):(+)191.318	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.95	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	SPT-1	2	2	3	5			0.95m		
1.5											
2.0											
2.5	2.5	UDS-1					Brownish grey, Medium stiff, Silty clay of low plasticity	CL			
3.0											
3.5											
4.0	4	SPT-2	2	3	5	8					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	9	10	12	22					
7.5											
8.0							Brownish grey, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	11	14	16	30					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+872 km	*Northing :*3119597.349 m	*Easting :*704759.612 m
Reduced Level (m):(+)191.318	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.95	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	15	18	21	39					
13.5							Brownish grey, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	18	20	22	42					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	30	48	52 (8cm)	>100	Brownish grey, Hard, Silty clay of low plasticity with gravel	CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+872 km	*Northing :*3119597.349 m	*Easting :*704759.612 m
Reduced Level (m):(+)191.318	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.95	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	35	52	48 (6cm)	>100					
21.0											
21.5											
22.0	22	SPT-9	40	61	39 (5cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-10	35	63	37 (11cm)	>100					
24.0											
24.5											
25.0	25	SPT-11	40	60	40 (9cm)	>100	Brownish grey, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-12	45	65	35 (13cm)	>100					
27.0											
27.5											
28.0	28	SPT-13	47	70	30 (11cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-14	40	100 (15cm)	-	>100					
	29.8	DS-2									
30.0	30										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+872 km	*Northing :*3119588.153 m	*Easting :*704753.576 m
Reduced Level (m):(+)191.150	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	UDS-1							1.00m		
1.5											
2.0											
2.5	2.5	SPT-1	3	8	8	16					
3.0											
3.5							Brownish grey, Very stiff, Silty clay of low plasticity	CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	6	8	14	22					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	4	8	12	20	Brownish grey, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+872 km	*Northing :*3119588.153 m	*Easting :*704753.576 m
Reduced Level (m):(+)191.150	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	8	11	15	26					
12.0											
12.5											
13.0	13	UDS-5					Brownish grey, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
13.5											
14.0											
14.5	14.5	SPT-5	14	17	21	38					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	16	28	35	63					
18.0							Brownish grey, Hard, Silty clay of low plasticity with gravel	CL			
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*17+872 km	*Northing :*3119588.153 m	*Easting :*704753.576 m
Reduced Level (m):(+)191.150	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*09-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	29	43	57	100					
21.0											
21.5											
22.0	22	SPT-8	32	48	52 (8cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-9	28	40	60 (5cm)	>100					
24.0											
24.5											
25.0	25	SPT-10	24	48	52 (11cm)	>100	Brownish grey, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-11	28	58	42 (10cm)	>100					
27.0											
27.5											
28.0	28	SPT-12	28	65	35 (9cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-13	33	70	30 (12cm)	>100					
30.0	29.92	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*New Ch. 19+010 km_IMT Sohna Station	*Northing :*3119187.74 m	*Easting :*704417.312 m
Reduced Level (m):(+)190.138	*BH. No. :*BH-PLT-07	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-12-2021	*Date of Completion :*20-12-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5									0.60m		
	0.75	UDS-1									
1.0											
1.5	1.5	SPT-1	1	2	3	5	Medium, Blackish, Silty clay with low Plasticity	CL			
2.0											
	2.25	SPT-2	2	4	6	10					
2.5											
3.0	3	SPT-3	4	7	9	16					
3.5											
	3.75	SPT-4	9	10	12	22					
4.0											
4.5	4.5	UDS-2									
5.0											
5.5											
6.0	6	SPT-5	10	14	16	30					
6.5							Medium Dense, Brownish Sandy Silt	ML-CL			
7.0											
7.5	7.5	UDS-3									
8.0											
8.5											
9.0	9	SPT-6	15	17	21	38					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*New Ch. 19+010 km_IMT Sohna Station	*Northing :*3119187.74 m	*Easting :*704417.312 m
Reduced Level (m):(+)190.138	*BH. No. :*BH-PLT-07	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-12-2021	*Date of Completion :*20-12-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5	10.5	UDS-4					Medium Dense, Brownish Sandy Silt	ML-CL			
11.0											
11.5											
12.0	12	SPT-7	18	24	27	51					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*18+750 km	*Northing :*3119029.392 m	*Easting :*704113.173 m
Reduced Level (m):(+)190.420	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.22	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	SPT-1	2	3	4	7					
1.5									1.22m		
2.0							Yellowish brown, Medium stiff, Silty clay of low plasticity	CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	6	10	14	24					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Yellowish brown, Medium dense, Silty sand	SM			
7.0	7	SPT-3	6	12	17	29					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Yellowish brown, Stiff, Silty clay of low plasticity	CL			
10.0	10	SPT-4	4	6	8	14					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*18+750 km	*Northing :*3119029.392 m	*Easting :*704113.173 m
Reduced Level (m):(+)190.420	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.22	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4					Yellowish brown, Stiff, Silty clay of low plasticity	CL			
12.0											
12.5											
13.0	13	SPT-5	14	27	39	66					
13.5							Yellowish brown, Very dense, Silty sand with clay	SM-SC			
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	10	13	22	35					
16.5											
17.0											
17.5	17.5	UDS-6					Yellowish brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
18.0											
18.5											
19.0	19	SPT-7	10	16	21	37					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*18+750 km	*Northing :*3119029.392 m	*Easting :*704113.173 m
Reduced Level (m):(+)190.420	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.22	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	12	19	27	46					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	14	28	37	65	Yellowish brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	17	35	43	78					
28.5											
29.0											
29.5	29.5	SPT-11	19	37	47	84					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*18+750 km	*Northing :*3119020.849 m	*Easting :*704095.09 m
Reduced Level (m):(+)190.095	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	UDS-1									
1.5									1.50m		
2.0											
2.5	2.5	SPT-1	4	5	8	13					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Yellowish brown, Stiff to very stiff, Silty clay of low plasticity	CL			
5.5	5.5	SPT-2	4	7	10	17					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	3	4	7	11					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*18+750 km	*Northing :*3119020.849 m	*Easting :*704095.09 m
Reduced Level (m):(+)190.095	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	5	8	12	20	Yellowish brown, Stiff to very stiff, Silty clay of low plasticity	CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	9	14	18	32					
15.0											
15.5											
16.0	16	UDS-6									
16.5							Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
17.0											
17.5	17.5	SPT-6	10	18	22	40					
18.0											
18.5											
19.0	19	UDS*									
19.5	19.5	SPT-7	11	20	34	54					
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*18+750 km	*Northing :*3119020.849 m	*Easting :*704095.09 m
Reduced Level (m):(+)190.095	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	12	22	30	52					
21.0											
21.5											
22.0	22	UDS-7									
22.5											
23.0											
23.5	23.5	SPT-9				52					
24.0											
24.5											
25.0	25	UDS-8					Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-10				58					
27.0											
27.5											
28.0	28	SPT-11				75					
28.5											
29.0											
29.5	29.5	SPT-12				70					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118866.702 m	*Easting :*703426.871 m
Reduced Level (m):(+)190.997	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5									0.60m		
1.0	1	UDS-1									
1.5											
2.0							Brown, Stiff, Silty clay of low plasticity	CL			
2.5	2.5	SPT-1	2	3	5	8					
3.0											
3.5											
4.0	4	UDS*									
4.5	4.5	SPT-2	4	6	10	16					
5.0											
5.5	5.5	SPT-3	6	8	11	19					
6.0											
6.5											
7.0	7	UDS-2					Brown, Medium dense, Silty sand	SM			
7.5											
8.0											
8.5	8.5	SPT-4	4	7	10	17					
9.0											
9.5											
10.0	10	UDS-3									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118866.702 m	*Easting :*703426.871 m
Reduced Level (m):(+)190.997	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

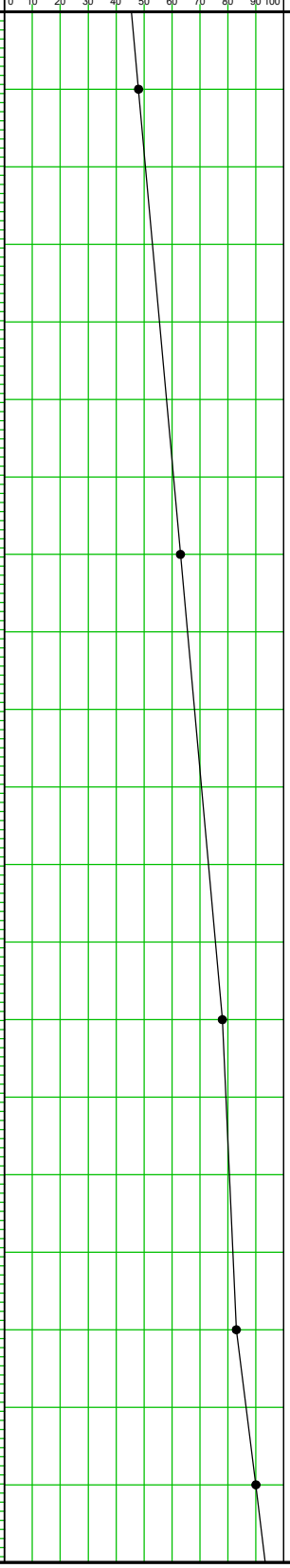
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-5	6	8	12	20					
12.0											
12.5											
13.0	13	UDS-4									
13.5											
14.0											
14.5	14.5	SPT-6	7	9	12	21					
15.0							Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
15.5											
16.0	16	UDS-5									
16.5											
17.0											
17.5	17.5	SPT-7	10	14	19	33					
18.0											
18.5											
19.0	19	UDS-6									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118866.702 m	*Easting :*703426.871 m
Reduced Level (m):(+)190.997	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	14	20	28	48					
21.0											
21.5											
22.0	22	UDS-7									
22.5											
23.0											
23.5	23.5	SPT-9	17	29	34	63					
24.0											
24.5											
25.0	25	UDS-8					Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-10	20	33	45	78					
27.0											
27.5											
28.0	28	UDS*									
28.5	28.5	SPT-11	23	36	47	83					
29.0											
29.5	29.5	SPT-12	28	40	50	90					
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118866.702 m	*Easting :*703426.871 m
Reduced Level (m):(+)190.997	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5							Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
31.0	31	SPT-13	30	44	56 (14cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-14	28	46	54 (7cm)	>100					
33.0											
33.5											
34.0	34	SPT-15	31	48	52 (10cm)	>100					
34.5											
35.0											
35.5	35.5	SPT-16	32	51	49 (8cm)	>100	Brown, Very dense, Silty sand with gravel	SM-SC			
36.0											
36.5											
37.0	37	SPT-17	29	49	51 (11cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-18	31	57	43 (9cm)	>100					
39.0											
39.5											
40.0	40	SPT-19	34	65	35 (7cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118862.655 m	*Easting :*703375.297 m
Reduced Level (m):(+)191.964	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	3	6					
1.5											
2.0							Brown, Medium stiff, Silty clay of low plasticity	CL	1.85m		
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	6	9	15					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	4	5	9	14	Brown, Stiff to very stiff, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	3	6	11	17					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118862.655 m	*Easting :*703375.297 m
Reduced Level (m):(+)191.964	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Stiff to very stiff, Silty clay of low plasticity	CL			
13.0	13	SPT-5	7	10	12	22					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	8	14	18	32					
16.5											
17.0											
17.5	17.5	UDS-6					Brown, Hard, Silty clay of low plasticity with gravel	CL			
18.0											
18.5											
19.0	19	SPT-7	10	16	19	35					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118862.655 m	*Easting :*703375.297 m
Reduced Level (m):(+)191.964	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7					Brown, Hard, Silty clay of low plasticity with gravel	CL			
21.0											
21.5											
22.0	22	SPT-8	24	33	42	75					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	19	29	41	70	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	UDS*									
27.0	26.95	SPT-10	22	32	43	75					
27.5											
28.0	28	SPT-11	26	36	46	82					
28.5											
29.0											
29.5	29.5	SPT-12	36	66	34 (7cm)	>100					
30.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118862.655 m	*Easting :*703375.297 m
Reduced Level (m):(+)191.964	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-13	32	53	47 (11cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
31.5											
32.0											
32.5	32.5	SPT-14	25	34	44	78					
33.0											
33.5											
34.0	34	SPT-15	18	30	38	68					
34.5											
35.0											
35.5	35.5	UDS*									
36.0	35.95	SPT-16	26	38	44	82	Brown, Hard, Silty clay of low plasticity with gravel	CL			
36.5											
37.0	37	SPT-17	22	33	40	73					
37.5											
38.0											
38.5	38.5	SPT-18	27	48	49	97					
39.0											
39.5											
40.0	40	SPT-19	31	41	51	92					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118858.609 m	*Easting :*703323.723 m
Reduced Level (m):(+)191.063	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5									1.60m		
2.0											
2.5	2.5	SPT-1	5	8	10	18					
3.0											
3.5							Brown, Very stiff, Silty clay of low plasticity	CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	8	11	19					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	3	4	4	8	Brown, Medium stiff, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

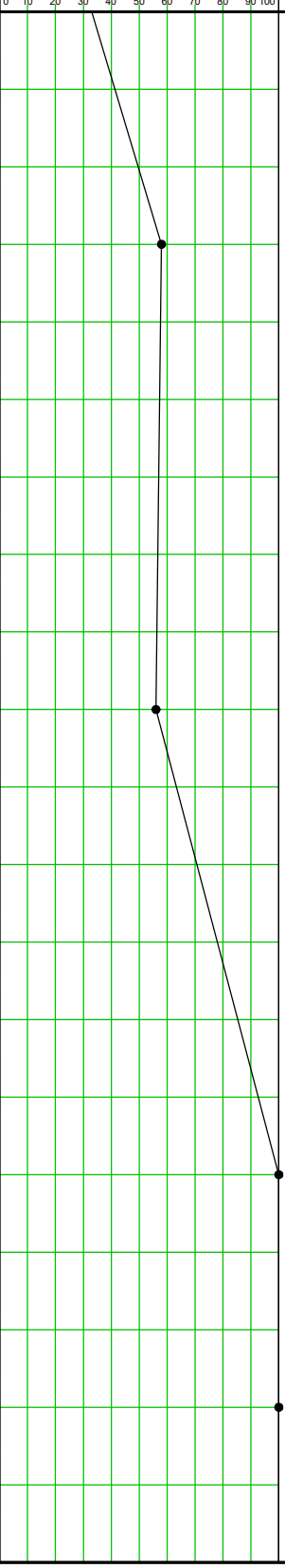
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118858.609 m	*Easting :*703323.723 m
Reduced Level (m):(+)191.063	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	14	25	33	58					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	13	21	35	56					
15.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	29	50	50 (10cm)	>100					
18.0											
18.5											
19.0	19	SPT-7	36	79	21 (3cm)	>100					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118858.609 m	*Easting :*703323.723 m
Reduced Level (m):(+)191.063	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*10-10-2021	

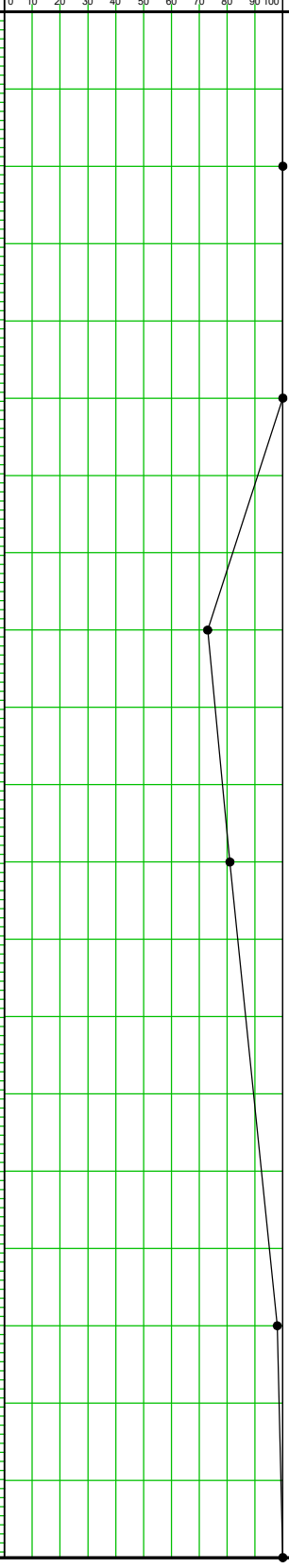
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	40	100 (15cm)	-	>100					
21.0											
21.5											
22.0	22	SPT-9	34	34	41	75					
22.5											
23.0											
23.5	23.5	SPT-10	36	70	30 (4cm)	>100					
24.0											
24.5											
25.0	25	SPT-11	24	49	51 (10cm)	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-12	28	48	52 (8cm)	>100					
27.0											
27.5											
28.0	28	SPT-13	38	54	46 (8cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-14	49	64	36 (8cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+500 km	*Northing :*3118858.609 m	*Easting :*703323.723 m
Reduced Level (m):(+)191.063	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*10-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-15	42	100 (15cm)	-	>100					
31.5											
32.0											
32.5	32.5	SPT-16	32	56	44 (7cm)	>100					
33.0											
33.5											
34.0	34	SPT-17	21	30	43	73					
34.5											
35.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
35.5	35.5	SPT-18	18	33	48	81					
36.0											
36.5											
37.0	37	UDS-7									
37.5											
38.0											
38.5	38.5	SPT-19	28	46	52	98					
39.0											
39.5											
40.0	40	SPT-20	45	59	41 (4cm)	>100					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.67 m	*Easting :*703175.974 m
Reduced Level (m):(+)190.645	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-11-2021	*Date of Completion :*12-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	SPT-1	1	2	2	4			0.85m		
1.5											
2.0											
2.5	2.5	UDS-1					Greyish brown, Soft to medium stiff, Silty clay of low plasticity	CL			
3.0											
3.5											
4.0	4	SPT-2	2	3	4	7					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	5	8	10	18	Greyish brown, Medium dense, Silty sand	SM			
7.5											
8.0											
8.5	8.5	UDS*									
9.0	9	SPT-4	4	9	11	20					
9.5							Greyish brown, Very stiff, Silty clay of low plasticity	CL			
10.0	10	SPT-5	6	11	13	24					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.67 m	*Easting :*703175.974 m
Reduced Level (m):(+)190.645	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-11-2021	*Date of Completion :*12-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-3									
12.0											
12.5											
13.0	13	SPT-6	7	10	12	22					
13.5							Greyish brown, Very stiff, Silty clay of low plasticity	CL			
14.0											
14.5	14.5	UDS-4									
15.0											
15.5											
16.0	16	SPT-7	8	12	15	27					
16.5											
17.0											
17.5	17.5	UDS-5									
18.0											
18.5							Greyish brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
19.0	19	SPT-8	13	18	23	41					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.67 m	*Easting :*703175.974 m
Reduced Level (m):(+)190.645	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-11-2021	*Date of Completion :*12-11-2021	

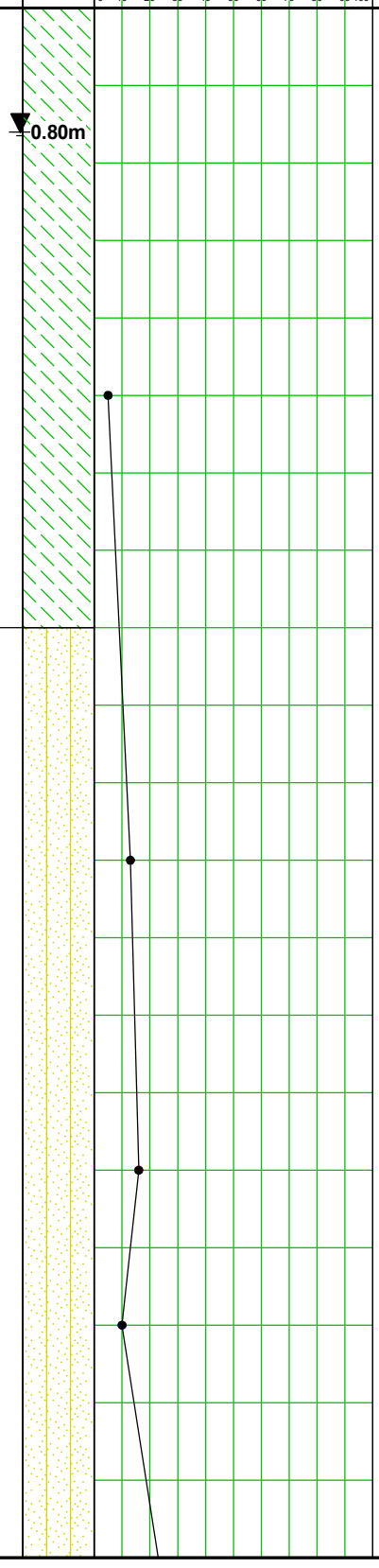
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-9	15	24	30	54					
22.5							Greyish brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
23.0											
23.5	23.5	UDS*									
24.0	24	SPT-10	18	28	32	60					
24.5											
25.0	25	SPT-11	25	42	53	95					
25.5											
26.0											
26.5	26.5	SPT-12	21	34	43	77					
27.0											
27.5							Greyish brown, Hard, Silty clay of low plasticity with gravel	CL			
28.0	28	SPT-13	24	36	45	81					
28.5											
29.0											
29.5	29.5	SPT-14	42	69	31 (5cm)	>100					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.544 m	*Easting :*703164.075 m
Reduced Level (m):(+)190.671	*BH. No. :*BH-P1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Greyish brown, Medium stiff, Silty clay of high plasticity	CI			
2.5	2.5	SPT-1	2	2	3	5					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	6	7	13					
6.0											
6.5											
7.0	7	UDS*					Greyish brown, Medium dense, Silty sand	SM			
7.5	7.5	SPT-3	5	7	9	16					
8.0											
8.5	8.5	SPT-4	3	4	6	10					
9.0											
9.5											
10.0	10	UDS-3									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.544 m	*Easting :*703164.075 m
Reduced Level (m):(+)190.671	*BH. No. :*BH-P1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

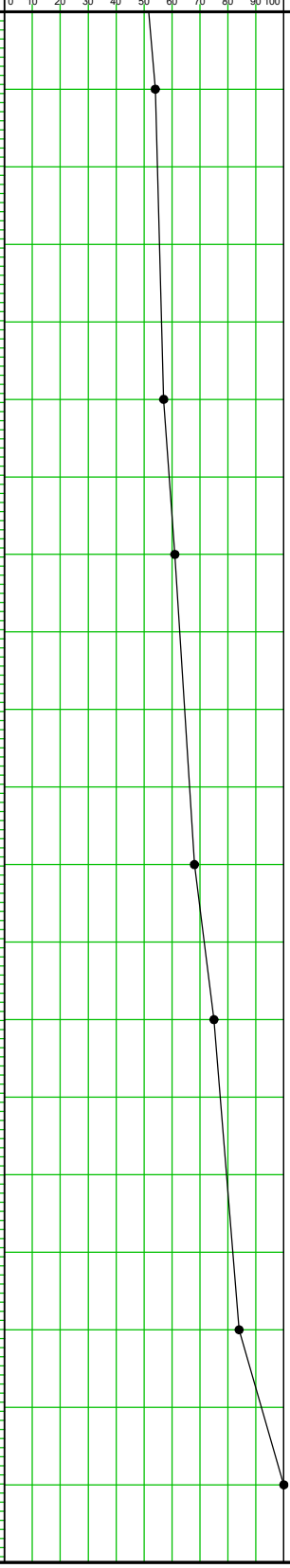
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-5	8	15	21	36					
12.0											
12.5											
13.0	13	UDS*									
13.5	13.5	SPT-6	8	16	19	35					
14.0											
14.5	14.5	SPT-7	7	18	22	40	Greyish brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
15.0											
15.5											
16.0	16	UDS-4									
16.5											
17.0											
17.5	17.5	SPT-8	10	17	23	40					
18.0											
18.5											
19.0	19	UDS-5									
19.5							Greyish brown, Hard, Silty clay of low plasticity with gravel	CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.544 m	*Easting :*703164.075 m
Reduced Level (m):(+)190.671	*BH. No. :*BH-P1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	14	23	31	54					
21.0											
21.5											
22.0	22	UDS*									
22.5	22.5	SPT-10	12	23	34	57					
23.0											
23.5	23.5	SPT-11	15	25	36	61					
24.0											
24.5											
25.0	25	UDS*					Greyish brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5	25.5	SPT-12	18	29	39	68					
26.0											
26.5	26.5	SPT-13	21	34	41	75					
27.0											
27.5											
28.0	28	UDS*									
28.5	28.5	SPT-14	25	38	46	84					
29.0											
29.5	29.5	SPT-15	38	48	52 (7cm)	>100					
30.0	30	DS-2									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.568 m	*Easting :*703152.175 m
Reduced Level (m):(+)190.592	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.45	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*16-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5									0.45m		
1.0	1	SPT-1	2	4	5	9					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	2	3	3	6	Greyish brown, Stiff, Silty clay of low plasticity	CL			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	4	6	8	14					
7.5											
8.0											
8.5	8.5	UDS*									
9.0	9	SPT-4	6	9	12	21	Greyish brown, Medium dense, Silty sand	SM			
9.5											
10.0	10	SPT-5	8	13	16	29					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.568 m	*Easting :*703152.175 m
Reduced Level (m):(+)190.592	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.45	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*16-11-2021	

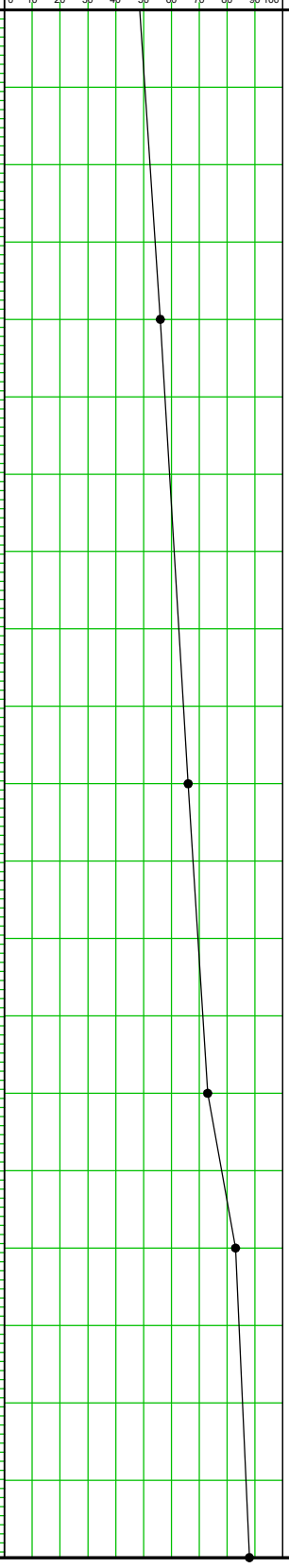
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0							Greyish brown, Medium dense, Silty sand	SM			
11.5	11.5	UDS*									
12.0	12	SPT-6	11	17	20	37					
12.5											
13.0	13	SPT-7	9	14	18	32					
13.5											
14.0											
14.5	14.5	UDS-3					Greyish brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
15.0											
15.5											
16.0	16	SPT-8	11	14	17	31					
16.5											
17.0											
17.5	17.5	UDS-4									
18.0											
18.5							Greyish brown, Hard, Silty clay of low plasticity with gravel	CL			
19.0	19	SPT-9	13	19	26	45					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*19+715 km	*Northing :*3118849.568 m	*Easting :*703152.175 m
Reduced Level (m):(+)190.592	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*0.45	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*16-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-5									
21.0											
21.5											
22.0	22	SPT-10	16	25	31	56					
22.5											
23.0											
23.5	23.5	UDS-6									
24.0											
24.5											
25.0	25	SPT-11	19	29	37	66	Greyish brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	UDS*									
27.0	27	SPT-12	20	33	40	73					
27.5											
28.0	28	SPT-13	22	39	44	83					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	SPT-14	24	41	47	88					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118908.161 m	*Easting :*702617.165 m
Reduced Level (m):(+)190.950	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	6	8	10	18			1.00m		
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	6	9	11	20					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	13	16	22	38	Brown, Dense, Silty sand with clay & gravel	SM-SC			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Hard with gravel Silty clay of low plasticity	CL			
10.0	10	SPT-4	14	18	28	46					

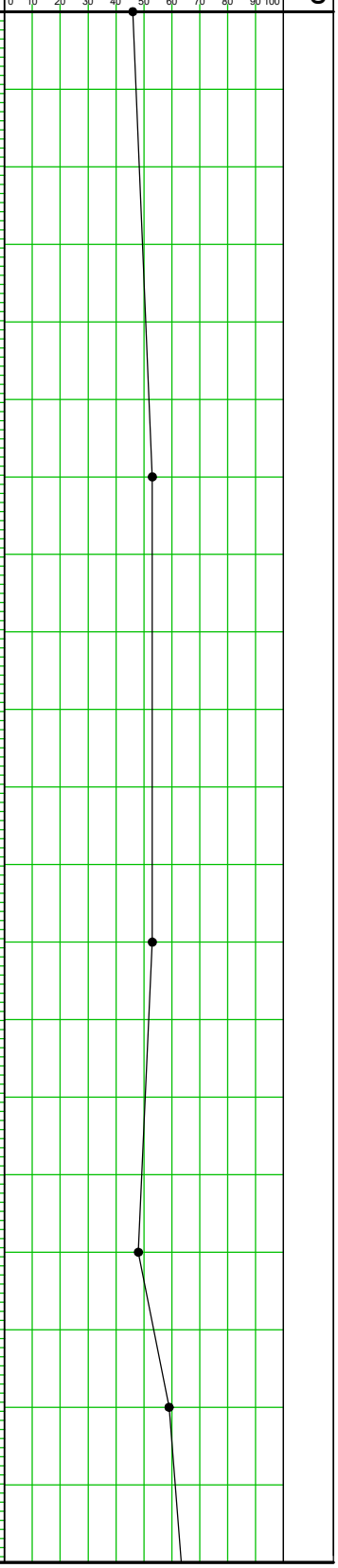
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118908.161 m	*Easting :*702617.165 m
Reduced Level (m):(+)190.950	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	16	23	30	53					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Hard with gravel Silty clay of low plasticity	CL			
15.5											
16.0	16	SPT-6	20	24	29	53					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0	18	SPT-7	19	23	25	48					
18.5											
19.0	19	SPT-8	21	27	32	59					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118908.161 m	*Easting :*702617.165 m
Reduced Level (m):(+)190.950	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-9	28	34	38	72					
22.5											
23.0											
23.5	23.5	UDS*									
24.0	24	SPT-10	25	28	29	57					
24.5											
25.0							Brown, Hard with gravel Silty clay of low plasticity	CL			
25.5	25.5	SPT-11	21	28	33	61					
26.0											
26.5	26.5	UDS-8									
27.0											
27.5											
28.0	28	SPT-12	20	25	30	55					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	SPT-13	22	26	35	61					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118908.161 m	*Easting :*702617.165 m
Reduced Level (m):(+)190.950	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*1.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-14	20	28	38	66					
31.5											
32.0											
32.5	32.5	UDS-9									
33.0											
33.5											
34.0	34	SPT-15	27	32	39	71					
34.5											
35.0							Brown, Hard with gravel Silty clay of low plasticity	CL			
35.5	35.5	SPT-16	29	38	40	78					
36.0											
36.5											
37.0	37	SPT-17	29	35	42	77					
37.5											
38.0											
38.5	38.5	SPT-18	42	54	46 (10cm)	>100					
39.0											
39.5											
40.0	40	SPT-19	33	48	52 (7cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118911.568 m	*Easting :*702589.211 m
Reduced Level (m):(+)191.187	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*11-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS					Brown, Medium stiff, Silty clay of low plasticity	CL	2.10m	0 10 20 30 40 50 60 70 80 90 100	
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	2	3	5	8					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	7	12	19					
6.0											
6.5											
7.0	7	UDS-3					Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	SPT-3	7	9	13	22					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118911.568 m	*Easting :*702589.211 m
Reduced Level (m):(+)191.187	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*11-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	10	14	19	33					
12.0											
12.5											
13.0	13	UDS-5									
13.5							Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
14.0											
14.5	14.5	SPT-5	14	17	23	40					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	18	25	25	50					
18.0											
18.5											
19.0	19	UDS-7					Brown, Hard with gravel Silty clay of low plasticity	CL			
19.5	19.5	SPT-7	22	23	28	51					
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118911.568 m	*Easting :*702589.211 m
Reduced Level (m):(+)191.187	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*11-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	25	27	31	58					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-9	29	32	36	68					
24.0											
24.5											
25.0	25	UDS-9					Brown, Hard with gravel Silty clay of low plasticity	CL			
25.5											
26.0											
26.5	26.5	SPT-10	30	45	55 (5cm)	>100					
27.0											
27.5											
28.0	28	SPT-11	30	52	48 (4cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-12	35	45	55 (7cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118911.568 m	*Easting :*702589.211 m
Reduced Level (m):(+)191.187	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.10	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*11-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0											
31.5	31.5	SPT-13	37	40	60 (6cm)	>100					
32.0											
32.5	32.5	SPT-14	42	48	52 (6cm)	>100					
33.0											
33.5											
34.0	34	SPT-15	47	58	42 (5cm)	>100					
34.5											
35.0							Brown, Hard with gravel Silty clay of low plasticity	CL			
35.5	35.5	SPT-16	35	50	50 (4cm)	>100					
36.0											
36.5											
37.0	37	SPT-17	30	57	43 (4cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-18	31	60	40 (8cm)	>100					
39.0											
39.5											
40.0	40	SPT-19	25	55	45 (10cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118913.897 m	*Easting :*702570.093 m
Reduced Level (m):(+)191.622	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*11-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	3	5	8					
1.5											
2.0							Brown, Medium stiff, Silty clay of low plasticity	CL			
2.5	2.5	UDS-1							2.25m		
3.0											
3.5											
4.0	4	SPT-2	4	6	7	13					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	5	9	9	18	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	7	11	13	24					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118913.897 m	*Easting :*702570.093 m
Reduced Level (m):(+)191.622	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*11-10-2021	

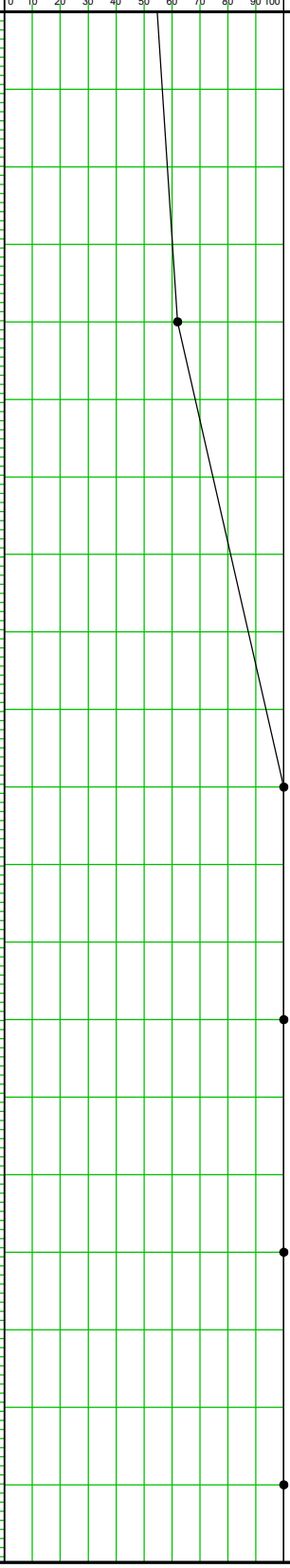
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	9	15	18	33					
13.5											
14.0											
14.5	14.5	UDS-5					Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
15.0											
15.5											
16.0	16	SPT-6	12	19	26	45					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	14	22	29	51					
19.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118913.897 m	*Easting :*702570.093 m
Reduced Level (m):(+)191.622	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*11-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	19	28	34	62					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	28	45	55 (10cm)	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-10	32	52	48 (7cm)	>100					
27.0											
27.5											
28.0	28	SPT-11	34	57	43 (6cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-12	47	100 (10cm)	-	>100					
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118913.897 m	*Easting :*702570.093 m
Reduced Level (m):(+)191.622	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.25	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-10-2021	*Date of Completion :*11-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-13	30	41	59 (7cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-14	39	49	51 (5cm)	>100					
33.0											
33.5											
34.0	34	SPT-15	41	77	23 (10cm)	>100					
34.5											
35.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
35.5	35.5	SPT-16	44	100 (6cm)	-	>100					
36.0											
36.5											
37.0	37	SPT-17	45	80	20 (12cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-18	47	77	23 (9cm)	>100					
39.0											
39.5											
40.0	40	SPT-19	52	100 (6cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118916.469 m	*Easting :*702548.989 m
Reduced Level (m):(+)191.622	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-11-2021	*Date of Completion :*17-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	4	6	10			2.55m		
3.0											
3.5											
4.0	4	UDS-2									
4.5	4.5	SPT-2	6	8	10	18					
5.0							Brown, Stiff to very stiff, Silty clay of low plasticity with gravel	CL			
5.5											
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	7	9	12	21					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118916.469 m	*Easting :*702548.989 m
Reduced Level (m):(+)191.622	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-11-2021	*Date of Completion :*17-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	9	12	16	28	Brown, Stiff to 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	14.5	SPT-5	11	14	18	32					
15.0											
15.5											
16.0	16	UDS-6					Brown, Hard, Silty clay of low plasticity with gravel	CL			
16.5											
17.0											
17.5	17.5	SPT-6	11	16	20	36					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118916.469 m	*Easting :*702548.989 m
Reduced Level (m):(+)191.622	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-11-2021	*Date of Completion :*17-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	13	18	25	43					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	14	20	28	48					
24.0											
24.5											
25.0	25	UDS*					Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5	25.5	SPT-9	21	28	34	62					
26.0											
26.5	26.5	SPT-10	18	31	37	68					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0											
29.5	29.5	SPT-11	25	38	42	80					
30.0											

UDS*-UDS not recovered

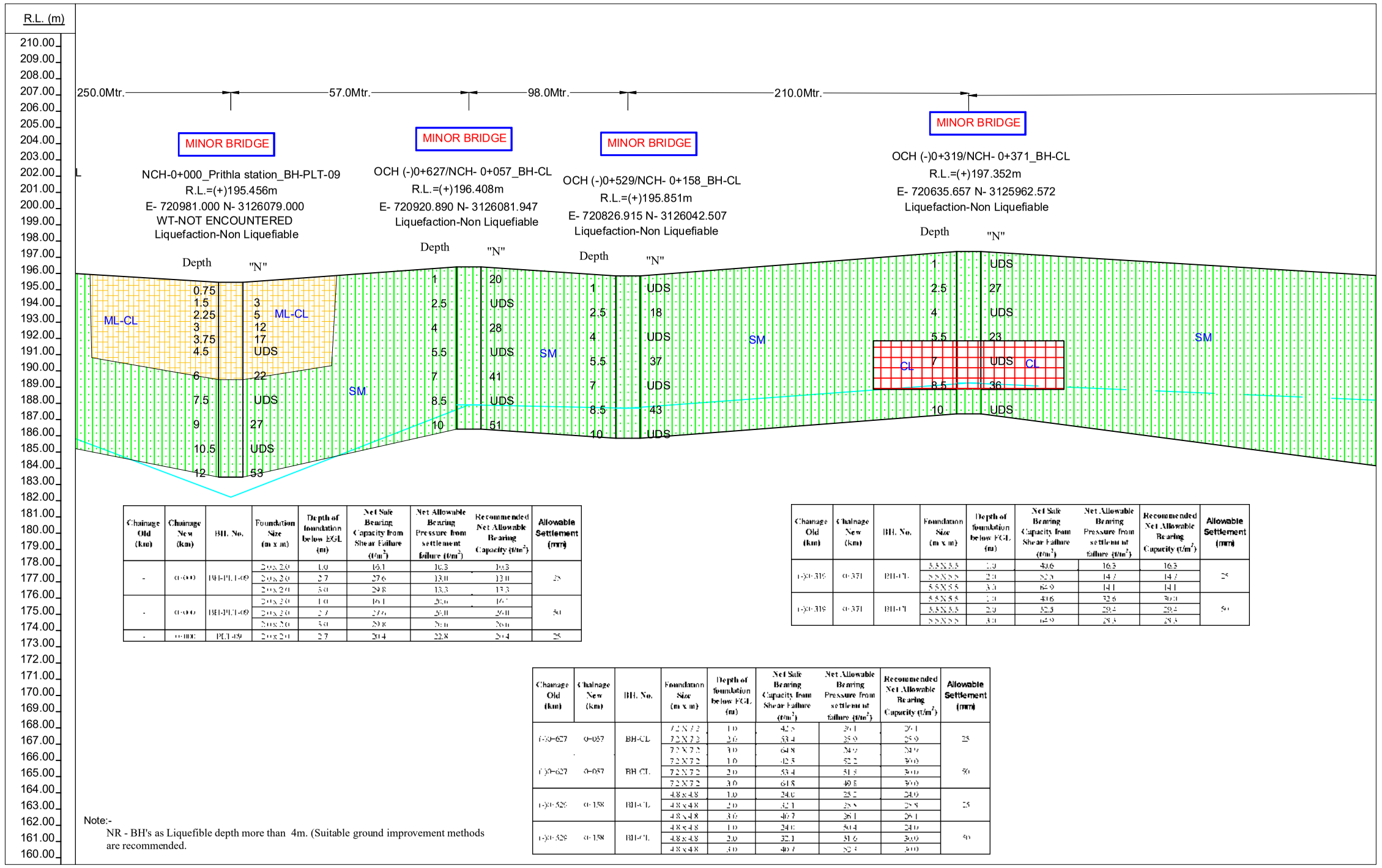
FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*20+300 km	*Northing :*3118916.469 m	*Easting :*702548.989 m
Reduced Level (m):(+)191.622	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*2.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-11-2021	*Date of Completion :*17-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	UDS-10									
31.5											
32.0							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
32.5	32.5	SPT-12	28	36	48	84					
33.0											
33.5											
34.0	34	SPT-13	24	48	52 (15cm)	>100					
34.5											
35.0											
35.5	35.5	SPT-14	32	44	56 (12cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	34	50	50 (8cm)	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
37.5											
38.0											
38.5	38.5	SPT-16	29	55	45 (7cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	42	59	41 (6cm)	>100					

UDS*-UDS not recovered

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
-	0+000	BH-PLT-09	2.0 x 2.0	1.0	16.1	16.3	16.3	25
			2.0 x 2.0	2.0	27.6	13.0	13.0	
			2.0 x 2.0	3.0	29.8	13.3	13.3	
-	0+000	BH-PLT-09	2.0 x 2.0	1.0	16.1	26.0	16.1	50
			2.0 x 2.0	2.0	27.6	26.0	26.0	
			2.0 x 2.0	3.0	29.8	26.0	26.0	
-	0+000	PLT-09	2.0 x 2.0	2.0	20.4	22.8	20.4	25

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
(-)0+319	0+371	BH-CL	5.5 X 5.5	2.0	49.6	16.3	16.3	25
			5.5 X 5.5	2.0	52.3	14.7	14.7	
			5.5 X 5.5	3.0	62.9	14.1	14.1	
(-)0+319	0+371	BH-CL	5.5 X 5.5	2.0	49.6	32.6	32.6	50
			5.5 X 5.5	2.0	52.3	29.4	29.4	
			5.5 X 5.5	3.0	62.9	28.3	28.3	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement at failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
(-)0+627	0+057	BH-CL	7.2 X 7.2	1.0	42.5	26.1	26.1	25
			7.2 X 7.2	2.0	53.4	25.9	25.9	
			7.2 X 7.2	3.0	64.8	24.2	24.2	
(-)0+627	0+057	BH-CL	7.2 X 7.2	1.0	42.5	52.2	36.0	50
			7.2 X 7.2	2.0	53.4	51.8	36.0	
			7.2 X 7.2	3.0	64.8	40.5	36.0	
(-)0+529	0+158	BH-CL	4.8 x 4.8	1.0	24.0	25.7	24.0	25
			4.8 x 4.8	2.0	32.1	25.8	25.8	
			4.8 x 4.8	3.0	40.7	26.1	26.1	
(-)0+529	0+158	BH-CL	4.8 x 4.8	1.0	24.0	50.4	24.0	50
			4.8 x 4.8	2.0	32.1	51.6	36.0	
			4.8 x 4.8	3.0	40.7	52.3	36.0	

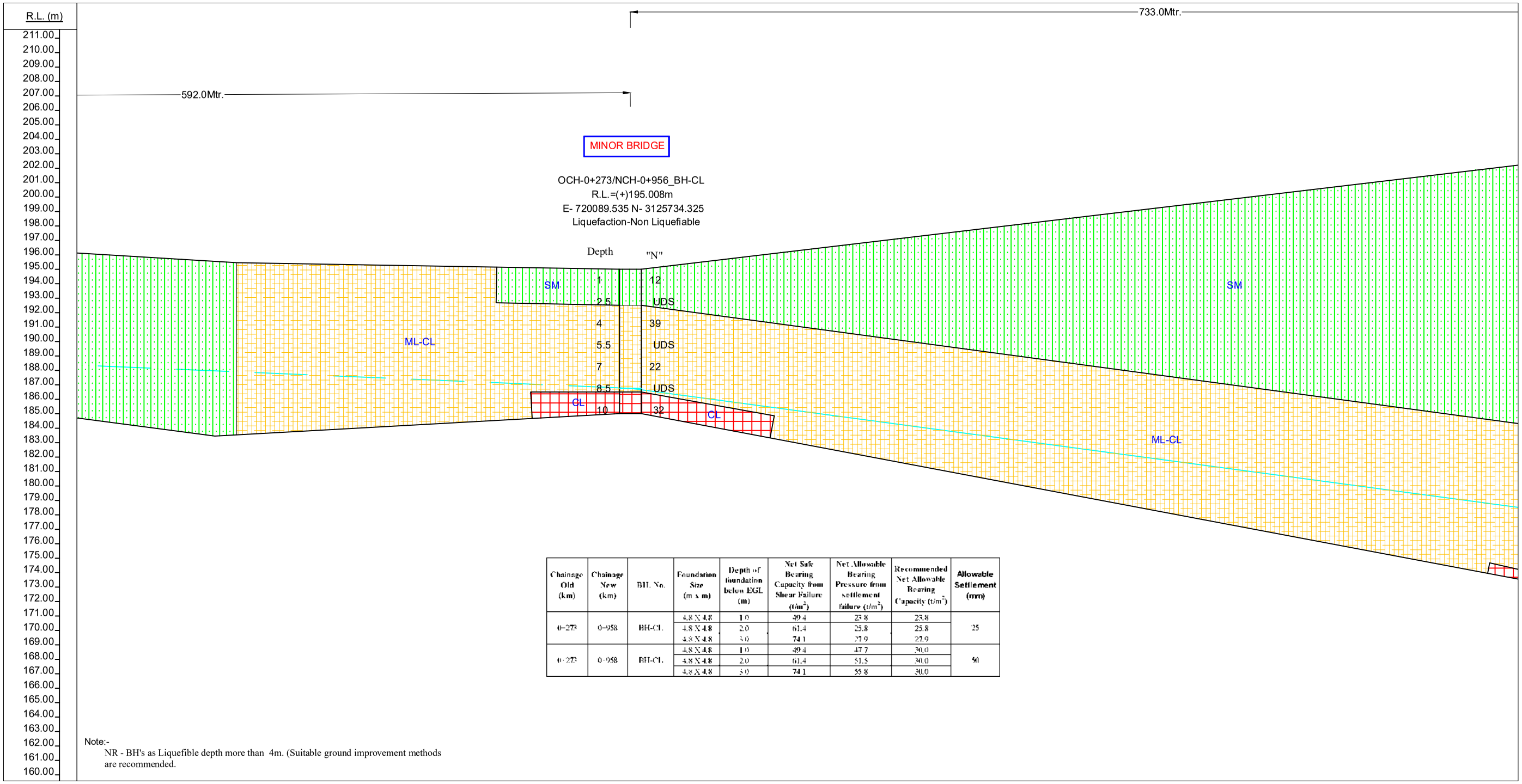
Note:-

NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

SYMBOL	DESCRIPTION		
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)		
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)		
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)		
	CL-Silty Clay of low plasticity (Above A-line, LL<35)		
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)		LIQUEFACTION
	BOREHOLE REQUIRED		WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 | SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



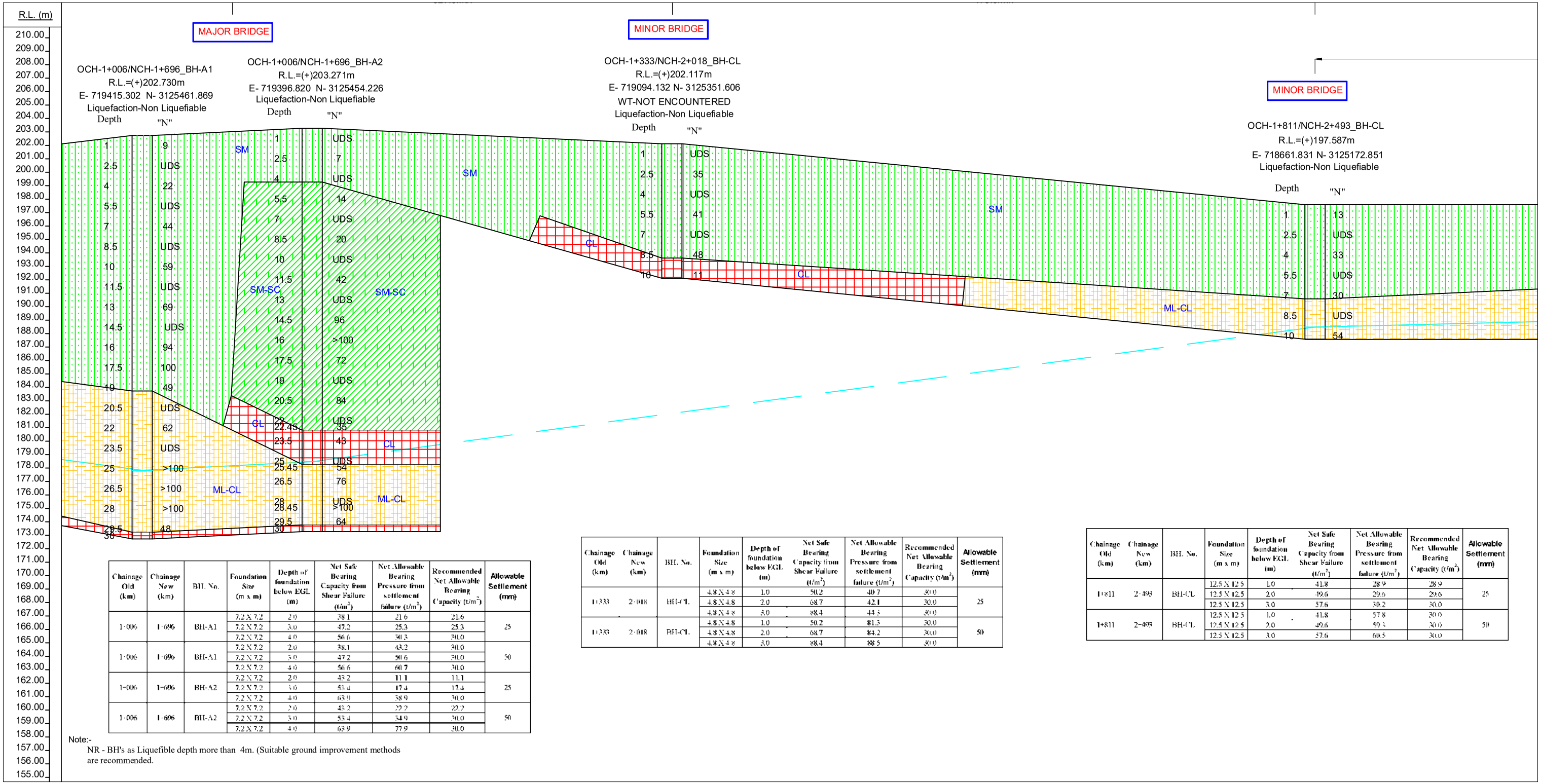
Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)	Allowable Settlement (mm)
0+273	0+958	BH-CL	4.8 X 4.8	1.0	49.4	23.8	23.8	25
			4.8 X 4.8	2.0	61.4	25.8	25.8	
			4.8 X 4.8	3.0	74.1	22.9	22.9	
0+273	0+958	BH-CL	4.8 X 4.8	1.0	49.4	47.7	30.0	50
			4.8 X 4.8	2.0	61.4	51.5	30.0	
			4.8 X 4.8	3.0	74.1	55.8	30.0	

Note:-

NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

SYMBOL	DESCRIPTION		
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)		
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)		
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)		
	CL-Silty Clay of low plasticity (Above A-line, LL<35)		
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)		LIQUEFACTION
	BOREHOLE REQUIRED		WATER TABLE
Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)	SCALE:- HOR:- 1:2850	SCALE:- VER:- 1:285	

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
1+006	1+696	BH-A1	7.2 X 7.2	2.0	38.1	21.6	21.6	25
			7.2 X 7.2	3.0	47.2	25.3	25.3	
			7.2 X 7.2	4.0	56.6	50.3	50.0	
			7.2 X 7.2	2.0	38.1	43.2	30.0	50
			7.2 X 7.2	3.0	47.2	50.6	50.0	
			7.2 X 7.2	4.0	56.6	60.7	30.0	
1+006	1+696	BH-A2	7.2 X 7.2	2.0	43.2	11.1	11.1	25
			7.2 X 7.2	3.0	53.4	17.4	17.4	
			7.2 X 7.2	4.0	63.9	58.9	30.0	
1+006	1+696	BH-A2	7.2 X 7.2	2.0	43.2	22.2	22.2	50
			7.2 X 7.2	3.0	53.4	34.9	30.0	
			7.2 X 7.2	4.0	63.9	77.9	30.0	

Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
1+333	2+018	BH-CL	4.8 X 4.8	1.0	50.2	40.7	30.0	25
			4.8 X 4.8	2.0	68.7	42.1	30.0	
			4.8 X 4.8	3.0	88.4	44.3	30.0	
1+333	2+018	BH-CL	4.8 X 4.8	1.0	50.2	81.3	30.0	50
			4.8 X 4.8	2.0	68.7	84.2	30.0	
			4.8 X 4.8	3.0	88.4	88.5	30.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
1+811	2+493	BH-CL	12.5 X 12.5	1.0	41.8	28.9	28.9	25
			12.5 X 12.5	2.0	49.6	29.6	29.6	
			12.5 X 12.5	3.0	57.6	30.2	30.0	
1+811	2+493	BH-CL	12.5 X 12.5	1.0	41.8	57.8	30.0	50
			12.5 X 12.5	2.0	49.6	59.3	30.0	
			12.5 X 12.5	3.0	57.6	60.5	30.0	

SYMBOL	DESCRIPTION		
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)		
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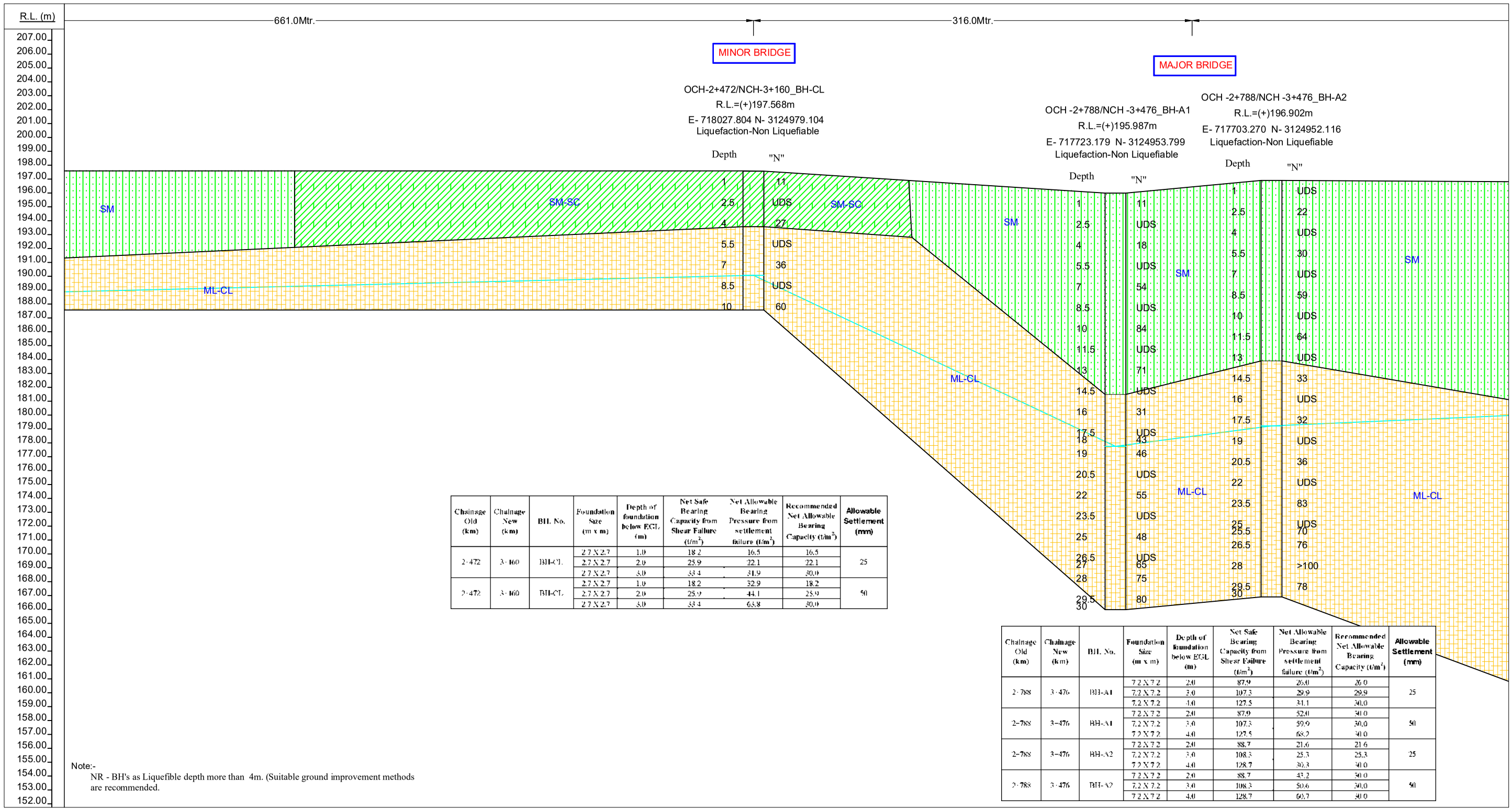
	CL-Silty Clay of low plasticity (Above A-line, LL<35)		
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)		LIQUEFACTION
	BOREHOLE REQUIRED		WATER TABLE
Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)		SCALE:- HOR:- 1:2850	SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
2+472	3+160	BH-CL	2.7 X 2.7	1.0	18.2	16.5	16.5	25
			2.7 X 2.7	2.0	25.9	22.1	22.1	
			2.7 X 2.7	3.0	33.4	31.9	30.0	
2+472	3+160	BH-CL	2.7 X 2.7	1.0	18.2	32.9	18.2	50
			2.7 X 2.7	2.0	25.9	44.1	25.9	
			2.7 X 2.7	3.0	33.4	63.8	30.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
2+788	3+476	BH-A1	7.2 X 7.2	2.0	87.9	26.0	26.0	25
			7.2 X 7.2	3.0	107.3	29.9	29.9	
			7.2 X 7.2	4.0	127.5	31.1	30.0	
2+788	3+476	BH-A1	7.2 X 7.2	2.0	87.9	52.0	30.0	50
			7.2 X 7.2	3.0	107.3	59.9	30.0	
			7.2 X 7.2	4.0	127.5	68.2	30.0	
2+788	3+476	BH-A2	7.2 X 7.2	2.0	88.7	21.6	21.6	25
			7.2 X 7.2	3.0	108.3	25.3	25.3	
			7.2 X 7.2	4.0	128.7	30.3	30.0	
2+788	3+476	BH-A2	7.2 X 7.2	2.0	88.7	43.2	30.0	50
			7.2 X 7.2	3.0	108.3	50.6	30.0	
			7.2 X 7.2	4.0	128.7	60.7	30.0	

Note:-

NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

SYMBOL	DESCRIPTION		
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)		
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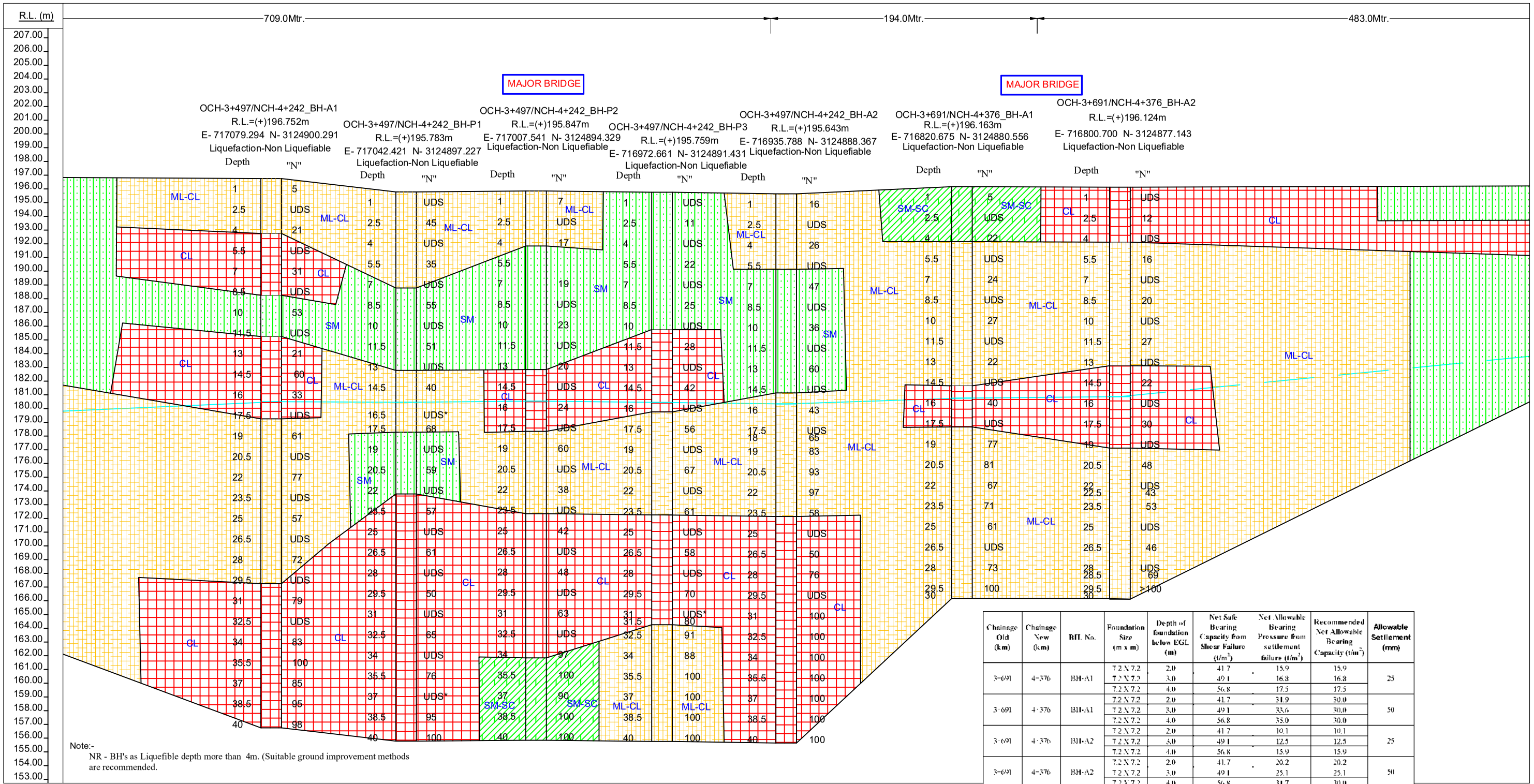
	CL-Silty Clay of low plasticity (Above A-line, LL<35)		
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)		LIQUEFACTION
	BOREHOLE REQUIRED		WATER TABLE
Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)	SCALE:- HOR:- 1:2850	SCALE:- VER:- 1:285	

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
3+691	4+376	BH-A1	7.2 X 7.2	2.0	41.7	15.9	15.9	25
			7.2 X 7.2	3.0	49.1	16.8	16.8	
			7.2 X 7.2	4.0	56.8	17.5	17.5	
3+691	4+376	BH-A1	7.2 X 7.2	2.0	41.7	31.9	30.0	50
			7.2 X 7.2	3.0	49.1	33.6	30.0	
			7.2 X 7.2	4.0	56.8	35.0	30.0	
3+691	4+376	BH-A2	7.2 X 7.2	2.0	41.7	10.1	10.1	25
			7.2 X 7.2	3.0	49.1	12.5	12.5	
			7.2 X 7.2	4.0	56.8	15.9	15.9	
3+691	4+376	BH-A2	7.2 X 7.2	2.0	41.7	20.2	20.2	50
			7.2 X 7.2	3.0	49.1	25.1	25.1	
			7.2 X 7.2	4.0	56.8	31.7	30.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
3+497	4+242	BH-A1	7.2 X 7.2	2.0	22.1	7.2	7.2	25
			7.2 X 7.2	3.0	23.0	10.2	10.2	
			7.2 X 7.2	4.0	25.9	17.3	17.3	
3+497	4+242	BH-A1	7.2 X 7.2	2.0	22.1	14.3	14.3	50
			7.2 X 7.2	3.0	23.0	20.5	20.5	
			7.2 X 7.2	4.0	25.9	34.6	25.9	
3+497	4+242	BH-P1	7.2 X 7.2	2.0	62.5	44.2	30.0	25
			7.2 X 7.2	3.0	73.0	45.7	30.0	
			7.2 X 7.2	4.0	83.9	46.5	30.0	
3+497	4+242	BH-P1	7.2 X 7.2	2.0	62.5	88.3	30.0	50
			7.2 X 7.2	3.0	73.0	91.4	30.0	
			7.2 X 7.2	4.0	83.9	93.0	30.0	
3+497	4+242	BH-P2	7.2 X 7.2	2.0	41.5	14.1	14.1	25
			7.2 X 7.2	3.0	51.2	14.5	14.5	
			7.2 X 7.2	4.0	61.4	14.8	14.8	
3+497	4+242	BH-P2	7.2 X 7.2	2.0	41.5	28.2	28.2	50
			7.2 X 7.2	3.0	51.2	29.0	29.0	
			7.2 X 7.2	4.0	61.4	29.5	29.4	

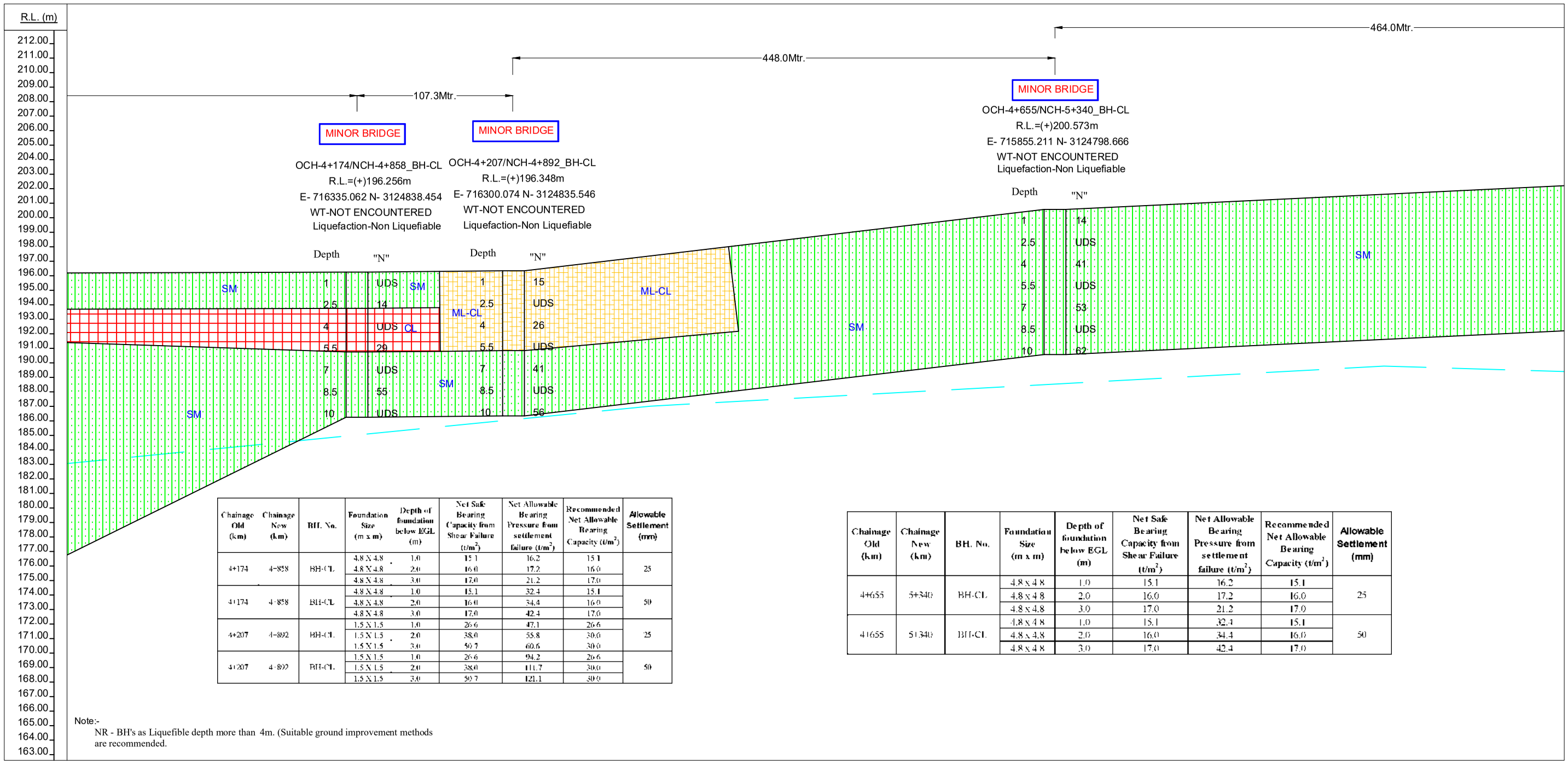
Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
3+497	4+242	BH-P3	7.2 X 7.2	2.0	48.9	14.9	14.9	25
			7.2 X 7.2	3.0	60.2	15.6	15.6	
			7.2 X 7.2	4.0	72.0	16.6	16.6	
3+497	4+242	BH-P3	7.2 X 7.2	2.0	48.9	29.8	29.8	50
			7.2 X 7.2	3.0	60.2	31.2	30.0	
			7.2 X 7.2	4.0	72.0	33.1	30.0	
3+497	4+242	BH-A2	7.2 X 7.2	2.0	71.1	29.0	29.0	25
			7.2 X 7.2	3.0	87.1	30.2	30.0	
			7.2 X 7.2	4.0	103.7	31.6	30.0	
3+497	4+242	BH-A2	7.2 X 7.2	2.0	71.1	58.0	30.0	50
			7.2 X 7.2	3.0	87.1	60.3	30.0	
			7.2 X 7.2	4.0	103.7	63.3	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
4+174	4+858	BH-CL	4.8 X 4.8	1.0	15.1	16.2	15.1	25
			4.8 X 4.8	2.0	16.0	17.2	16.0	
			4.8 X 4.8	3.0	17.0	21.2	17.0	
41174	4+858	BH-CL	4.8 X 4.8	1.0	15.1	32.4	15.1	50
			4.8 X 4.8	2.0	16.0	34.4	16.0	
			4.8 X 4.8	3.0	17.0	42.4	17.0	
4+207	4+892	BH-CL	1.5 X 1.5	1.0	26.6	47.1	26.6	25
			1.5 X 1.5	2.0	38.0	55.8	30.0	
			1.5 X 1.5	3.0	50.7	60.6	30.0	
41207	4+892	BH-CL	1.5 X 1.5	1.0	26.6	94.2	26.6	50
			1.5 X 1.5	2.0	38.0	111.7	30.0	
			1.5 X 1.5	3.0	50.7	121.1	30.0	

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
4+655	5+340	BH-CL	4.8 x 4.8	1.0	15.1	16.2	15.1	25
			4.8 x 4.8	2.0	16.0	17.2	16.0	
			4.8 x 4.8	3.0	17.0	21.2	17.0	
41655	51340	BH-CL	4.8 x 4.8	1.0	15.1	32.4	15.1	50
			4.8 x 4.8	2.0	16.0	34.4	16.0	
			4.8 x 4.8	3.0	17.0	42.4	17.0	

Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
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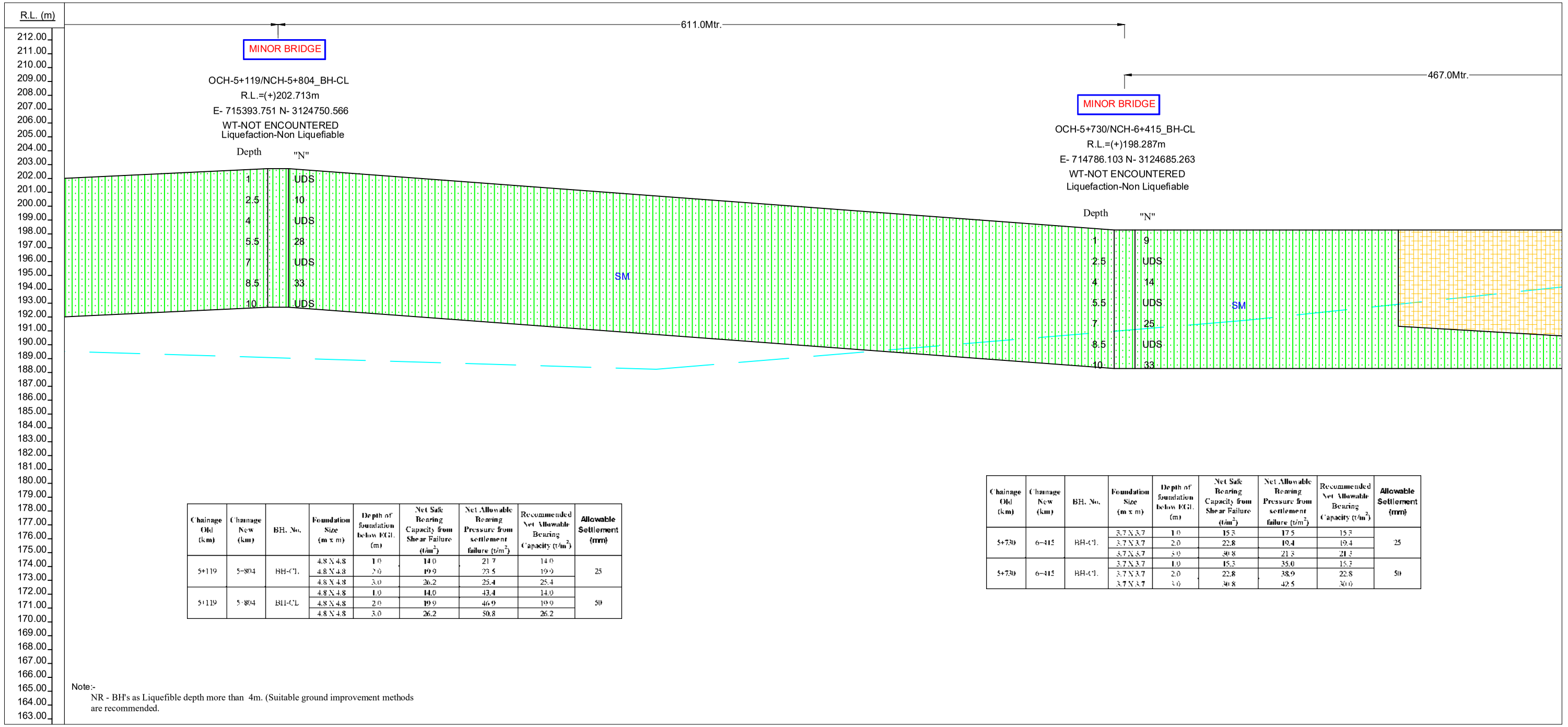
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 | SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
5+119	5-804	BH-CL	4.8 X 4.8	1.0	14.0	21.7	14.0	25
			4.8 X 4.8	2.0	19.9	23.5	19.9	
			4.8 X 4.8	3.0	26.2	25.4	25.4	
5+119	5-804	BH-CL	4.8 X 4.8	1.0	14.0	43.4	14.0	50
			4.8 X 4.8	2.0	19.9	46.9	19.9	
			4.8 X 4.8	3.0	26.2	50.8	26.2	

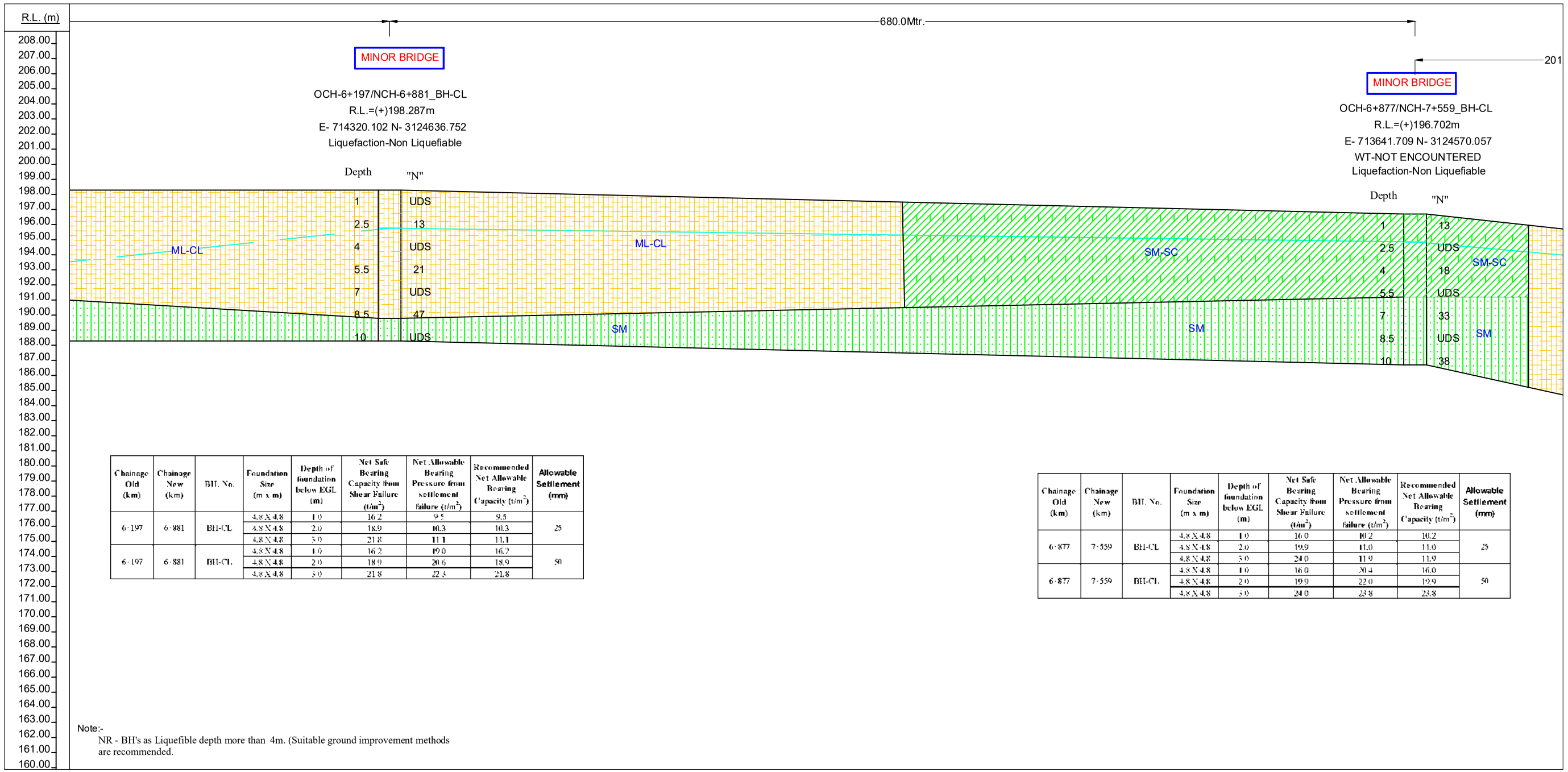
Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)	Allowable Settlement (mm)
5+730	6-415	BH-CL	3.7 X 3.7	1.0	15.3	17.5	15.3	25
			3.7 X 3.7	2.0	22.8	19.4	19.4	
			3.7 X 3.7	3.0	30.8	21.3	21.3	
5+730	6-415	BH-CL	3.7 X 3.7	1.0	15.3	35.0	15.3	50
			3.7 X 3.7	2.0	22.8	38.9	22.8	
			3.7 X 3.7	3.0	30.8	42.5	30.0	

Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
6·197	6·881	BH-CL	4.8 X 4.8	1.0	16.2	9.5	9.5	25
			4.8 X 4.8	2.0	18.9	10.3	10.3	
			4.8 X 4.8	3.0	21.8	11.1	11.1	
6·197	6·881	BH-CL	4.8 X 4.8	1.0	16.2	19.0	16.2	50
			4.8 X 4.8	2.0	18.9	20.6	18.9	
			4.8 X 4.8	3.0	21.8	22.5	21.8	

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
6·877	7·559	BH-CL	4.8 X 4.8	1.0	16.0	10.2	10.2	25
			4.8 X 4.8	2.0	19.9	11.0	11.0	
			4.8 X 4.8	3.0	24.0	11.9	11.9	
6·877	7·559	BH-CL	4.8 X 4.8	1.0	16.0	20.4	16.0	50
			4.8 X 4.8	2.0	19.9	22.0	19.9	
			4.8 X 4.8	3.0	24.0	23.8	23.8	

Note:-
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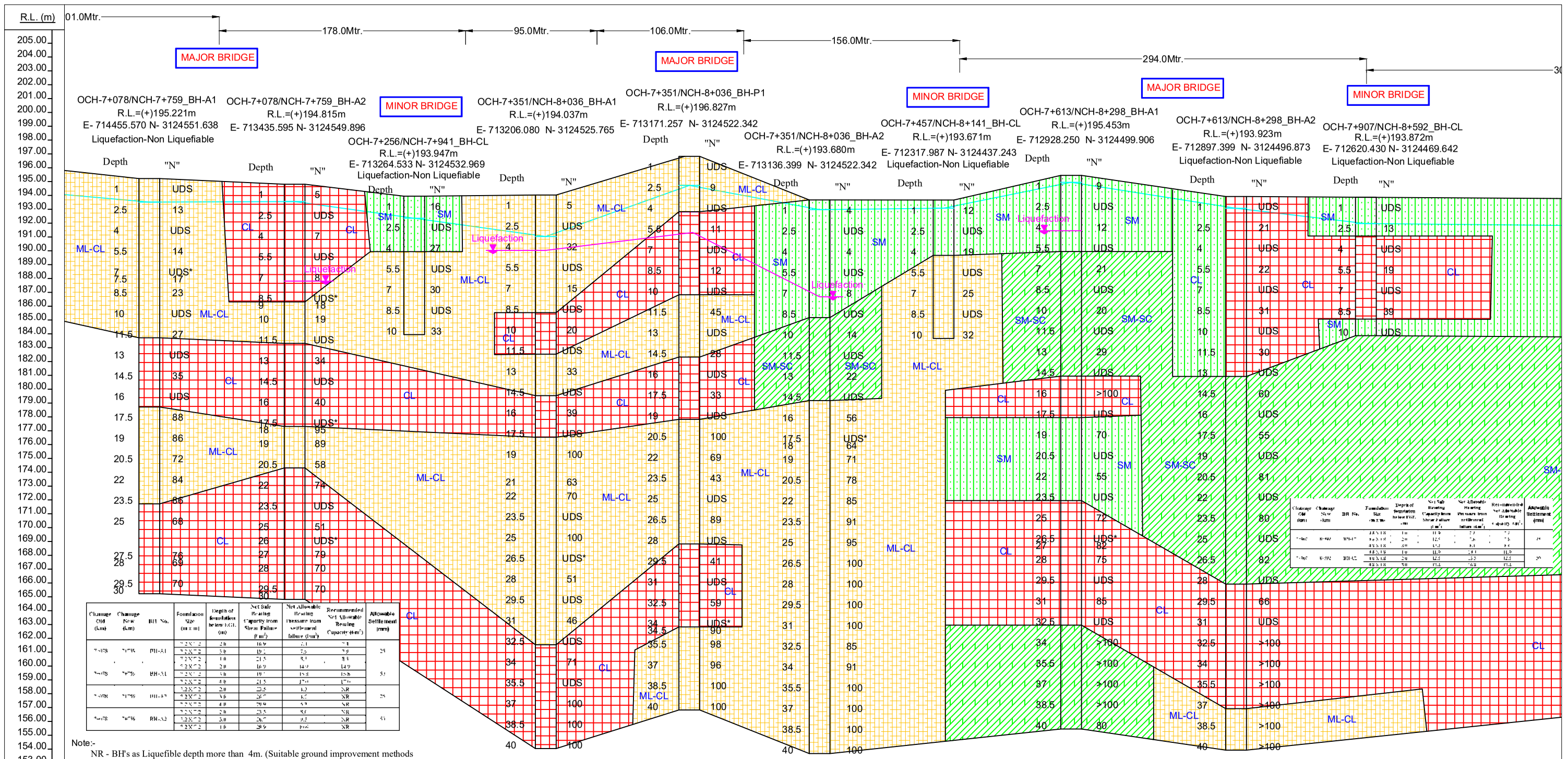
SYMBOL	DESCRIPTION		
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)		
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)		
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)		
	CL-Silty Clay of low plasticity (Above A-line, LL<35)		
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)		LIQUEFACTION
	BOREHOLE REQUIRED		WATER TABLE
Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)		SCALE:- HOR:- 1:2850	SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
7+078	7+078	BH-A1	2.5X2.5	2.0	16.9	6.1	6.1	25
			3.0X3.0	3.0	19.7	7.5	7.5	
			2.5X2.5	1.0	21.5	8.3	8.3	
			3.0X3.0	2.0	16.9	14.9	14.9	50
7+078	7+078	BH-A1	2.5X2.5	3.0	19.7	15.8	15.8	
			3.0X3.0	4.0	21.5	17.0	17.0	
			3.0X3.0	2.0	22.5	4.2	NR	25
7+078	7+078	BH-A2	2.5X2.5	3.0	26.7	6.7	NR	
			3.0X3.0	4.0	29.9	8.9	NR	
			2.5X2.5	2.0	23.5	9.0	NR	50
7+078	7+078	BH-A2	3.0X3.0	3.0	26.7	9.2	NR	
			3.0X3.0	4.0	29.9	10.6	NR	

Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Chainage Old (km)	Chainage New (km)	BH. No	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
7+351	8+036	BH-P1	2.5X2.5	2.0	9.3	6.2	NR	25
			3.0X3.0	3.0	11.4	7.6	NR	
			2.5X2.5	4.0	14.6	8.4	NR	
7+351	8+036	BH-P1	2.5X2.5	2.0	9.3	12.3	NR	50
			3.0X3.0	3.0	11.4	14.1	NR	
			2.5X2.5	4.0	12.6	15.7	NR	
7+351	8+036	BH-A2	2.5X2.5	2.0	9.3	12.8	NR	25
			3.0X3.0	3.0	11.4	15.5	NR	
			2.5X2.5	4.0	13.6	18.3	NR	
7+351	8+036	BH-A2	2.5X2.5	2.0	9.3	25.7	NR	50
			3.0X3.0	3.0	11.4	27.0	NR	
			2.5X2.5	4.0	14.6	28.6	NR	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
7+351	8+036	BH-A2	2.5X2.5	2.0	16.1	13.6	13.6	25
			3.0X3.0	3.0	17.6	14.2	14.2	
			2.5X2.5	1.0	15.1	14.0	14.0	
7+351	8+036	BH-A2	2.5X2.5	2.0	16.1	27.2	16.1	50
			3.0X3.0	3.0	17.6	28.4	17.6	
			2.5X2.5	1.0	15.1	28.6	15.1	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
7+256	7+941	BH-CL	2.5X2.5	2.0	11.6	15.9	11.9	25
			3.0X3.0	3.0	13.1	17.1	13.1	
			2.5X2.5	1.0	11.8	26.9	11.8	50
7+256	7+941	BH-CL	2.5X2.5	2.0	19.3	20.9	19.3	
			3.0X3.0	3.0	25.1	24.2	25.1	
7+457	8+141	BH-CL	2.5X2.5	2.0	17.5	10.8	10.8	25
			3.0X3.0	2.0	21.4	12.5	12.5	
			2.5X2.5	3.0	25.4	13.7	13.7	
7+457	8+141	BH-CL	2.5X2.5	1.0	17.5	21.5	17.6	50
			2.5X2.5	2.0	21.3	24.7	21.3	
			3.0X3.0	3.0	25.1	27.3	25.1	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
7+613	8+298	BH-A1	2.5X2.5	2.0	22.3	11.0	11.0	25
			3.0X3.0	3.0	26.3	10.0	10.0	
			2.5X2.5	4.0	20.7	8.9	8.9	
7+613	8+298	BH-A1	2.5X2.5	2.0	42.3	21.9	21.9	50
			3.0X3.0	3.0	26.3	21.2	21.2	
			2.5X2.5	4.0	20.7	19.8	19.8	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
7+613	8+298	BH-A2	2.5X2.5	2.0	18.2	11.9	11.9	25
			3.0X3.0	3.0	18.8	15.7	15.7	
			2.5X2.5	1.0	19.5	16.7	16.7	
7+613	8+298	BH-A2	2.5X2.5	2.0	18.2	29.8	18.2	50
			3.0X3.0	3.0	18.8	31.5	18.8	
			2.5X2.5	1.0	19.5	33.5	19.5	

SYMBOL	DESCRIPTION
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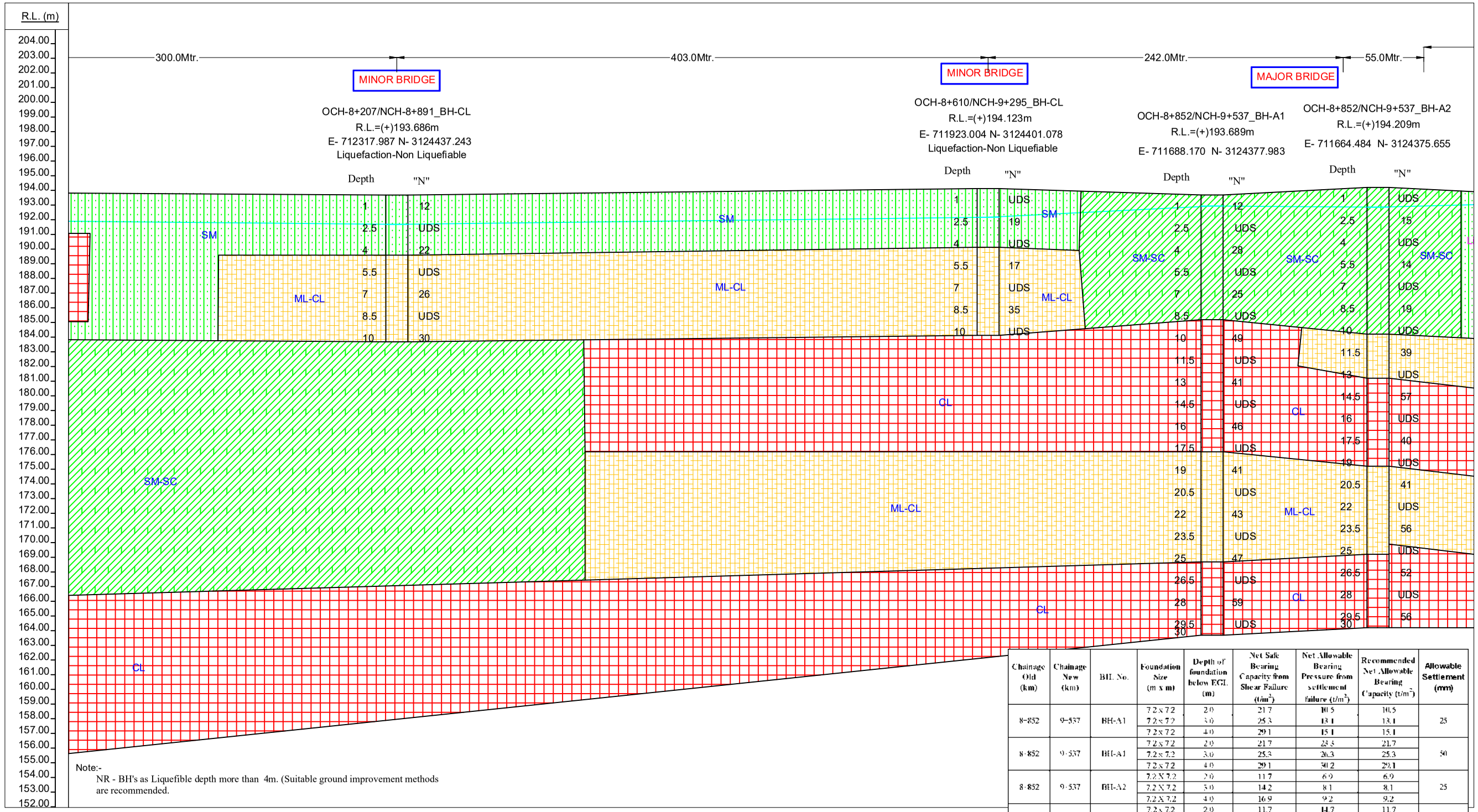
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 | SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

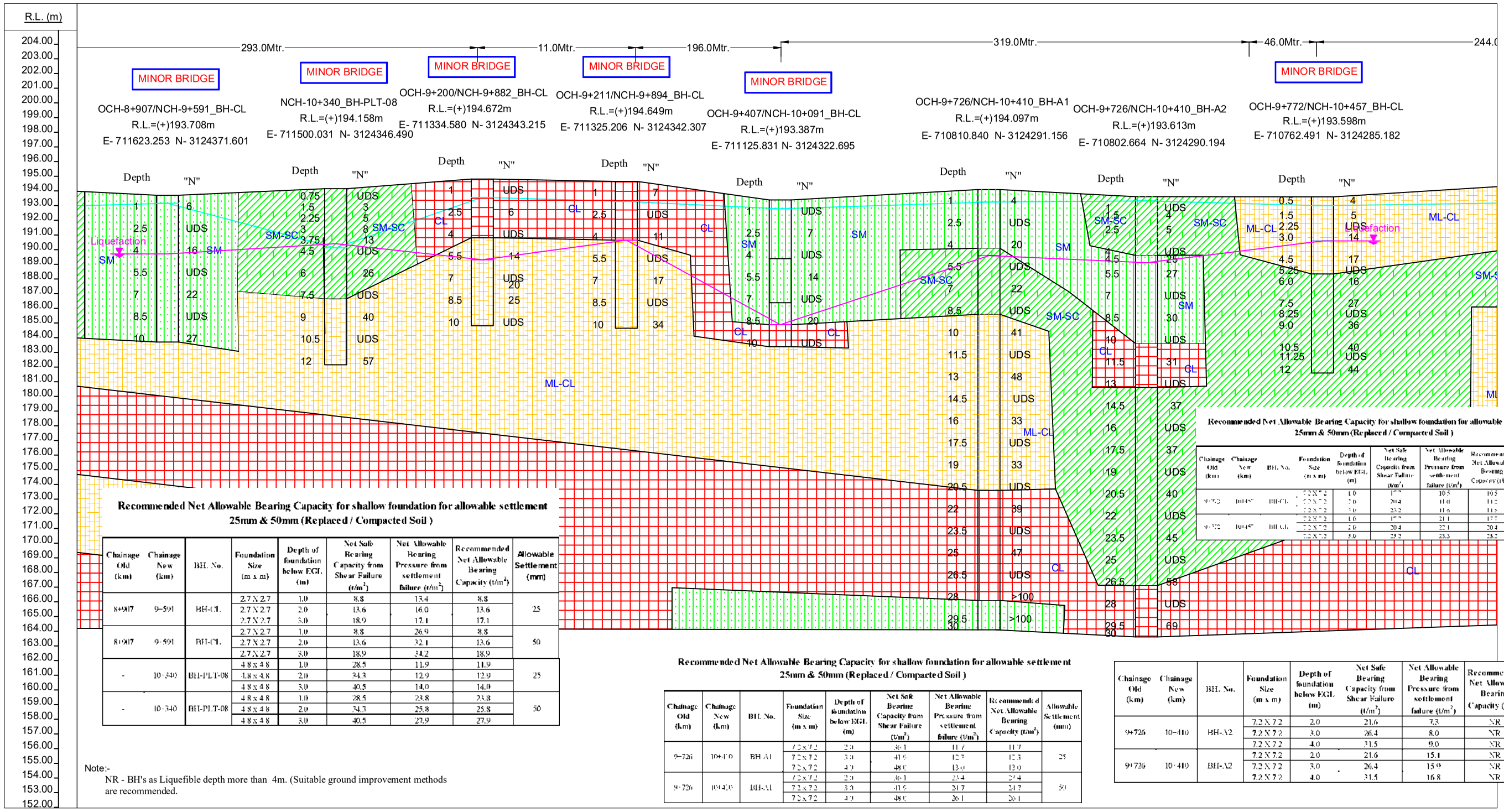
Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)	Allowable Settlement (mm)
8+207	8+891	BH-CL	4.8 X 4.8	1.0	18.5	9.2	9.2	25
			4.8 X 4.8	2.0	21.8	9.9	9.9	
			4.8 X 4.8	3.0	25.3	10.6	10.6	
8+207	8+891	BH-CL	4.8 X 4.8	1.0	18.5	18.3	18.3	50
			4.8 X 4.8	2.0	21.8	19.7	19.7	
			4.8 X 4.8	3.0	25.3	21.3	21.3	
8+610	9+295	BH-CL	7.2 X 7.2	1.0	17.3	9.3	9.3	25
			7.2 X 7.2	2.0	21.8	9.7	9.7	
			7.2 X 7.2	3.0	26.5	10.2	10.2	
			7.2 X 7.2	1.0	17.3	18.5	17.3	
8+610	9+295	BH-CL	7.2 X 7.2	2.0	21.8	19.4	19.4	50
			7.2 X 7.2	3.0	26.5	20.4	20.4	

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
8+852	9+537	BH-A1	7.2 x 7.2	2.0	21.7	10.5	10.5	25
			7.2 x 7.2	3.0	25.3	13.1	13.1	
			7.2 x 7.2	4.0	29.1	15.1	15.1	
8+852	9+537	BH-A1	7.2 x 7.2	2.0	21.7	23.3	21.7	50
			7.2 x 7.2	3.0	25.3	26.3	25.3	
			7.2 x 7.2	4.0	29.1	30.2	29.1	
8+852	9+537	BH-A2	7.2 X 7.2	2.0	11.7	6.9	6.9	25
			7.2 X 7.2	3.0	14.2	8.1	8.1	
			7.2 X 7.2	4.0	16.9	9.2	9.2	
8+852	9+537	BH-A2	7.2 x 7.2	2.0	11.7	14.7	11.7	50
			7.2 x 7.2	3.0	14.2	16.2	14.2	
			7.2 x 7.2	4.0	16.9	18.3	16.9	

SYMBOL	DESCRIPTION		
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)		
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)		
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)		
	CL-Silty Clay of low plasticity (Above A-line, LL<35)		
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)		LIQUEFACTION
	BOREHOLE REQUIRED		WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 | SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
8+907	9-591	BH-CL	2.7 X 2.7	1.0	8.8	13.4	8.8	25
			2.7 X 2.7	2.0	13.6	16.0	13.6	
			2.7 X 2.7	3.0	18.9	17.1	17.1	
8+907	9-591	BH-CL	2.7 X 2.7	1.0	8.8	26.9	8.8	50
			2.7 X 2.7	2.0	13.6	32.1	13.6	
			2.7 X 2.7	3.0	18.9	34.2	18.9	
-	10-340	BH-PLT-08	4.8 x 4.8	1.0	28.5	11.9	11.9	25
			4.8 x 4.8	2.0	34.3	12.9	12.9	
			4.8 x 4.8	3.0	40.5	14.0	14.0	
-	10-340	BH-PLT-08	4.8 x 4.8	1.0	28.5	23.8	23.8	50
			4.8 x 4.8	2.0	34.3	25.8	25.8	
			4.8 x 4.8	3.0	40.5	27.9	27.9	

Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
9+726	10+410	BH-A1	7.2 x 7.2	2.0	36.1	11.7	11.7	25
			7.2 x 7.2	3.0	41.6	12.3	12.3	
			7.2 x 7.2	4.0	48.0	13.0	13.0	
9+726	10+410	BH-A1	7.2 x 7.2	2.0	36.1	23.4	23.4	50
			7.2 x 7.2	3.0	41.6	24.7	24.7	
			7.2 x 7.2	4.0	48.0	26.1	26.1	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
9+726	10+410	BH-A2	7.2 X 7.2	2.0	21.6	7.3	NR	25
			7.2 X 7.2	3.0	26.4	8.0	NR	
			7.2 X 7.2	4.0	31.5	9.0	NR	
9+726	10+410	BH-A2	7.2 X 7.2	2.0	21.6	15.1	NR	50
			7.2 X 7.2	3.0	26.4	15.9	NR	
			7.2 X 7.2	4.0	31.5	16.8	NR	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

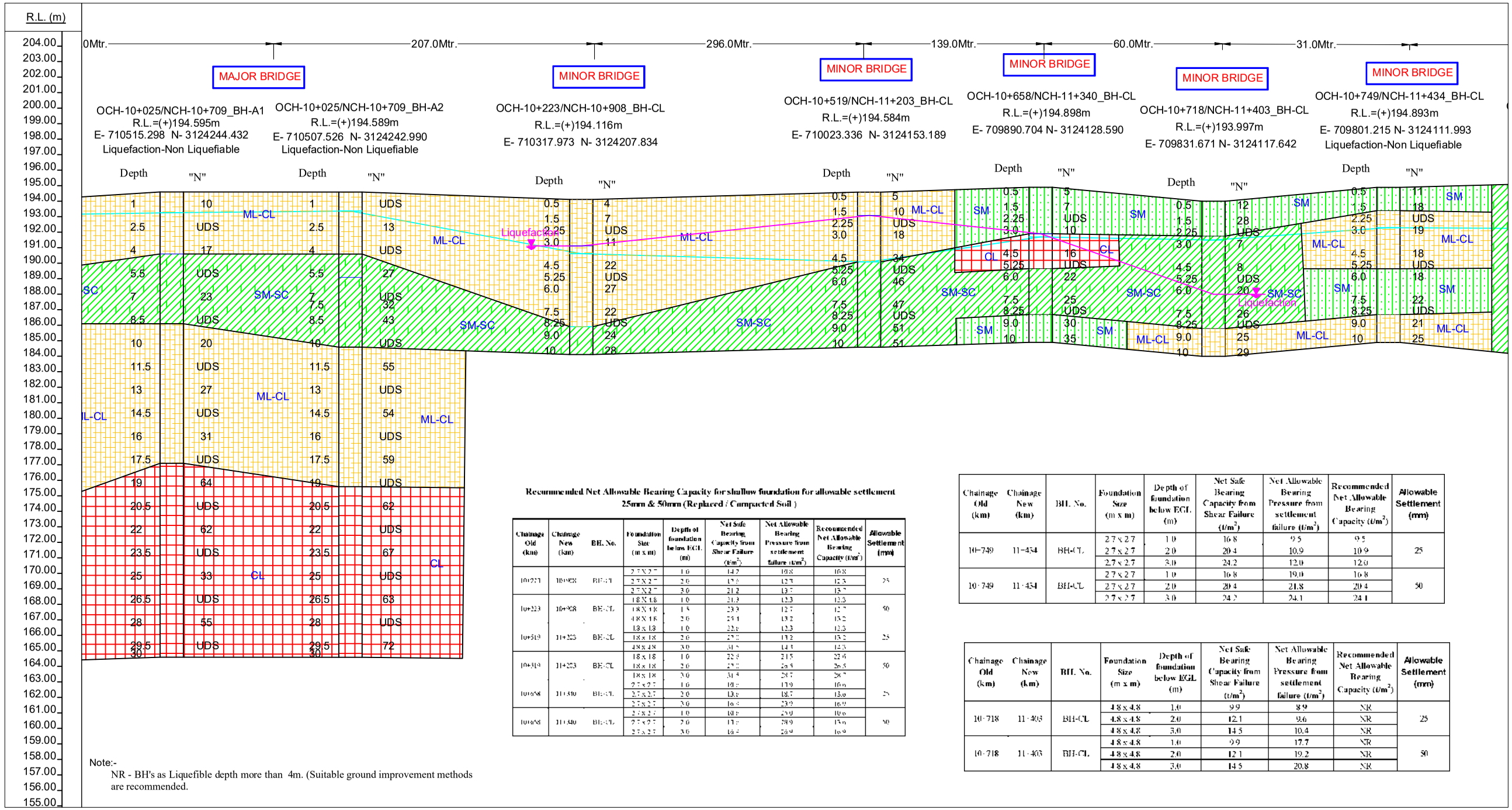
Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
9+211	9-894	BH-CL	6.0 x 6.0	1.0	22.6	9.3	9.3	25
			6.0 x 6.0	2.0	26.5	9.9	9.9	
			6.0 x 6.0	3.0	30.5	10.6	10.6	
9+211	9-894	BH-CL	6.0 x 6.0	1.0	22.6	18.7	18.7	50
			6.0 x 6.0	2.0	26.5	19.8	19.8	
			6.0 x 6.0	3.0	30.5	21.2	21.2	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
9+200	9-882	BH-CL	2.7 X 2.7	1.0	4.0	8.3	NR	25
			2.7 X 2.7	2.0	6.2	9.6	NR	
			2.7 X 2.7	3.0	8.7	10.6	NR	
9+200	9-882	BH-CL	2.7 X 2.7	1.0	4.0	16.7	NR	50
			2.7 X 2.7	2.0	6.2	19.2	NR	
			2.7 X 2.7	3.0	8.7	21.2	NR	
9+407	10+091	BH-CL	3.7 X 3.7	1.0	3.6	5.6	NR	25
			3.7 X 3.7	2.0	3.9	6.2	NR	
			3.7 X 3.7	3.0	4.3	6.7	NR	
9+407	10+091	BH-CL	3.7 X 3.7	1.0	3.6	11.1	NR	50
			3.7 X 3.7	2.0	3.9	12.4	NR	
			3.7 X 3.7	3.0	4.3	13.4	NR	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
10+223	10+908	BH-CL	2.7 X 2.7	1.0	14.2	10.8	10.8	25
			2.7 X 2.7	2.0	17.6	12.3	12.3	
			2.7 X 2.7	3.0	21.2	13.7	13.7	
10+223	10+908	BH-CL	1.8 X 1.8	1.0	21.3	12.3	12.3	50
			1.8 X 1.8	1.5	23.3	12.7	12.7	
			1.8 X 1.8	2.0	25.1	13.2	13.2	
10+519	11+225	BH-CL	1.8 x 1.8	1.0	22.6	12.3	12.3	25
			1.8 x 1.8	2.0	27.2	13.2	13.2	
			1.8 x 1.8	3.0	31.5	14.3	14.3	
10+519	11+225	BH-CL	1.8 x 1.8	1.0	22.9	21.5	22.9	50
			1.8 x 1.8	2.0	27.2	26.5	26.5	
			1.8 x 1.8	3.0	31.4	28.7	28.7	
10+658	11+340	BH-CL	2.7 x 2.7	1.0	10.6	17.9	10.6	25
			2.7 x 2.7	2.0	13.6	18.5	13.6	
			2.7 x 2.7	3.0	16.5	23.0	16.5	
10+658	11+340	BH-CL	2.7 x 2.7	1.0	10.6	29.9	10.6	50
			2.7 x 2.7	2.0	13.6	28.9	13.6	
			2.7 x 2.7	3.0	16.5	26.9	16.5	

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
10+749	11+434	BH-CL	2.7 x 2.7	1.0	16.8	9.5	9.5	25
			2.7 x 2.7	2.0	20.4	10.9	10.9	
			2.7 x 2.7	3.0	24.2	12.0	12.0	
10+749	11+434	BH-CL	2.7 x 2.7	1.0	16.8	19.0	16.8	50
			2.7 x 2.7	2.0	20.4	21.8	20.4	
			2.7 x 2.7	3.0	24.2	24.1	24.1	

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
10+718	11+403	BH-CL	4.8 x 4.8	1.0	9.9	8.9	NR	25
			4.8 x 4.8	2.0	12.1	9.6	NR	
			4.8 x 4.8	3.0	14.5	10.4	NR	
10+718	11+403	BH-CL	4.8 x 4.8	1.0	9.9	17.7	NR	50
			4.8 x 4.8	2.0	12.1	19.2	NR	
			4.8 x 4.8	3.0	14.5	20.8	NR	

Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
10+025	10+709	BH-A1	7.2 X 7.2	2.0	14.5	8.0	8.0	25
			7.2 X 7.2	3.0	16.3	8.4	8.4	
			7.2 X 7.2	4.0	18.2	8.9	8.9	
10+025	10+709	BH-A1	7.2 X 7.2	2.0	14.5	15.9	14.5	50
			7.2 X 7.2	3.0	16.3	16.8	16.3	
			7.2 X 7.2	4.0	18.2	17.7	17.7	
10+025	10+709	BH-A2	7.2 X 7.2	2.0	17.5	12.8	12.8	25
			7.2 X 7.2	3.0	19.5	13.5	13.5	
			7.2 X 7.2	4.0	21.6	14.3	14.3	
10+025	10+709	BH-A2	7.2 X 7.2	2.0	17.5	25.7	17.5	50
			7.2 X 7.2	3.0	19.5	27.0	19.5	
			7.2 X 7.2	4.0	21.6	28.6	21.6	

SYMBOL	DESCRIPTION		
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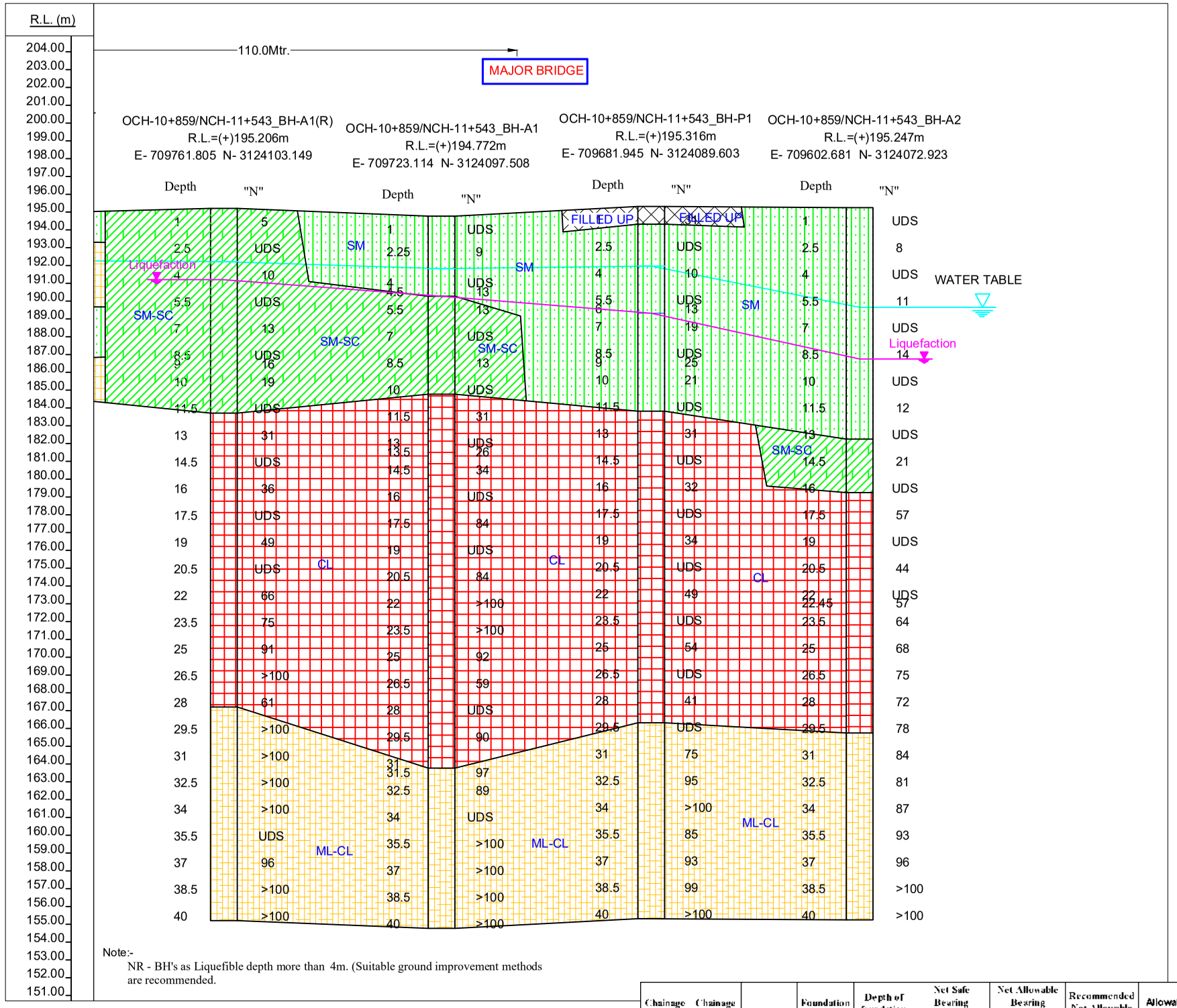
	CL-Silty Clay of low plasticity (Above A-line, LL<35)		
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)		LIQUEFACTION
	BOREHOLE REQUIRED		WATER TABLE
Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)	SCALE:- HOR:- 1:2850	SCALE:- VER:- 1:285	

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
10+859	11+543	BH-A1(R)	7.2 x 7.2	2.0	15.8	8.4	8.4	25
			7.2 x 7.2	3.0	18.5	9.0	9.0	
			7.2 x 7.2	4.0	21.2	9.8	9.8	
10+859	11+543	BH-A1(R)	7.2 x 7.2	2.0	15.8	16.8	15.8	50
			7.2 x 7.2	3.0	18.5	18.0	18.0	
			7.2 x 7.2	4.0	21.2	19.7	19.7	

Chainage Old (km)	Chainage New (km)	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)	Allowable Settlement (mm)
10+859	11+543	BH-A1	7.2 X 7.2	2.0	9.1	10.7	NR	25
			7.2 X 7.2	3.0	11.2	11.5	NR	
			7.2 X 7.2	4.0	13.3	12.7	NR	
10+859	11+543	BH-A1	7.2 X 7.2	2.0	11.7	10.7	NR	50
			7.2 X 7.2	3.0	13.4	11.5	NR	
			7.2 X 7.2	4.0	15.2	12.7	NR	
10+859	11+543	BH-P1	7.2 X 7.2	2.0	9.1	7.0	NR	25
			7.2 X 7.2	3.0	11.3	7.3	NR	
			7.2 X 7.2	4.0	13.4	7.6	NR	
10+859	11+543	BH-P1	7.2 X 7.2	2.0	9.1	14.0	NR	50
			7.2 X 7.2	3.0	11.3	15.0	NR	
			7.2 X 7.2	4.0	13.4	16.3	NR	
10+859	11+543	BH-A2	7.2 X 7.2	2.0	9.7	3.8	NR	25
			7.2 X 7.2	3.0	12.0	3.9	NR	
			7.2 X 7.2	4.0	14.3	4.1	NR	
10+859	11+543	BH-A2	7.2 X 7.2	2.0	9.7	7.6	NR	50
			7.2 X 7.2	3.0	12.0	8.0	NR	
			7.2 X 7.2	4.0	14.3	8.4	NR	

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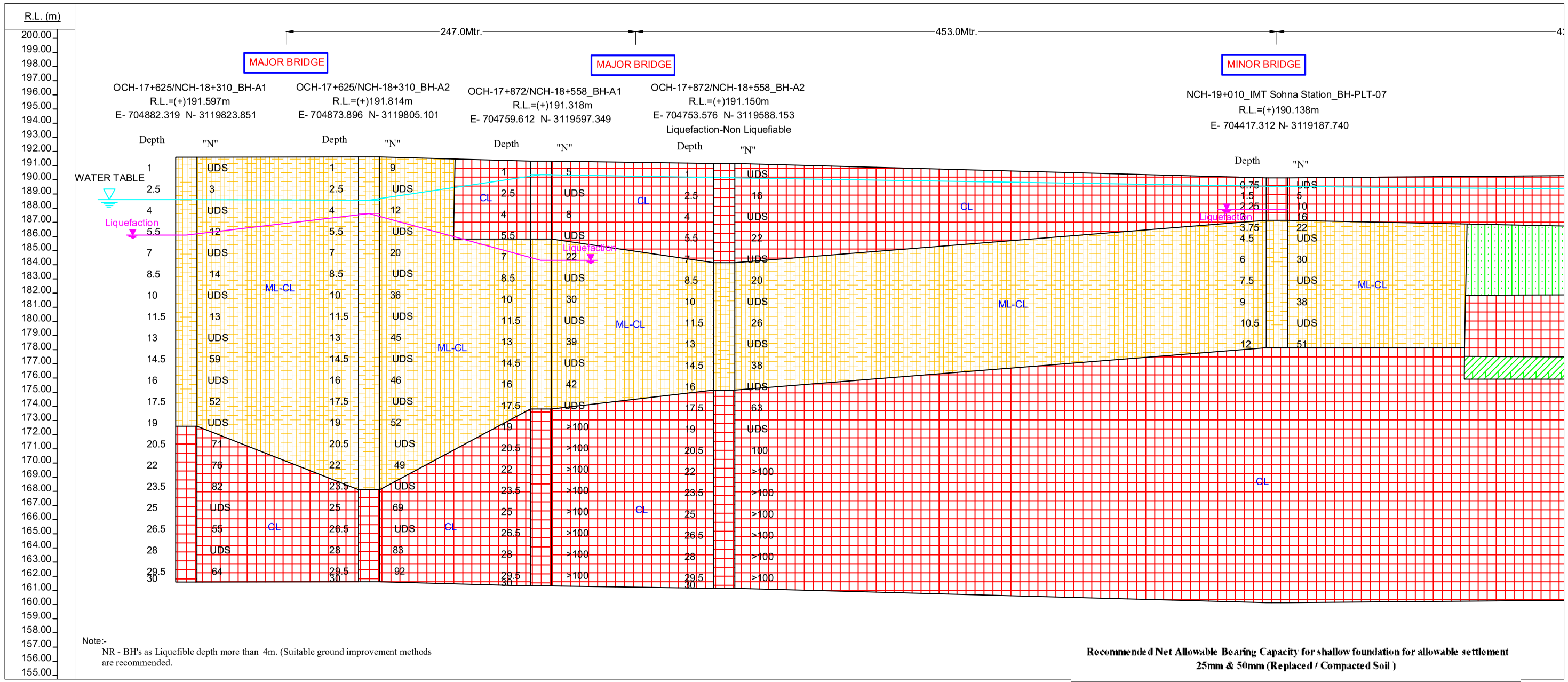
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Note:-
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Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
17+625	18+310	BH-A1	7.2 X 7.2	2.0	17.8	7.5	NR	25
			7.2 X 7.2	3.0	20.1	7.9	NR	
			7.2 X 7.2	4.0	22.5	8.4	NR	
17+625	18+310	BH-A1	7.2 X 7.2	2.0	17.8	15.0	NR	50
			7.2 X 7.2	3.0	20.1	15.9	NR	
			7.2 X 7.2	4.0	22.5	16.8	NR	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
17+625	18+310	BH-A2	7.2 x 7.2	2.0	37.1	13.5	13.5	25
			7.2 x 7.2	3.0	42.7	13.5	13.5	
			7.2 x 7.2	4.0	48.6	13.0	13.0	
17+625	18+310	BH-A2	7.2 x 7.2	2.0	37.1	27.0	27.0	50
			7.2 x 7.2	3.0	42.7	27.0	27.0	
			7.2 x 7.2	4.0	48.6	26.1	26.1	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
17+872	18+558	BH-A1	7.2 X 7.2	2.0	6.3	6.4	NR	25
			7.2 X 7.2	3.0	6.6	8.2	NR	
			7.2 X 7.2	4.0	6.9	12.3	NR	
17+872	18+558	BH-A1	7.2 X 7.2	2.0	6.3	12.7	NR	50
			7.2 X 7.2	3.0	6.6	16.4	NR	
			7.2 X 7.2	4.0	6.9	24.6	NR	
17+872	18+558	BH-A2	7.2 X 7.2	2.0	18.4	11.8	11.8	25
			7.2 X 7.2	3.0	19.0	10.9	10.9	
			7.2 X 7.2	4.0	19.7	10.6	10.6	
17+872	18+558	BH-A2	7.2 X 7.2	2.0	18.4	21.2	18.4	50
			7.2 X 7.2	3.0	19.0	21.7	19.0	
			7.2 X 7.2	4.0	19.7	22.1	19.7	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
-	19+010	BH-PLT-07	4.8 x 4.8	1.0	11.2	11.5	11.2	25
			4.8 x 4.8	2.0	12.3	12.5	12.3	
			4.8 x 4.8	3.0	13.4	13.5	13.4	
-	19+010	BH-PLT-07	4.8 x 4.8	1.0	11.2	23.0	11.2	50
			4.8 x 4.8	2.0	12.3	24.9	12.3	
			4.8 x 4.8	3.0	13.4	27.0	13.4	

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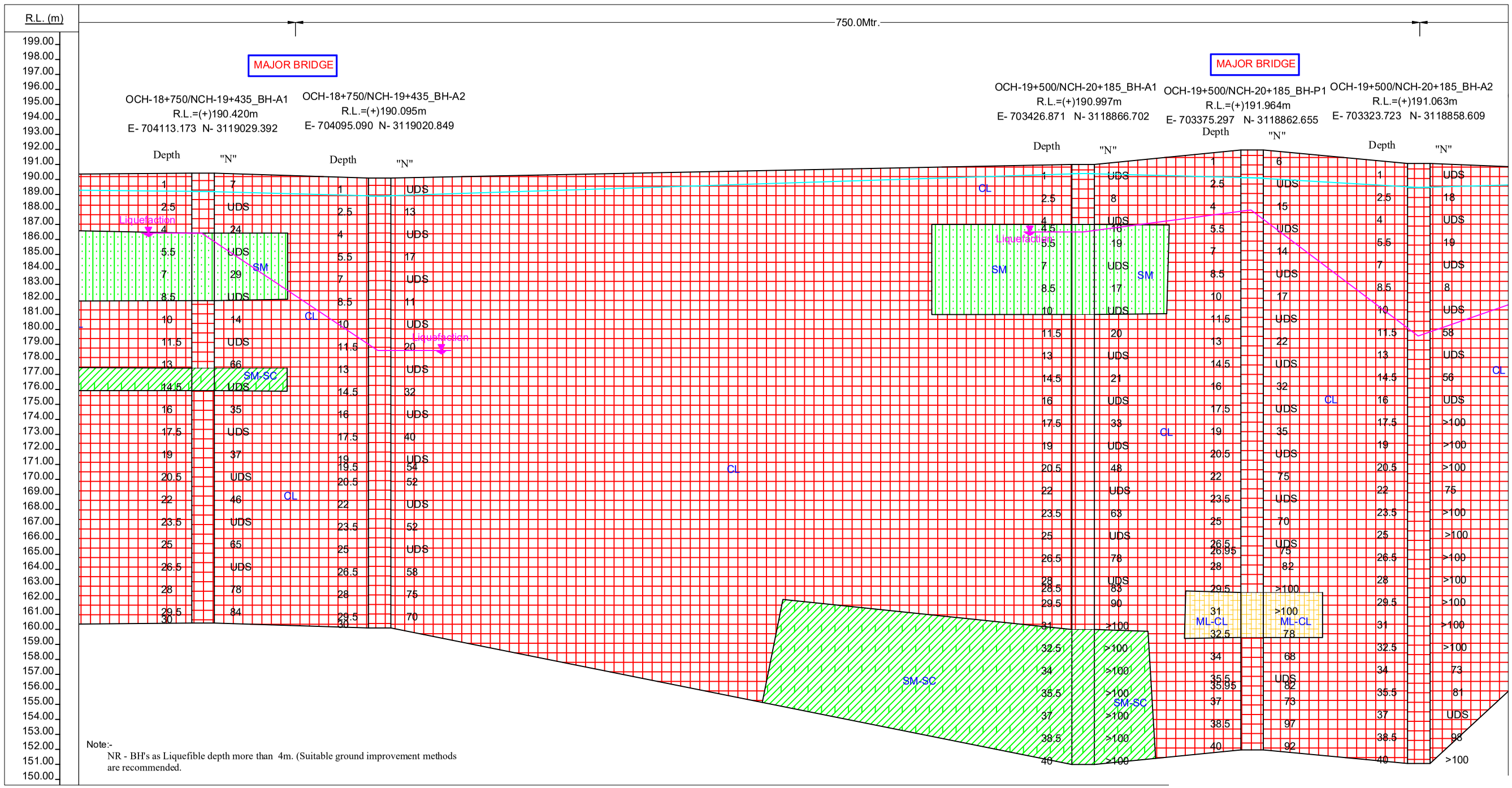
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
18+750	19+435	BH-A1	7.2 x 7.2	2.0	17.8	23.5	17.8	25
			7.2 x 7.2	3.0	21.2	24.8	21.2	
			7.2 x 7.2	4.0	24.8	26.2	24.8	
18+750	19+435	BH-A1	7.2 x 7.2	2.0	17.8	47.0	17.8	50
			7.2 x 7.2	3.0	21.2	49.5	21.2	
			7.2 x 7.2	4.0	24.8	52.3	24.8	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
18+750	19+435	BH-A2	7.2 X 7.2	2.0	10.5	8.9	NR	25
			7.2 X 7.2	3.0	11.0	8.4	NR	
			7.2 X 7.2	4.0	11.4	9.3	NR	
18+750	19+435	BH-A2	7.2 X 7.2	2.0	10.5	15.5	NR	50
			7.2 X 7.2	3.0	11.0	16.8	NR	
			7.2 X 7.2	4.0	11.4	18.6	NR	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
19+500	20+185	BH-A1	7.2 X 7.2	2.0	7.0	6.8	NR	25
			7.2 X 7.2	3.0	7.3	8.4	NR	
			7.2 X 7.2	4.0	7.6	11.0	NR	
19+500	20+185	BH-A1	7.2 X 7.2	2.0	7.0	13.5	NR	50
			7.2 X 7.2	3.0	7.3	16.8	NR	
			7.2 X 7.2	4.0	7.6	22.0	NR	
19+500	20+185	BH-A2	7.2 X 7.2	2.0	15.0	30.9	NR	25
			7.2 X 7.2	3.0	15.5	32.6	NR	
			7.2 X 7.2	4.0	16.1	34.4	NR	
19+500	20+185	BH-A2	7.2 X 7.2	2.0	15.0	61.9	NR	50
			7.2 X 7.2	3.0	15.5	65.2	NR	
			7.2 X 7.2	4.0	16.1	68.9	NR	

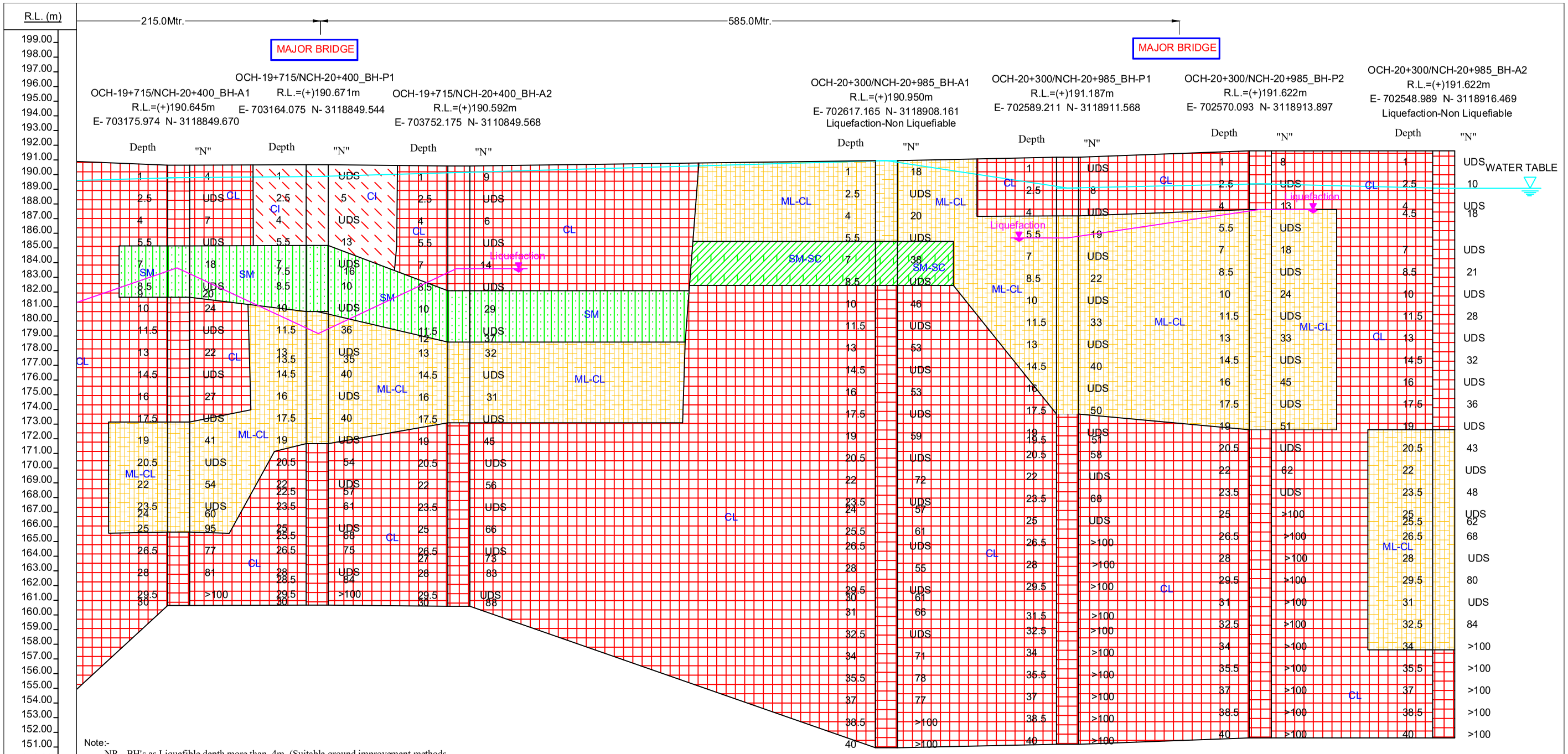
Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
19+500	20+185	BH-P1	7.2 X 7.2	2.0	21.7	7.0	7.0	25
			7.2 X 7.2	3.0	23.5	6.9	6.9	
			7.2 X 7.2	4.0	26.1	6.9	6.9	
19+500	20+185	BH-P1	7.2 X 7.2	2.0	21.7	14.0	14.0	50
			7.2 X 7.2	3.0	23.5	13.9	13.9	
			7.2 X 7.2	4.0	26.1	13.7	13.7	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50) — LIQUEFACTION
	BOREHOLE REQUIRED — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Note:-
NR - BH's as Liquefible depth more than 4m. (Suitable ground improvement methods are recommended.

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
19+715	20+400	BH-A1	7.2 X 7.2	2.0	17.8	4.5	NR	25
			7.2 X 7.2	3.0	21.7	5.3	NR	
			7.2 X 7.2	4.0	25.8	6.6	NR	
19+715	20+400	BH-A1	7.2 X 7.2	2.0	17.8	8.9	NR	50
			7.2 X 7.2	3.0	21.7	10.5	NR	
			7.2 X 7.2	4.0	25.8	13.2	NR	
19+715	20+400	BH-P1	7.2 X 7.2	2.0	13.0	4.7	NR	25
			7.2 X 7.2	3.0	16.0	6.3	NR	
			7.2 X 7.2	4.0	19.0	10.1	NR	
19+715	20+400	BH-P1	7.2 X 7.2	2.0	13.0	9.5	NR	50
			7.2 X 7.2	3.0	16.0	12.5	NR	
			7.2 X 7.2	4.0	19.0	20.1	NR	
19+715	20+400	BH-A2	7.2 X 7.2	2.0	10.9	6.1	NR	25
			7.2 X 7.2	3.0	11.4	6.7	NR	
			7.2 X 7.2	4.0	11.8	7.3	NR	
19+715	20+400	BH-A2	7.2 X 7.2	2.0	10.9	12.2	NR	50
			7.2 X 7.2	3.0	11.4	13.3	NR	
			7.2 X 7.2	4.0	11.8	14.6	NR	

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
20+300	20+985	BH-A1	7.2 X 7.2	2.0	28.1	15.1	15.1	25
			7.2 X 7.2	3.0	31.9	17.4	17.4	
			7.2 X 7.2	4.0	35.7	20.7	20.7	
20+300	20+985	BH-A1	7.2 X 7.2	2.0	28.1	30.2	28.1	50
			7.2 X 7.2	3.0	31.9	34.9	30.0	
			7.2 X 7.2	4.0	35.7	41.4	30.0	
20+300	20+985	BH-P1	7.2 X 7.2	2.0	22.3	8.5	NR	25
			7.2 X 7.2	3.0	25.2	10.2	NR	
			7.2 X 7.2	4.0	28.2	10.8	NR	
20+300	20+985	BH-P1	7.2 X 7.2	2.0	22.3	16.9	NR	50
			7.2 X 7.2	3.0	25.2	20.4	NR	
			7.2 X 7.2	4.0	28.2	21.6	NR	
20+300	20+985	BH-A2	7.2 X 7.2	2.0	16.4	13.8	13.8	25
			7.2 X 7.2	3.0	17.0	14.5	14.5	
			7.2 X 7.2	4.0	17.6	15.3	15.3	
20+300	20+985	BH-A2	7.2 X 7.2	2.0	16.4	27.5	16.4	50
			7.2 X 7.2	3.0	17.0	29.0	17.0	
			7.2 X 7.2	4.0	17.6	30.6	17.6	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m²)	Net Allowable Bearing Pressure from settlement failure (t/m²)	Recommended Net Allowable Bearing Capacity (t/m²)	Allowable Settlement (mm)
20+300	20+985	BH-P2	7.2 X 7.2	2.0	17.1	13.9	13.9	25
			7.2 X 7.2	3.0	19.2	14.5	14.5	
			7.2 X 7.2	4.0	21.5	14.7	13.7	
20+300	20+985	BH-P2	7.2 X 7.2	2.0	17.1	27.8	17.1	50
			7.2 X 7.2	3.0	19.2	29.1	16.2	
			7.2 X 7.2	4.0	21.5	29.3	21.5	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
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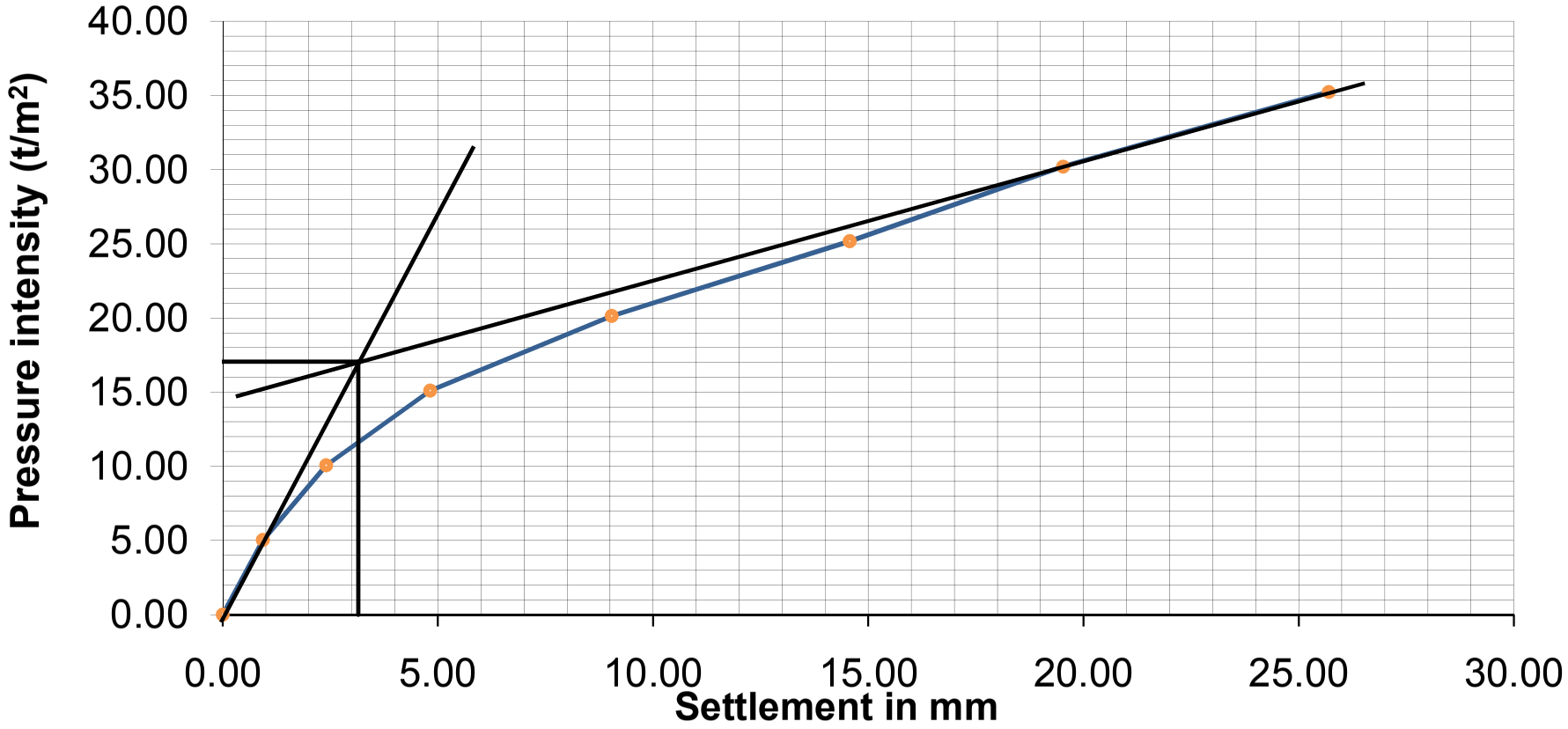
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	LIQUEFACTION
	BOREHOLE REQUIRED
	WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 | SCALE:- VER:- 1:285



Test Depth = 2.70m below NGL

Size of Plate = 450mm x 450mm, Thickness of Plate = 25mm

Ultimate Bearing Capacity of Soil = 17.05t/m^2 w.r.t. settlement of 3.15mm from the graph

Net Safe Bearing Capacity of Soil = 17.05/2.5 = 6.82 t/m^2

APPENDIX – B (LAB TEST RESULTS)

Appendix No.	ITEMS
B-1	SOIL CHARACTERISTICS SHEETS
B-2	RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES
B-3	RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLES
B-4	GSD CURVES
B-5	SHEAR CURVE
B-6	CONSOLIDATION CURVE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							23-12-2021	to	23-12-2021	New Ch. 0+000 Prithla Station		BH-PLT-09		Not Encountered		12.00 m		720981.000 m			3126079.000 m			(+)195.456 m		SR-544_21-22			

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brownish, Medium dnese, Sandy Silt	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	0.75	-	-		ML-CL		6	50	38	5	1	0	0	26	19	7	-	1.64	10.80	1.48	2.62	DST	0.15	26	-	-	-	-	-	-	-	-
SPT-1	1.50	3	4		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	2.25	5	7		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	12	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	3.75	17	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.50	-	-		ML-CL		6	51	37	5	1	0	0	26	19	7	-	1.67	11.20	1.50	2.62	DST	0.18	27	-	-	-	-	-	-	-	-
SPT-5	6.00	22	21	Brownish, Medium dense to Dense, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.50	-	-		SM		0	21	71	5	2	1	0	-	Nil	NP	-	1.67	10.40	1.51	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-6	9.00	27	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.50	-	-		SM		0	20	71	4	2	2	0	-	Nil	NP	-	1.70	11.60	1.52	2.63	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-7	12.00	53	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-10-2021	to	14-10-2021	(-)0+627 Minor Bridge	BH-CL	8.50 m	10.00 m	720920.890 m	3126081.947 m	(+)196.408 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense to very dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	20	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	14	80	2	1	3	0	-	Nil	NP	-	1.78	11.20	1.60	2.62	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-2	4.00	28	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	18	70	5	3	4	0	-	Nil	NP	-	1.84	13.40	1.62	2.63	DST	0.00	31	-	-	-	-	-	-	-	-
SPT-3	7.00	41	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	15	72	3	4	6	0	-	Nil	NP	-	1.85	15.64	1.60	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	51	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-10-2021	to	14-10-2021	(-)0+529 Minor Bridge	BH-CL	8.15 m	10.00 m	720826.915 m	3126042.507 m	(+)195.851 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense to dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	19	70	6	2	3	0	-	Nil	NP	-	1.74	11.36	1.56	2.62	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-1	2.50	18	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	20	68	4	3	5	0	-	Nil	NP	-	1.80	12.43	1.60	2.63	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-2	5.50	37	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	17	72	2	3	5	1	-	Nil	NP	-	1.83	14.26	1.60	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	43	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	14	71	6	2	7	0	-	NIL	NP	-	1.86	16.11	1.60	2.62	DST	0.00	31	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		15-10-2021	to	15-10-2021	(-)0+319 Minor Bridge	BH-CL	8.10 m	10.00 m	720635.657 m	3125962.572 m	(+)197.352 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	26	72	1	1	0	0	-	Nil	NP	-	1.79	11.26	1.61	2.62	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-1	2.50	27	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	24	68	4	2	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	23	23	Brown, Very stiff, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		10	55	25	3	2	4	1	32	21	11	-	1.86	18.38	1.57	2.67	UUT	0.79	5	-	-	-	-	-	-	-	-
SPT-3	8.50	36	24	Brown, Dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	19	61	9	5	5	1	-	Nil	NP	-	1.84	16.47	1.58	2.63	DST	0.00	30	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

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		14-10-2021	to	14-10-2021	0+273 Minor Bridge	BH-CL	8.25 m	10.00 m	720089.535 m	3125734.325 m	(+)195.008 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	12	19		SM		0	20	73	2	3	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-	Brown, Medium dense to dense, Sandy silt of low with gravel	ML-CL		7	45	31	6	3	8	0	28	21	7	-	1.85	13.43	1.63	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-2	4.00	39	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	50	30	3	5	5	0	27	20	7	-	1.79	15.30	1.55	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	22	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Dense, Silty sand with gravel	SM		0	18	70	4	2	6	0	-	Nil	NP	-	1.79	15.60	1.55	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-4	10.00	32	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						04-10-2021	to	05-10-2021	1+006 Major Bridge	BH-A1	24.90 m	30.00 m	719415.302 m	3125461.869 m	(+)202.730 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		SM		0	46	48	4	2	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	42	51	4	2	1	0	-	Nil	NP	-	1.67	10.60	1.51	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	44	48	4	2	2	0	-	Nil	NP	-	1.76	11.22	1.58	2.62	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-3	7.00	44	41	Brown, Dense to very dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	32	58	2	2	6	0	-	Nil	NP	-	1.83	12.37	1.63	2.63	DST	0.00	31	-	-	-	-	-	-	-	-
SPT-4	10.00	59	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM		0	23	62	5	3	7	0	-	Nil	NP	-	1.84	12.89	1.63	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	69	50		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		SM		0	26	61	3	2	6	2	-	Nil	NP	-	1.88	13.24	1.66	2.62	DST	0.00	32	-	-	-	-	-	-	-	-
SPT-6	16.00	94	61		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	17.50	100	62		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	49	29	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	52	32	2	2	5	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		8	50	30	3	2	7	0	28	21	7	-	1.88	17.46	1.60	2.66	DST	0.18	27	-	-	-	-	-	-	-	-
SPT-9	22.00	62	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		6	48	29	5	3	8	1	26	20	6	-	1.97	19.10	1.65	2.66	DST	0.18	28	-	-	-	-	-	-	-	-
SPT-10	25.00	100 (17cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	100 (26cm)	-		ML-CL		7	48	30	3	2	10	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		04-10-2021	to	05-10-2021	1+006 Major Bridge	BH-A1	24.90 m	30.00 m	719415.302 m	3125461.869 m	(+)202.730 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	100 (20cm)	-	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	48	48	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	57	21	4	1	6	0	30	20	10	-	1.98	21.00	1.64	2.68	UUT+	1.56	4	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEGTH
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		04-10-2021	to	04-10-2021	1+006 Major Bridge	BH-A2	24.80 m	30.00 m	719396.820 m	3125454.226 m	(+)203.271 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	46	52	2	0	0	0	-	Nil	NP	-	1.62	10.24	1.47	2.62	DST	0.00	27	-	-	-	-	-	-	-	-
SPT-1	2.50	7	9		SM		0	48	51	0	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense, Silty sand with clay	SM-SC		5	43	50	2	0	0	0	26	20	6	-	1.70	12.07	1.52	2.64	DST	0.06	28	-	-	-	-	-	-	-	-
SPT-2	5.50	14	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM-SC		6	40	49	2	2	1	0	25	19	6	-	1.74	12.84	1.54	2.65	DST	0.09	29	-	-	-	-	-	-	-	-
SPT-3	8.50	20	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense, Silty sand with clay	SM-SC		5	43	43	3	2	4	0	26	21	5	-	1.82	13.74	1.60	2.65	DST	0.11	31	-	-	-	-	-	-	-	-
SPT-4	11.50	42	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Very dense, Silty sand with clay with gravel	SM-SC		5	38	45	6	1	5	0	26	20	6	-	1.92	14.69	1.67	2.66	DST	0.10	32	-	-	-	-	-	-	-	-
SPT-5	14.50	96	66		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	100 (29cm)	-		SM-SC		7	40	40	4	1	8	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	17.50	72	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	19.00	-	-		SM-SC		6	38	46	3	1	6	0	26	20	6	-	1.90	15.72	1.64	2.65	DST	0.08	32	-	-	-	-	-	-	-	-
SPT-8	20.50	84	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	22.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.45	35	35	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	54	23	5	2	4	0	33	22	11	-	1.94	19.50	1.62	2.68	UUT+	1.29	4	-	-	-	-	-	-	-	-
SPT-10	23.50	43	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.45	54	21		ML-CL		8	44	37	3	1	7	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	26.50	76	27	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	47	32	4	2	6	2	27	20	7	-	1.92	20.00	1.60	2.66	DST+	0.22	26	-	-	-	-	-	-	-	-
UDS*	28.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.45	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	64	64	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	60	21	3	1	5	0	30	20	10	-	2.02	21.00	1.67	2.67	UUT+	2.05	4	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						15-10-2021	to	15-10-2021	1+333 Minor Bridge	BH-CL	Not Encountered	10.00 m	719094.132 m	3125351.606 m	(+)202.117 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	20	73	2	1	4	0	-	Nil	NP	-	1.80	10.43	1.63	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-1	2.50	35	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	19	68	4	3	5	1	-	Nil	NP	-	1.81	11.56	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	17	70	5	2	4	2	-	Nil	NP	-	1.82	12.40	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	48	48	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	53	26	3	4	4	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		11	47	28	5	3	5	1	32	21	11	-	1.89	16.22	1.63	2.67	UUT	1.58	5	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							15-10-2021	to	15-10-2021	1+811 Minor Bridge		BH-CL		9.10 m		10.00 m		718661.831 m			3125172.851 m			(+)197.587 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	13	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	18	71	6	3	2	0	-	Nil	NP	-	1.72	11.26	1.55	2.62	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	4.00	33	37	Brown, Dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	13	76	4	2	5	0	-	Nil	NP	-	1.82	13.19	1.61	2.63	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-3	7.00	30	28	Brown, Medium dense, Sandy silt of low plasticity with gravel	ML-CL		7	47	35	4	2	5	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		6	49	31	5	3	4	2	26	20	6	-	1.87	17.14	1.60	2.66	DST	0.21	25	-	-	-	-	-	-	-	-
SPT-4	10.00	54	30	Brown, Very dense, Silty sand with gravel	SM		0	17	70	2	3	8	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							16-10-2021	to	16-10-2021	2+472 Minor Bridge	BH-CL	7.50 m	10.00 m	718027.804 m	3124979.104 m	(+)197.568 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	11	17		SM-SC		5	32	51	10	2	0	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		4	35	47	9	4	1	0	25	20	5	-	1.72	11.60	1.54	2.65	DST	0.08	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	27	30	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		6	49	35	4	2	4	0	27	20	7	-	1.83	14.49	1.60	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	36	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	52	29	5	2	5	0	27	20	7	-	1.91	18.60	1.61	2.66	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-4	10.00	60	33	Brown, Very dense, Silty sand with gravel	SM		0	22	69	2	1	6	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		03-10-2021	to	04-10-2021	2+788 Major Bridge	BH-A1	18.24 m	30.00 m	717723.179 m	3124953.799 m	(+)195.987 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	11	18		SM		0	38	60	2	0	0	0	0	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	37	62	1	0	0	0	-	Nil	NP	-	1.71	11.36	1.54	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Very dense, Silty sand with gravel	SM		0	28	64	2	1	5	0	0	Nil	NP	-	1.84	12.40	1.64	2.63	DST	0.00	32	-	-	-	-	-	-	-	-	-
SPT-3	7.00	54	50		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	27	60	3	2	8	0	0	Nil	NP	-	1.87	12.85	1.66	2.62	DST	0.00	32	-	-	-	-	-	-	-	-	-
SPT-4	10.00	84	68		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM		0	30	58	4	2	6	0	0	Nil	NP	-	1.86	13.45	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	71	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		6	46	42	2	1	3	0	26	20	6	-	1.80	16.30	1.55	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-6	16.00	31	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	18.00	43	26		ML-CL		7	64	21	3	1	4	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	46	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		7	59	26	2	1	4	1	27	20	7	-	1.88	19.63	1.57	2.66	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-9	22.00	55	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		8	55	23	6	2	6	0	28	21	7	-	1.88	20.30	1.56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	48	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		03-10-2021	to	04-10-2021	2+788 Major Bridge	BH-A1	18.24 m	30.00 m	717723.179 m	3124953.799 m	(+)195.987 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-8	26.50	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		7	55	26	4	3	5	0	26	19	7	-	1.90	19.80	1.59	2.67	DST	0.20	28	-	-	-	-	-	-	-	-
SPT-11	27.00	65	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	75	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	80	28		ML-CL		7	55	28	2	2	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

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		03-10-2021	to	04-10-2021	2+788 Major Bridge	BH-A2	17.68 m	30.00 m	717703.270 m	3124952.116 m	(+)196.902 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	41	52	4	1	2	0	0	Nil	NP	-	1.79	11.60	1.60	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-1	2.50	22	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	25	67	4	1	2	1	0	Nil	NP	-	1.79	12.10	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Very dense, Silty sand with gravel	SM		0	27	60	5	2	6	0	0	Nil	NP	-	1.86	13.44	1.64	2.63	DST	0.00	32	-	-	-	-	-	-	-	-	-
SPT-3	8.50	59	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	34	56	3	2	5	0	0	Nil	NP	-	1.86	13.60	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	64	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		7	50	32	4	3	3	1	27	20	7	-	1.82	16.48	1.56	2.66	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-5	14.50	33	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	53	33	2	1	4	0	26	20	6	-	1.83	17.34	1.56	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	32	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		8	52	30	5	2	3	0	28	21	7	-	1.84	19.70	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	36	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		6	52	31	3	1	7	0	25	19	6	-	1.93	20.04	1.61	2.66	DST	0.19	28	-	-	-	-	-	-	-	-	-
SPT-8	23.50	83	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		7	46	28	4	5	10	0	26	20	6	-	1.93	19.88	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.50	70	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		03-10-2021	to	04-10-2021	2+788 Major Bridge	BH-A2	17.68 m	30.00 m	717703.270 m	3124952.116 m	(+)196.902 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	26.50	76	28	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.00	100 (17cm)	-		ML-CL		7	46	34	3	1	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	78	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Abbreviations:-
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-10-2021	to	22-10-2021	3+497 Major Bridge	BH-A1	16.25 m	40.00 m	717079.294 m	3124900.291 m	(+)196.752 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %			Shrinkage Limit	Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index						Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	49	29	13	3	0	0	28	21	7	-	1.64	12.10	1.46	2.66	DST	0.21	22	-	-	-	-	-	-	-	-	-
SPT-2	4.00	21	21	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	62	17	5	3	2	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		9	61	19	6	2	3	0	30	20	10	-	1.82	15.26	1.58	2.68	UUT	0.85	4	-	-	-	-	-	-	-	-	-
SPT-3	7.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Very dense, Silty sand with gravel	SM		0	28	57	10	1	4	0	-	Nil	NP	-	1.80	11.24	1.62	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-4	10.00	53	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Very stiff to hard, Silty clay of low plasticity	CL		9	59	21	7	1	3	0	31	21	10	-	1.80	16.37	1.55	2.67	UUT	0.72	5	-	-	-	0.725	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.51 6.02 5.13 4.52	1.76 1.54 1.05 0.65	0.140
SPT-5	13.00	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		11	60	17	6	2	4	0	32	21	11	-	1.88	17.46	1.60	2.67	UUT	1.13	5	-	-	-	-	-	-	-	-	-
SPT-6	16.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	50	27	4	3	9	0	27	20	7	-	1.89	19.93	1.58	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	61	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		6	50	30	6	2	6	0	26	20	6	-	1.92	20.04	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	77	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		7	45	32	5	4	5	2	27	20	7	-	1.90	20.10	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	57	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		8	52	27	3	4	6	0	28	21	7	-	1.90	20.20	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-10-2021	to	22-10-2021	3+497 Major Bridge	BH-A1	16.25 m	40.00 m	717079.294 m	3124900.291 m	(+)196.752 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
SPT-10	28.00	62	24	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	29.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	52	16	7	5	8	0	33	22	11	-	2.04	20.74	1.69	2.68	UUT	2.51	5	-	-	-	-	-	-	-	-	-
SPT-11	31.00	79	79		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	32.50	-	-		CL		10	44	18	12	9	7	0	30	20	10	-	2.05	20.60	1.70	2.67	UUT	3.12	4	-	-	-	-	-	-	-	-	-
SPT-12	34.00	83	83		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	100 (21cm)	100 (21cm)		CL		11	49	16	13	3	6	2	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	37.00	85	85		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	95	95		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	98	98		CL		12	46	19	7	4	10	2	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						20-10-2021	to	22-10-2021	3+497 Major Bridge	BH-P1	15.32 m	40.00 m	717042.421 m	3124897.227 m	(+)195.783 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %			Shrinkage Limit	Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index						Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	45	28	9	6	5	0	27	20	7	-	1.82	12.04	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	2.50	45	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	52	30	4	3	4	1	26	20	6	-	1.81	12.49	1.61	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-2	5.50	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Very dense, Silty sand with gravel	SM		0	13	58	14	8	7	0	-	Nil	NP	-	1.80	11.41	1.62	2.63	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-3	8.50	55	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	22	64	6	2	6	0	-	Nil	NP	-	1.81	11.80	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	51	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		8	55	23	9	5	0	0	28	21	7	-	1.83	15.26	1.59	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-5	14.50	40	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	16.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	68	30	Brown, Very dense, Silty sand with gravel	SM		0	21	61	7	2	7	2	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	19.00	-	-		SM		0	37	50	4	1	8	0	-	Nil	NP	-	1.86	16.03	1.60	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-7	20.50	59	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	22.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		13	45	16	8	8	10	0	34	23	11	-	2.02	21.98	1.66	2.68	UUT	1.96	5	-	-	-	-	-	-	-	-	-
SPT-8	23.50	57	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		CL		11	53	18	6	3	7	2	32	21	11	-	2.02	21.70	1.66	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	61	61		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-10-2021	to	22-10-2021	3+497 Major Bridge	BH-P1	15.32 m	40.00 m	717042.421 m	3124897.227 m	(+)195.783 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
UDS-9	28.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	47	15	11	3	12	0	33	22	11	-	2.02	22.14	1.65	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	50	50		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	31.00	-	-		CL		13	53	19	4	2	9	0	34	23	11	-	2.02	20.97	1.67	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	32.50	65	65		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	34.00	-	-		CL		12	56	13	8	2	9	0	33	22	11	-	2.03	20.86	1.68	2.67	UUT	2.41	5	-	-	-	-	-	-	-	-
SPT-12	35.50	76	76		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	37.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	38.50	95	95		CL		11	54	17	6	4	8	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	40.00	100	100		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-10-2021	to	22-10-2021	3+497 Major Bridge	BH-P2	15.30 m	40.00 m	717007.541 m	3124894.329 m	(+)195.847 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %			Shrinkage Limit	Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index						Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	7	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	44	37	11	1	0	0	27	21	6	-	1.66	12.06	1.48	2.66	DST	0.18	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	17	19	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	29	49	18	1	3	0	-	Nil	NP	-	1.72	11.87	1.54	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	7.00	19	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	32	57	7	2	2	0	-	Nil	NP	-	1.73	12.10	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	23	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM		0	26	64	3	4	3	0	-	Nil	NP	-	1.74	12.31	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	20	20	Brown, Very stiff, Silty clay of low plasticity	CL		11	62	17	4	3	3	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		10	59	19	6	2	4	0	31	20	11	-	1.82	16.74	1.56	2.67	UUT	0.75	5	-	-	-	0.715	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.71 6.26 5.54 4.50	2.25 1.55 1.03 0.67	0.1430
SPT-6	16.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		7	46	26	10	3	7	1	27	21	6	-	1.87	19.40	1.57	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	60	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		6	54	29	3	4	4	0	26	20	6	-	1.89	21.04	1.56	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-8	22.00	38	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	59	11	7	4	8	0	32	21	11	-	2.00	23.30	1.62	2.68	UUT	1.49	5	-	-	-	-	-	-	-	-	-
SPT-9	25.00	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		CL		12	58	16	3	5	6	0	33	22	11	-	2.01	23.17	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-10-2021	to	22-10-2021	3+497 Major Bridge	BH-P2	15.30 m	40.00 m	717007.541 m	3124894.329 m	(+)195.847 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %			Shrinkage Limit	Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index						Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	48	48	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	29.50	-	-		CL		11	55	19	7	2	4	2	31	20	11	-	2.02	21.79	1.66	2.67	UUT	2.02	5	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	63	63		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	32.50	-	-		CL		10	53	22	3	4	8	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	34.00	97	32	Brown, Very dense, Silty sand with clay & gravel	SM-SC		4	35	40	10	11	0	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	37.00	90	29		SM-SC		5	40	42	3	8	2	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	28	64	8	0	0	0	-	Nil	NP	-	1.68	11.46	1.51	2.63	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.50	11	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense, Silty sand	SM		0	22	70	4	2	2	0	-	Nil	NP	-	1.75	12.06	1.56	2.62	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	18	68	7	4	2	1	-	Nil	NP	-	1.75	12.20	1.56	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	25	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	57	20	5	2	4	0	33	22	11	-	1.86	16.24	1.60	2.67	UUT	1.00	5	-	-	-	-	-	-	-	-
SPT-4	11.50	28	28	Brown, Very stiff to hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		11	59	18	7	1	4	0	32	21	11	-	1.87	17.10	1.60	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	50	27	6	2	6	1	28	21	7	-	1.91	20.74	1.58	2.66	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-6	17.50	56	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	52	30	3	1	7	0	27	20	7	-	1.91	21.19	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	67	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	52	27	3	5	4	2	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	61	61		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	52	16	9	2	9	0	33	22	11	-	2.03	22.10	1.66	2.67	UUT	1.98	5	-	-	-	-	-	-	-	-
SPT-9	26.50	58	58		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	55	19	4	3	7	1	32	21	11	-	2.03	21.48	1.67	2.68	UUT	2.24	5	-	-	-	-	-	-	-	-	-
SPT-10	29.50	70	70		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	31.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.50	80	28	Brown, Very Dense, Sandy silt of low plasticity with gravel	ML-CL		7	49	29	2	2	11	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	91	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	85	29		ML-CL		8	50	26	1	1	14	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	>100	-		ML-CL		7	48	28	3	2	10	2	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							21-10-2021	to	23-10-2021	3+497 Major Bridge	BH-A2	15.30 m	40.00 m	716935.788 m	3124888.367 m	(+)195.643 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	16	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	44	38	10	1	0	0	28	21	7	-	1.79	13.10	1.58	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	26	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Dense to Very dense, Silty sand with gravel	SM		0	25	61	8	2	4	0	-	Nil	NP	-	1.82	12.16	1.62	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-3	7.00	47	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	24	65	4	3	3	1	-	Nil	NP	-	1.81	12.40	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	36	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM		0	26	60	7	2	5	0	-	Nil	NP	-	1.83	13.27	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	60	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		7	49	24	12	1	7	0	27	20	7	-	1.83	16.79	1.57	2.66	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-6	16.00	43	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		6	49	27	6	3	8	1	26	20	6	-	1.94	18.95	1.63	2.66	DST	0.20	29	-	-	-	-	-	-	-	-	-
SPT-7	18.00	65	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	83	34		ML-CL		7	48	23	11	5	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	88	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	97	37		ML-CL		7	51	27	4	3	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	58	58	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	25.00	-	-		CL		11	51	24	3	3	8	0	30	20	10	-	2.01	22.10	1.65	2.67	UUT	1.82	5	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							21-10-2021	to	23-10-2021	3+497 Major Bridge	BH-A2	15.30 m	40.00 m	716935.788 m	3124888.367 m	(+)195.643 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %			Shrinkage Limit	Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index						Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	26.50	50	50	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.00	76	76		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	29.50	-	-		CL		12	49	21	8	1	9	0	33	22	11	-	2.05	20.46	1.70	2.68	UUT	3.15	5	-	-	-	-	-	-	-	-	-
SPT-14	31.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	32.50	100 (25cm)	100 (25cm)		CL		11	48	19	8	3	11	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	34.00	100 (20cm)	100 (20cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.50	100 (20cm)	100 (20cm)		CL		10	47	22	6	4	9	2	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	37.00	100 (17cm)	100 (17cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	38.50	>100	-		CL		11	50	18	7	4	7	3	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	40.00	100 (24cm)	100 (24cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-10-2021	to	25-10-2021	3+691 Major Bridge	BH-A1	15.40 m	30.00 m	716820.675 m	3124880.556 m	(+)196.163 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Brown, Loose, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	41	50	1	2	1	0	25	20	5	-	1.67	11.64	1.50	2.65	DST	0.11	25	-	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	58	29	3	1	2	0	27	20	7	-	1.79	14.26	1.57	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	24	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	56	25	6	2	3	0	28	21	7	-	1.81	15.24	1.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	27	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		7	54	27	7	3	2	0	26	19	7	-	1.81	16.33	1.56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	22	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	57	24	3	1	5	0	31	21	10	-	1.94	19.72	1.62	2.68	UUT	1.36	4	-	-	-	0.655	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	10.09 8.47 7.12 5.76	1.58 1.16 0.81 0.47	0.100
SPT-6	16.00	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	49	21	11	6	5	0	28	21	7	-	1.93	20.40	1.60	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	77	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	81	33		ML-CL		6	51	26	6	3	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	67	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	71	28		ML-CL		7	50	23	9	4	7	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	61	25				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	26.50	-	-		ML-CL		6	54	25	4	2	6	3	26	19	7	-	1.94	20.34	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-10-2021	to	25-10-2021	3+691 Major Bridge	BH-A1	15.40 m	30.00 m	716820.675 m	3124880.556 m	(+)196.163 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	73	28	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100	34		ML-CL		7	50	23	5	4	10	1	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-10-2021	to	25-10-2021	3+691 Major Bridge	BH-A2	15.25 m	30.00 m	716800.700 m	3124877.143 m	(+)196.124 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS-1	0.00	-	-	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		12	57	18	10	3	0	0	32	21	11	-	1.70	13.20	1.50	2.67	UUT	0.43	4	-	-	-	-	-	-	-	-	-
SPT-1	2.50	12	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		8	48	26	13	3	2	0	28	21	7	-	1.72	12.46	1.53	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	54	27	7	2	2	1	27	20	7	-	1.74	13.04	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	20	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	52	28	6	4	3	0	26	19	7	-	1.78	14.60	1.55	2.66	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-4	11.50	27	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Very stiff, Silty clay of low plasticity with gravel	CL		12	51	16	13	4	4	0	33	22	11	-	1.87	20.13	1.56	2.68	UUT	0.75	5	-	-	-	-	-	-	-	-	-
SPT-5	14.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		11	60	20	3	2	4	0	32	21	11	-	1.96	22.64	1.60	2.67	UUT	1.02	4	-	-	-	-	-	-	-	-	-
SPT-6	17.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		7	44	25	16	2	6	0	27	20	7	-	1.88	20.71	1.56	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	48	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	22.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.50	43	20		ML-CL		6	53	30	2	3	5	1	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	53	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		ML-CL		7	52	26	6	2	7	0	26	19	7	-	1.91	21.60	1.57	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-10-2021	to	25-10-2021	3+691 Major Bridge	BH-A2	15.25 m	30.00 m	716800.700 m	3124877.143 m	(+)196.124 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	26.50	46	21	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	28.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.50	69	27		ML-CL		8	46	24	9	4	9	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							16-10-2021	to	16-10-2021	4+174 Minor Bridge	BH-CL	Not Encountered	10.00 m	716335.062 m	3124838.454 m	(+)196.256 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	20	72	5	2	1	0	-	Nil	NP	-	1.68	10.23	1.52	2.62	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-1	2.50	14	18	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		9	50	28	7	4	2	0	30	20	10	-	1.78	15.26	1.54	2.67	UUT	0.63	5	-	-	-	0.735	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	10.01 7.96 6.11 4.96	2.10 1.41 0.95 0.59	0.130
SPT-2	5.50	29	30	Brown, Medium dense to very dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	22	67	4	3	3	1	-	Nil	NP	-	1.82	13.24	1.61	2.62	DST	0.00	31	-	-	-	-	-	-	-	-
SPT-3	8.50	55	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	20	70	3	1	6	0	-	Nil	NP	-	1.87	14.16	1.64	2.63	DST	0.00	32	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							16-10-2021	to	16-10-2021	4+207 Minor Bridge		BH-CL		Not Encountered		10.00 m		716300.074 m			3124835.546 m			(+)196.348 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	15	24		ML-CL		7	46	33	11	2	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	52	31	6	3	2	0	26	19	7	-	1.78	12.46	1.58	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-2	4.00	26	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Dense to very dense, Silty sand with gravel	SM		0	17	72	3	2	6	0	-	Nil	NP	-	1.81	11.47	1.62	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-3	7.00	41	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	14	70	4	4	8	0	-	Nil	NP	-	1.83	12.23	1.63	2.63	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-4	10.00	56	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-10-2021	to	16-10-2021	4+655 Minor Bridge	BH-CL	Not Encountered	10.00 m	715855.211 m	3124798.666 m	(+)200.573 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	14	22		SM		0	13	81	2	3	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-	Brown, Dense to very dense, Silty sand with gravel	SM		0	20	68	4	3	5	0	-	Nil	NP	-	1.81	11.34	1.63	2.63	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-2	4.00	41	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	15	71	5	2	7	0	-	Nil	NP	-	1.84	12.06	1.64	2.62	DST	0.00	32	-	-	-	-	-	-	-	-	-
SPT-3	7.00	53	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	16	72	3	1	6	2	-	Nil	NP	-	1.84	12.46	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	62	50		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-10-2021	to	16-10-2021	5+119 Minor Bridge	BH-CL	Not Encountered	10.00 m	715393.751 m	3124750.566 m	(+)202.713 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	23	70	4	2	1	0	-	Nil	NP	-	1.66	10.74	1.50	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.50	10	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense to dense, Silty sand with gravel	SM		0	16	73	5	3	3	0	-	Nil	NP	-	1.78	11.43	1.60	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	5.50	28	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	19	69	4	3	5	0	-	Nil	NP	-	1.79	12.16	1.60	2.62	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-3	8.50	33	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	13	75	6	2	4	0	-	Nil	NP	-	1.81	13.24	1.60	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		17-10-2021	to	17-10-2021	5+730 Minor Bridge	BH-CL	Not Encountered	10.00 m	714786.103 m	3124685.263 m	(+)198.287 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	26	62	10	2	0	0	-	Nil	NP	-	1.69	11.06	1.52	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	14	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	19	75	1	2	3	0	-	Nil	NP	-	1.77	11.76	1.58	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-3	7.00	25	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	14	72	9	1	4	0	-	Nil	NP	-	1.79	12.40	1.59	2.62	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-4	10.00	33	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							17-10-2021	to	17-10-2021	6+197 Minor Bridge	BH-CL	2.52 m	10.00 m	714320.102 m	3124636.752 m	(+)198.287 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	50	29	13	2	0	0	26	20	6	-	1.78	16.26	1.53	2.66	DST	0.14	22	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		7	46	31	10	4	2	0	27	20	7	-	1.84	19.46	1.54	2.63	DST	0.15	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	21	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		6	46	30	9	5	3	1	26	19	7	-	1.87	20.87	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	47	31	Brown, Dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	23	70	1	1	5	0	-	Nil	NP	-	1.86	16.20	1.60	2.62	DST	0.00	31	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						17-10-2021	to	17-10-2021	6+877 Minor Bridge	BH-CL	1.85 m	10.00 m	713641.709 m	3124570.057 m	(+)196.702 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	13	20		SM-SC		4	45	41	7	3	0	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	42	39	13	1	0	0	26	21	5	-	1.80	16.43	1.55	2.65	DST	0.09	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Dense, Silty sand	SM		0	26	55	19	0	0	0	-	Nil	NP	-	1.84	16.14	1.58	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-3	7.00	33	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	18	66	15	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	38	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		03-10-2021	to	05-10-2021	7+078 Major Bridge	BH-A1	1.70 m	30.00 m	713455.570 m	3124551.638 m	(+)195.221 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	63	26	4	1	0	0	26	19	7	-	1.80	18.23	1.52	2.66	DST	0.18	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		5	60	28	4	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	14	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	7.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.50	17	17		ML-CL		6	54	32	5	2	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	8.50	23	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	10.00	-	-		ML-CL		7	54	30	3	4	2	0	27	20	7	-	1.88	21.14	1.55	2.67	DST	0.23	24	-	-	-	-	-	-	-	-	-
SPT-5	11.50	27	27	Brown, Very stiff to hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	13.00	-	-		CL		11	67	16	2	1	2	1	32	21	11	-	1.99	24.10	1.60	2.68	UUT	1.02	4	25.0	-	-	-	-	-	-	-	-
SPT-6	14.50	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	16.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	53	23	6	3	7	0	28	21	7	-	1.94	19.64	1.62	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-7	17.50	88	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	86	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	72	36		ML-CL		7	48	28	7	1	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	84	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	86	86	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	61	16	3	1	7	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	25.00	68	68		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		03-10-2021	to	05-10-2021	7+078 Major Bridge	BH-A1	1.70 m	30.00 m	713455.570 m	3124551.638 m	(+)195.221 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	27.50	76	76	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	28.00	69	69		CL		11	58	18	5	2	6	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	29.50	70	70		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						03-10-2021	to	04-10-2021	7+078 Major Bridge	BH-A2	1.25 m	30.00 m	713435.595 m	3124549.896 m	(+)194.815 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	5		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		11	71	13	3	2	0	0	33	22	11	-	1.88	29.10	1.46	2.68	UUT	0.24	5	-	-	-	0.835	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.69 6.21 5.03 4.23	2.55 1.85 1.28 0.75	0.169
SPT-2	4.00	7	7		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		12	69	11	4	3	1	0	32	21	11	-	1.88	28.96	1.46	-	-	-	-	28.0	-	-	-	-	-	-	-
SPT-3	7.00	8	8		CL		10	70	16	1	2	1	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.50	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	9.00	18	17		ML-CL		7	60	27	3	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	10.00	19	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	60	19	5	1	3	0	32	21	11	-	1.99	23.67	1.61	2.68	UUT	1.16	4	-	-	-	-	-	-	-	-
SPT-6	13.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		CL		13	58	17	4	3	5	0	33	22	11	-	2.00	23.19	1.62	2.67	UUT	1.35	4	24.0	-	-	-	-	-	-	-
SPT-7	16.00	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	18.00	95	46		ML-CL		6	45	35	4	2	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	19.00	89	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	20.50	58	58	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	56	23	3	2	6	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	22.00	74	74				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	23.50	-	-		CL		12	55	20	5	3	5	0	32	21	11	-	2.03	21.60	1.67	2.68	UUT	2.15	4	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		03-10-2021	to	04-10-2021	7+078 Major Bridge	BH-A2	1.25 m	30.00 m	713435.595 m	3124549.896 m	(+)194.815 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	25.00	51	51	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	26.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	27.00	79	79		CL		11	56	22	2	2	7	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	28.00	70	70		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	29.50	70	70		CL		10	52	25	4	2	6	1	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						28-10-2021	to	28-10-2021	7+256 Minor Bridge	BH-CL	1.59 m	10.00 m	713264.533 m	3124532.969 m	(+)193.947 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	16	25		SM		0	32	58	9	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	30	62	3	4	1	0	-	Nil	NP	-	1.82	15.36	1.58	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	4.00	27	25	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL		7	51	30	8	1	3	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		6	49	32	6	2	4	1	26	20	6	-	1.89	19.46	1.58	2.66	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	30	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	49	26	8	4	5	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	33	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-10-2021	to	26-10-2021	7+351 Major Bridge	BH-A1	3.00 m	40.00 m	713206.080 m	3124525.765 m	(+)194.037 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	47	30	12	5	0	0	26	20	6	-	1.70	16.23	1.46	2.66	DST	0.20	22	-	-	-	-	-	-	-	-	-
SPT-2	4.00	32	27	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	49	28	11	3	2	0	27	20	7	-	1.86	21.46	1.53	2.66	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	15	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Very stiff, Silty clay of low plasticity	CL		12	65	11	8	3	1	0	33	22	11	-	1.95	26.10	1.55	2.67	UUT	0.70	4	-	-	-	0.725	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.77 5.35 4.41 4.21	1.87 1.54 1.11 0.63	0.1360
SPT-4	10.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		7	46	29	10	3	5	0	28	21	7	-	1.87	20.18	1.56	2.65	DST	0.22	24	-	-	-	-	-	-	-	-	-
SPT-5	13.00	33	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	55	16	10	1	6	0	33	22	11	-	1.99	22.83	1.62	2.67	UUT	1.32	5	-	-	-	-	-	-	-	-	-
SPT-6	16.00	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	46	27	11	0	10	0	26	20	6	-	1.93	19.70	1.61	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	21.00	63	31		ML-CL		7	51	30	4	2	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	70	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		8	45	25	10	1	9	2	28	21	7	-	1.94	20.04	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							24-10-2021	to	26-10-2021	7+351 Major Bridge	BH-A1	3.00 m	40.00 m	713206.080 m	3124525.765 m	(+)194.037 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	51	24	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	51	30	2	3	7	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	29.50	-	-		ML-CL		6	49	28	7	2	6	2	26	20	6	-	1.89	19.87	1.58	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-12	31.00	46	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	32.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	48	16	12	4	8	0	33	22	11	-	2.03	21.60	1.67	2.68	UUT	2.28	5	-	-	-	-	-	-	-	-	-
SPT-13	34.00	71	71		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	35.50	-	-		CL		10	50	13	10	6	11	0	31	20	11	-	2.05	20.40	1.70	2.67	UUT	3.15	5	-	-	-	-	-	-	-	-	-
SPT-14	37.00	100 (23cm)	100 (23cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	100 (28cm)	100 (28cm)		CL		11	50	18	6	3	12	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	100 (20cm)	100 (20cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

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							23-10-2021	to	25-10-2021	7+351 Major Bridge	BH-P1	2.10 m	40.00 m	713171.257 m	3124522.342 m	(+)196.827 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	49	27	13	5	0	0	27	21	6	-	1.71	14.26	1.50	2.66	DST	0.18	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	9	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Very stiff, Silty clay of low plasticity	CL		12	60	16	10	1	1	0	33	22	11	-	1.91	27.41	1.50	2.67	UUT	0.41	4	-	-	-	0.780	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.54 7.53 6.03 5.26	2.16 1.72 1.11 0.72	0.159
SPT-2	5.50	11	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		11	63	19	3	2	2	0	32	21	11	-	1.92	27.80	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	12	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		8	53	27	3	4	5	0	28	21	7	-	1.93	20.36	1.60	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-4	11.50	45	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	47	30	9	2	5	0	27	20	7	-	1.93	20.40	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	28	28	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		11	61	20	3	2	3	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		10	59	14	8	5	4	0	31	20	11	-	1.99	24.10	1.60	2.68	UUT	1.02	5	-	-	-	-	-	-	-	-	-
SPT-6	17.50	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	45	26	10	2	9	0	28	21	7	-	1.92	20.30	1.60	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	69	34		ML-CL		6	55	30	2	1	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	43	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		ML-CL		7	49	28	6	2	8	0	27	20	7	-	1.94	19.89	1.62	2.66	DST	0.20	28.00	-	-	-	-	-	-	-	-	-
SPT-10	26.50	89	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-10-2021	to	25-10-2021	7+351 Major Bridge	BH-P1	2.10 m	40.00 m	713171.257 m	3124522.342 m	(+)196.827 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-9	28.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	55	15	11	2	6	0	32	21	11	-	2.00	23.48	1.62	2.68	UUT	1.36	5	-	-	-	-	-	-	-	-	-
SPT-11	29.50	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	31.00	-	-		CL		12	52	19	8	1	7	1	33	22	11	-	2.02	21.90	1.66	2.67	UUT	1.95	5	-	-	-	-	-	-	-	-	-
SPT-12	32.50	59	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	34.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.50	90	34		ML-CL		7	46	23	12	1	11	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	98	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	96	35		ML-CL		8	46	25	8	3	9	1	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						27-10-2021	to	28-10-2021	7+351 Major Bridge	BH-A2	0.70 m	40.00 m	713136.399 m	3124522.342 m	(+)193.680 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	4	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	17	76	6	1	0	0	-	Nil	NP	-	1.65	12.80	1.46	2.62	DST	0.00	27	-	-	-	-	-	-	-	-
SPT-2	4.00	4	6		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	19	71	8	2	0	0	-	Nil	NP	-	1.66	13.24	1.47	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	8	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Medium dense, Silty sand with clay	SM-SC		5	34	53	6	1	1	0	25	20	5	-	1.75	15.32	1.52	2.65	DST	0.10	27	-	-	-	-	-	-	-	-
SPT-4	10.00	14	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM-SC		6	34	51	5	2	2	0	26	20	6	-	1.79	16.29	1.54	2.66	DST	0.11	28.00	-	-	-	-	-	-	-	-
SPT-5	13.00	22	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	49	28	5	3	8	0	27	20	7	-	1.94	19.46	1.62	2.66	DST	0.22	27	-	-	-	-	-	-	-	-
SPT-6	16.00	56	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	18.00	64	36		ML-CL		8	48	27	6	1	10	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	71	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	78	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	85	42		ML-CL		7	45	31	5	2	9	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	91	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	25.00	95	44		ML-CL		8	53	25	6	1	7	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						27-10-2021	to	28-10-2021	7+351 Major Bridge	BH-A2	0.70 m	40.00 m	713136.399 m	3124522.342 m	(+)193.680 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	26.50	100 (27cm)	-	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	28.00	100 (22cm)	-		ML-CL		6	48	27	6	1	12	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	29.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	31.00	100 (20cm)	-		ML-CL		7	46	25	9	3	10	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	32.50	85	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	34.00	91	37		ML-CL		6	49	28	6	2	8	1	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	35.50	100 (28cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	37.00	100 (24cm)	-		ML-CL		7	50	25	6	1	11	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-21	38.50	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-22	40.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						24-10-2021	to	24-10-2021	7+457 Minor Bridge	BH-CL	0.59 m	10.00 m	713067.448 m	3124513.592 m	(+)193.671 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	12	19		SM		0	31	59	9	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	26	64	6	3	1	0	-	Nil	NP	-	1.78	15.46	1.54	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	4.00	19	21	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL		7	47	30	11	2	2	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	49	29	7	4	3	0	28	21	7	-	1.87	19.74	1.56	2.66	DST	0.22	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	25	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	48	26	10	5	4	0	26	19	7	-	1.90	20.14	1.58	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-4	10.00	32	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

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						26-10-2021	to	27-10-2021	7+613 Major Bridge	BH-A1	0.50 m	40.00 m	712928.250 m	3124499.906 m	(+)195.453 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	19	68	6	1	6	0	-	Nil	NP	-	1.74	14.63	1.52	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	4.00	12	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Medium dense, Silty sand with clay	SM-SC		6	43	43	4	2	2	0	26	20	6	-	1.81	16.89	1.55	2.65	DST	0.09	29	-	-	-	-	-	-	-	-	-
SPT-3	7.00	21	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM-SC		5	34	50	7	1	3	0	25	20	5	-	1.81	17.46	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	20	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM-SC		6	35	49	4	3	3	0	26	20	6	-	1.83	17.98	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	29	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	52	30	6	1	1	0	31	21	10	-	2.00	23.16	1.62	2.68	UUT	3.15	5	-	-	-	-	-	-	-	-	-
SPT-6	16.00	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Silty sand with gravel	SM		0	16	69	7	1	7	0	-	Nil	NP	-	1.89	16.46	1.62	2.63	DST	0.00	32	-	-	-	-	-	-	-	-	-
SPT-7	19.00	70	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		SM		0	17	70	3	2	8	0	-	Nil	NP	-	1.88	17.21	1.60	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-8	22.00	55	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	55	20	5	1	8	0	32	21	11	-	2.04	21.19	1.68	2.68	UUT	2.41	5	-	-	-	0.595	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.63 7.71 6.29 5.18	1.39 0.89 0.61 0.39	0.080
SPT-9	25.00	72	72		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		26-10-2021	to	27-10-2021	7+613 Major Bridge	BH-A1	0.50 m	40.00 m	712928.250 m	3124499.906 m	(+)195.453 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	27.00	82	82	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	49	22	7	1	7	2	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.00	75	75		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	29.50	-	-		CL		11	50	24	3	2	10	0	31	20	11	-	2.04	20.70	1.69	2.67	UUT	2.64	5	-	-	-	-	-	-	-	-	-
SPT-12	31.00	85	85		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	32.50	-	-	Brown, Very dense, Silty sand with clay & gravel	SM-SC		6	38	40	6	1	9	0	26	20	6	-	2.00	17.60	1.70	2.65	DST	0.11	32	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (21cm)	-		SM-SC		5	38	38	7	1	11	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (18cm)	-		SM-SC		5	32	43	6	2	12	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	80	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)				R.L.		Ref. Code					
							27-10-2021	to	28-10-2021	7+613 Major Bridge		BH-A2		0.85 m		40.00 m		7128973992.000 m		3124496.873 m		(+)193.923 m		SR-544_21-22					
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %			Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		11	50	30	6	1	2	0	32	21	11	-	1.95	25.14	1.56	2.68	UUT	0.72	5	-	-	-	-	-	-	-	-
SPT-1	2.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		10	55	25	4	3	2	1	30	20	10	-	1.95	24.80	1.56	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		11	52	24	7	2	4	0	31	20	11	-	1.98	23.79	1.60	2.67	UUT	1.02	6	-	-	-	-	-	-	-	-
SPT-3	8.50	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	54	21	6	2	5	0	33	22	11	-	1.98	23.70	1.60	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Very dense, Silty sand with clay & gravel	SM-SC		6	38	41	5	1	9	0	26	20	6	-	1.89	17.26	1.61	2.65	DST	0.11	30	-	-	-	-	-	-	-	-
SPT-5	14.50	60	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		SM-SC		5	35	43	8	2	7	0	25	20	5	-	1.89	17.40	1.61	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	55	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Very dense, Silty sand with gravel	SM		0	16	66	6	1	11	0	-	Nil	NP	-	1.89	16.88	1.62	2.62	DST	0.00	32	-	-	-	-	-	-	-	-
SPT-7	20.50	81	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		SM		0	20	65	5	2	7	1	-	Nil	NP	-	1.89	17.10	1.61	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	80	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		SM		0	14	68	7	1	8	2	-	Nil	NP	-	1.89	16.90	1.62	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	82	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)				R.L.		Ref. Code					
							27-10-2021	to	28-10-2021	7+613 Major Bridge		BH-A2		0.85 m		40.00 m		7128973992.000 m		3124496.873 m		(+)193.923 m		SR-544_21-22					
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	51	25	3	4	6	0	32	21	11	-	1.98	24.06	1.60	2.67	UUT	1.85	4	-	-	-	-	-	-	-	-
SPT-10	29.50	56	56		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		CL		12	49	23	5	1	10	0	33	22	11	-	2.01	22.67	1.64	2.68	UUT	3.13	4	-	-	-	-	-	-	-	-
SPT-11	32.50	100 (23cm)	100 (23cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	34.00	100 (26cm)	100 (26cm)		CL		10	45	26	3	4	12	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	100 (20cm)	100 (20cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	37.00	100 (20cm)	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	47	30	6	1	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		26-10-2021	to	26-10-2021	7+907 Minor Bridge	BH-CL	1.90 m	10.00 m	712620.430 m	3124469.642 m	(+)193.872 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	19	72	6	2	1	0	-	Nil	NP	-	1.67	13.11	1.48	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.50	13	13	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		10	52	28	6	2	2	0	31	20	11	-	1.93	26.73	1.52	2.67	UUT	0.53	5	-	-	-	-	-	-	-	-
SPT-2	5.50	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		12	51	27	5	2	3	0	32	21	11	-	1.96	26.18	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	39	28	Brown, Dense, Silty sand with gravel	SM		0	16	75	7	1	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	17	65	11	2	5	0	-	Nil	NP	-	1.86	16.23	1.60	2.63	DST	0.00	30	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							26-10-2021	to	26-10-2021	8+207 Minor Bridge	BH-CL	2.00 m	10.00 m	712317.987 m	3124437.243 m	(+)193.686 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brownish grey, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	12	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	54	30	6	1	2	0	27	20	7	-	1.83	18.23	1.55	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	50	31	7	1	3	0	28	21	7	-	1.88	20.34	1.56	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	26	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of medium plasticity	CI		15	62	13	5	1	4	0	36	24	12	-	1.98	23.86	1.60	2.68	UUT	1.02	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-10-2021	to	20-10-2021	8+610 Minor Bridge	BH-CL	1.95 m	10.00 m	711923.004 m	3124401.078 m	(+)194.123 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	19	64	16	1	0	0	-	Nil	NP	-	1.77	14.20	1.55	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-1	2.50	19	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense to dense, Silty sand with clay	SM-SC		5	41	44	6	2	2	0	26	21	5	-	1.80	17.16	1.54	2.65	DST	0.10	27	-	-	-	-	-	-	-	-	-
SPT-2	5.50	17	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM-SC		4	40	40	9	3	4	0	25	20	5	-	1.85	17.30	1.58	2.65	DST	0.11	28	-	-	-	-	-	-	-	-	-
SPT-3	8.50	35	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)				R.L.		Ref. Code					
							18-10-2021	to	19-10-2021	8+852 Major Bridge		BH-A1		0.75 m		30.00 m		711688.170 m		3124377.983 m		(+)193.689 m		SR-544_21-22					
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS-1	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	12	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	36	55	1	2	1	0	25	20	5	-	1.79	14.26	1.57	2.65	DST	0.10	27	-	-	-	-	-	-	-	-
SPT-2	4.00	28	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		6	38	49	3	2	2	0	26	21	5	-	1.80	15.13	1.56	2.65	DST	0.09	28	-	-	-	-	-	-	-	-
SPT-3	7.00	25	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	54	21	10	1	4	0	30	20	10	-	2.00	22.84	1.63	2.68	UUT	1.49	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	49	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		12	55	20	6	2	4	1	33	22	11	-	1.99	23.10	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		11	51	19	12	2	5	0	32	21	11	-	2.00	22.96	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		7	50	20	13	4	6	0	27	20	7	-	1.90	20.10	1.58	2.66	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	41	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		6	55	26	6	2	5	0	26	20	6	-	1.90	20.21	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	43	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	23.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-10-2021	to	19-10-2021	8+852 Major Bridge	BH-A1	0.75 m	30.00 m	711688.170 m	3124377.983 m	(+)193.689 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-9	25.00	47	47	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	57	20	3	2	6	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	26.50	-	-		CL		13	58	15	6	1	7	0	34	23	11	-	2.01	22.49	1.64	2.68	UUT	1.65	5	-	-	-	-	-	-	-	-	-
SPT-10	28.00	59	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	29.50	-	-		CL		11	55	17	5	3	9	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-10-2021	to	19-10-2021	8+852 Major Bridge	BH-A2	1.35 m	30.00 m	711664.484 m	3124375.655 m	(+)194.209 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		4	32	54	10	0	0	0	25	20	5	-	1.76	14.26	1.54	2.64	DST	0.11	27	-	-	-	-	-	-	-	-	-
SPT-1	2.50	15	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM-SC		5	42	47	2	2	2	0	25	19	6	-	1.77	15.74	1.53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	14	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM-SC		5	32	50	7	3	3	0	26	20	6	-	1.79	16.12	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	19	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		7	57	26	4	2	4	0	27	20	7	-	1.90	19.46	1.59	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-4	11.50	39	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	54	17	11	1	7	0	31	21	10	-	2.02	22.67	1.65	2.68	UUT	1.88	4	-	-	-	0.625	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	9.58 7.71 6.27 5.58	1.36 1.00 0.73 0.43	0.090
SPT-5	14.50	57	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		11	54	20	6	3	5	1	32	21	11	-	2.00	23.49	1.62	2.67	UUT	1.35	5	-	-	-	-	-	-	-	-	-
SPT-6	17.50	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		7	47	30	3	2	11	0	27	20	7	-	1.91	20.66	1.58	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	41	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		8	48	28	5	3	8	0	28	21	7	-	1.90	19.47	1.59	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-8	23.50	56	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-10-2021	to	19-10-2021	8+852 Major Bridge	BH-A2	1.35 m	30.00 m	711664.484 m	3124375.655 m	(+)194.209 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-9	25.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	58	20	2	2	6	0	33	22	11	-	2.01	22.47	1.64	2.67	UUT	1.72	5	-	-	-	-	-	-	-	-	-
SPT-9	26.50	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	28.00	-	-		CL		11	54	18	6	3	7	1	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	56	56		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		26-10-2021	to	26-10-2021	8+907 Minor Bridge	BH-CL	0.55 m	10.00 m	711623.253 m	3124371.601 m	(+)193.708 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	6	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	36	58	6	0	0	0	-	Nil	NP	-	1.70	13.46	1.50	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	16	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	29	63	7	1	0	0	-	Nil	NP	-	1.81	15.74	1.56	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-3	7.00	22	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	24	68	6	1	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	27	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						21-12-2021	to	21-12-2021	New Ch. 10+340 Silani Station	BH-PLT-08	4.03 m	12.00 m	711500.031 m	3124346.490 m	(+)194.158 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose/Very loose, Silty sand with gravles	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	0.75	-	-		SM-SC		5	40	42	11	2	0	0	26	19	7	-	1.79	15.66	1.55	2.63	DST	0.15	25	-	-	-	-	-	-	-	-	-
SPT-1	1.50	3	4		SM-SC		4	29	53	6	3	5	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	2.25	5	7		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	8	10		SM-SC		5	26	51	10	2	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	3.75	13	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.50	-	-		SM-SC		6	13	62	8	5	6	0	25	19	6	-	1.83	17.22	1.56	2.63	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-5	6.00	26	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.50	-	-	Brown, Medium dense, Sandy silt with clay	ML-CL		5	47	19	22	5	2	0	24	18	6	-	1.88	17.96	1.59	2.64	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-6	9.00	40	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	12.00	57	33		SM-SC		5	25	45	12	11	2	0	25	19	6	-	1.93	18.96	1.62	2.65	DST	0.22	27	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		05-10-2021	to	05-10-2021	9+200 Minor Bridge	BH-CL	1.25 m	10.00 m	711334.580 m	3124343.215 m	(+)194.672 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Grey, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		12	64	18	2	3	1	0	33	22	11	-	1.86	28.41	1.45	2.68	UUT	0.23	5	-	-	-	-	-	-	-	-	-
SPT-1	2.50	6	6		CL		11	71	15	1	1	1	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		6	56	32	3	2	1	0	26	20	6	-	1.86	21.65	1.53	2.66	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	5.50	14	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	7.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.45	20	19		ML-CL		7	61	23	4	3	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	8.50	25	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	10.00	-	-		ML-CL		6	59	24	6	2	3	0	26	19	7	-	1.87	20.78	1.55	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.	Depth of Water Table		Termination Depth		Cordinates (E,N)			R.L.		Ref. Code									
							06-10-2021	to	06-10-2021	9+211 Minor Bridge		BH-CL	1.36 m		10.00 m		711325.206 m		3124342.307 m	(+)194.649 m		SR-544_21-22									
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters					
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Soft, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	7	7		CL		10	64	18	6	2	0	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		11	65	16	4	3	1	0	32	21	11	-	1.86	29.10	1.44	2.68	UUT	0.15	5	-	-	-	-	-	-	-	-	-
SPT-2	4.00	11	14	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		6	60	27	5	1	1	0	26	20	6	-	1.83	20.30	1.52	2.66	DST	0.21	23	-	-	-	-	-	-	-	-	-
SPT-3	7.00	17	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	54	30	6	2	1	0	27	20	7	-	1.88	19.24	1.58	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-4	10.00	34	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							27-10-2021	to	27-10-2021	9+407 Minor Bridge		BH-CL		0.60 m		10.00 m		711125.831 m			3124322.695 m			(+)193.387 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	14	78	7	1	0	0	-	Nil	NP	-	1.70	14.15	1.49	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.50	7	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SP-SM		0	12	80	6	1	1	0	-	Nil	NP	-	1.76	15.26	1.53	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	5.50	14	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	17	72	6	3	2	0	-	Nil	NP	-	1.80	16.10	1.55	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	20	20	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		11	55	25	5	1	3	0	31	21	10	-	1.95	25.63	1.55	2.67	UUT	0.70	5	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						07-10-2021	to	08-10-2021	9+726 Major Bridge	BH-A1	0.85 m	30.00 m	710810.840 m	3124291.156 m	(+)194.097 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Yellowish brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	4	8		SM		0	34	58	6	2	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	28	65	5	1	1	0	-	Nil	NP	-	1.66	13.67	1.46	2.62	DST	0.00	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	20	22	Brown, Medium dense, Silty sand with clay	SM-SC		5	41	40	8	3	3	0	26	21	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		4	40	43	9	1	2	1	25	20	5	-	1.79	15.57	1.55	2.65	DST	0.11	27	-	-	-	-	-	-	-	-	-
SPT-3	7.00	22	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		7	55	25	6	2	5	0	27	20	7	-	1.92	19.74	1.60	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-4	10.00	41	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		6	52	27	3	4	7	1	26	20	6	-	1.92	20.10	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	48	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	50	28	5	3	5	2	26	19	7	-	1.91	20.63	1.58	2.66	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-6	16.00	33	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		8	51	29	5	1	6	0	28	21	7	-	1.91	20.80	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	33	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	52	20	7	3	6	0	33	22	11	-	2.00	23.40	1.62	2.68	UUT	1.32	5	-	-	-	0.655	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.75 6.33 5.65 5.01	1.71 1.23 0.84 0.54	0.113
SPT-8	22.00	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		CL		11	56	18	5	3	5	2	32	21	11	-	2.01	23.11	1.63	2.67	UUT	1.55	5	-	-	-	-	-	-	-	-	-
SPT-9	25.00	47	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		CL		12	51	22	6	2	7	0	34	23	11	-	2.00	22.90	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		07-10-2021	to	08-10-2021	9+726 Major Bridge	BH-A1	0.85 m	30.00 m	710810.840 m	3124291.156 m	(+)194.097 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	>100	-	Brown, Very dense, Silty sand with gravel	SM		0	32	57	8	2	1	0	-	Nil	NP	-	1.93	16.50	1.66	2.63	DST+	0.00	32	-	-	-	-	-	-	-	-
SPT-11	29.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							28-10-2021	to	29-10-2021	9+726 Major Bridge	BH-A2	0.29 m	30.00 m	710802.664 m	3124290.194 m	(+)193.613 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS-1	0.00	-	-	Brown, Loose, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	1.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.50	4	7		SM-SC		5	35	55	3	2	0	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	2.50	5	8		SM-SC		6	35	51	6	1	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	4.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.50	25	25	Brown, Medium dense, Silty sand with gravel	SM		0	14	75	7	1	3	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	5.50	27	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	7.00	-	-		SM		0	20	67	6	3	4	0	-	Nil	NP	-	1.83	15.80	1.58	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-5	8.50	30	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	10.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	53	25	5	1	5	0	32	21	11	-	1.98	23.76	1.60	2.67	UUT	1.06	6	-	-	-	-	-	-	-	-	-
SPT-6	11.50	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	13.00	-	-	Brown, Dense, Silty sand with clay & gravel	SM-SC		5	28	47	11	3	6	0	25	20	5	-	1.87	18.04	1.58	2.65	DST	0.11	29	-	-	-	-	-	-	-	-	-
SPT-7	14.50	37	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	16.00	-	-		SM-SC		5	30	51	7	1	5	1	26	19	7	-	1.87	18.10	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	17.50	37	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	19.00	-	-		SM-SC		4	33	48	6	2	7	0	25	20	5	-	1.87	17.90	1.59	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	40	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	22.00	-	-		SM-SC		6	30	51	6	2	5	0	26	20	6	-	1.87	17.87	1.59	2.65	DST	0.09	30	-	-	-	-	-	-	-	-	-
SPT-10	23.50	45	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	25.00	-	-		SM-SC		6	24	55	5	3	7	0	26	20	6	-	1.89	18.10	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-10-2021	to	29-10-2021	9+726 Major Bridge	BH-A2	0.29 m	30.00 m	710802.664 m	3124290.194 m	(+)193.613 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %			Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																		
SPT-11	26.50	58	58	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	44	26	9	2	9	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	28.00	-	-		CL		11	49	21	7	1	11	0	32	22	10	-	2.03	22.06	1.66	2.68	UUT	2.00	6	-	-	-	-	-	-	-	-
SPT-12	29.50	69	69		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						10-11-2021	to	10-11-2021	9+772 Minor Bridge	BH-CL	0.60 m	12.00 m	710762.491 m	3124285.182 m	(+)193.598 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	4	7		ML-CL		7	55	30	6	1	1	0	27	20	7	-	1.74	19.00	1.46	2.66	DST+	0.21	22	-	-	-	-	-	-	-	-
SPT-2	1.50	5	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		6	46	33	6	1	8	0	26	20	6	-	1.84	19.23	1.54	2.66	DST	0.20	24	-	-	-	-	-	-	-	-
SPT-3	3.00	14	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	17	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Medium dense to dense, Silty sand with clay & gravel	SM-SC		5	33	51	6	2	3	0	25	20	5	-	1.84	18.52	1.55	2.65	DST	0.10	27	-	-	-	-	-	-	-	-
SPT-5	6.00	16	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	27	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		SM-SC		6	32	50	5	2	5	0	26	20	6	-	1.89	19.03	1.59	2.65	DST	0.09	28	-	-	-	-	-	-	-	-
SPT-7	9.00	36	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	40	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.25	-	-		SM-SC		6	30	48	6	4	6	0	26	20	6	-	1.91	19.20	1.60	2.66	DST	0.11	29	-	-	-	-	-	-	-	-
SPT-9	12.00	44	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							05-10-2021	to	06-10-2021	10+025 Minor Bridge	BH-A1	1.34 m	30.00 m	710515.298 m	3124244.432 m	(+)194.595 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Yellowish brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	16		ML-CL		7	55	33	3	2	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	55	32	4	2	1	0	26	20	6	-	1.80	18.34	1.52	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-2	4.00	17	18	Yellowish brown, Medium dense, Silty sand with clay & gravel	SM-SC		5	16	74	3	1	1	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		4	24	65	3	2	2	0	25	20	5	-	1.82	17.10	1.55	2.65	DST	0.10	28	-	-	-	-	-	-	-	-	-
SPT-3	7.00	23	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Yellowish brown, Medium dense, Sandy silt of low plasticity	ML-CL		6	48	37	6	1	2	0	26	20	6	-	1.86	19.70	1.55	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-4	10.00	20	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		8	49	32	7	2	2	0	28	21	7	-	1.86	20.10	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	27	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	51	31	5	3	3	0	27	20	7	-	1.86	20.16	1.55	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-6	16.00	31	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		10	56	22	6	1	5	0	31	21	10	-	2.03	22.36	1.66	2.68	UUT	2.02	5	-	-	-	0.615	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.65 5.67 4.93 4.28	1.25 0.94 0.60 0.42	0.086
SPT-7	19.00	64	64		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		11	54	20	5	4	6	0	32	21	11	-	2.04	22.60	1.66	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	62	62		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		CL		12	49	26	5	1	7	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		CL		11	54	21	6	1	5	2	31	20	11	-	2.03	23.16	1.65	2.67	UUT	1.82	5	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		05-10-2021	to	06-10-2021	10+025 Minor Bridge	BH-A1	1.34 m	30.00 m	710515.298 m	3124244.432 m	(+)194.595 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
SPT-10	28.00	55	55	Yellowish brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	29.50	-	-		CL		10	53	23	3	5	6	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							05-10-2021	to	06-10-2021	10+025 Minor Bridge	BH-A2	1.22 m	30.00 m	710507.526 m	3124242.990 m	(+)194.589 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS-1	0.00	-	-	Yellowish brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	53	32	4	3	1	0	27	20	7	-	1.73	13.26	1.53	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Yellowish brown, Medium dense to dense, Silty sand with clay & gravel	SM-SC		5	19	65	6	2	3	0	26	21	5	-	1.84	16.23	1.58	2.65	DST	0.09	29	-	-	-	-	-	-	-	-	-
SPT-2	5.50	27	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	7.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.50	32	25		SM-SC		4	26	63	2	1	4	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	8.50	43	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	10.00	-	-	Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	51	30	2	3	7	0	27	20	7	-	1.91	19.63	1.60	2.66	DST	0.23	27	-	-	-	-	-	-	-	-	-
SPT-5	11.50	55	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	13.00	-	-		ML-CL		6	49	31	5	3	6	0	26	20	6	-	1.92	20.10	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	14.50	54	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	16.00	-	-		ML-CL		8	51	28	3	4	5	1	28	21	7	-	1.92	19.80	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	17.50	59	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	19.00	-	-	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		11	57	20	4	1	7	0	31	21	10	-	2.03	21.41	1.67	2.68	UUT	2.05	4	-	-	-	-	-	-	-	-	-
SPT-8	20.50	62	62		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	22.00	-	-		CL		12	53	19	5	3	8	0	33	22	11	-	2.03	21.60	1.67	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	67	67				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		CL		11	49	22	7	3	6	2	32	21	11	-	2.03	21.62	1.67	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		05-10-2021	to	06-10-2021	10+025 Minor Bridge	BH-A2	1.22 m	30.00 m	710507.526 m	3124242.990 m	(+)194.589 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	26.50	63	63	Yellowish brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	28.00	-	-		CL		11	53	21	6	4	5	0	34	22	12	-	2.03	21.13	1.68	2.68	UUT	2.31	4	-	-	-	-	-	-	-	-	-
SPT-11	29.50	72	72		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							29-10-2021	to	29-10-2021	10+223 Minor Bridge	BH-CL	3.50 m	10.00 m	710317.973 m	3124207.834 m	(+)194.116 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	4	7		ML-CL		6	52	35	6	1	0	0	26	20	6	-	1.65	12.50	1.47	2.66	DST+	0.18	23	-	-	-	-	-	-	-	-
SPT-2	1.50	7	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		7	54	31	4	3	1	0	27	20	7	-	1.77	15.64	1.53	2.66	DST	0.20	24	-	-	-	-	-	-	-	-
SPT-3	3.00	11	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	22	20		ML-CL		8	55	28	6	1	2	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		ML-CL		7	51	30	7	2	3	0	27	20	7	-	1.85	19.40	1.55	2.66	DST	0.19	25	-	-	-	-	-	-	-	-
SPT-5	6.00	27	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	22	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-	Brown, Medium dense, Silty sand with clay	SM-SC		5	35	50	6	1	3	0	25	20	5	-	1.84	18.46	1.55	2.65	DST	0.10	27	-	-	-	-	-	-	-	-
SPT-7	9.00	24	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	28	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						29-10-2021	to	29-10-2021	10+519 Minor Bridge	BH-CL	4.50 m	10.00 m	710023.336 m	3124153.189 m	(+)194.584 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		ML-CL		5	50	38	6	1	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	10	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		6	54	32	4	2	2	0	26	20	6	-	1.78	14.16	1.56	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	18	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	34	39	Brown, Dense to very dense, Silty sand with clay & gravel	SM-SC		6	30	53	7	1	3	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SM-SC		4	22	62	6	2	4	0	25	20	5	-	1.87	16.12	1.61	2.65	DST	0.20	26	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	46	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	47	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		SM-SC		5	18	60	9	3	5	0	26	21	5	-	1.88	16.80	1.61	2.65	DST	0.19	27	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	51	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	51	32		SM-SC		5	16	65	7	1	6	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		29-10-2021	to	29-10-2021	10+658 Minor Bridge	BH-CL	3.20 m	10.00 m	709890.704 m	3124128.590 m	(+)194.898 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		ML-CL		7	55	30	7	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	7	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		8	53	31	5	2	1	0	28	21	7	-	1.74	17.40	1.48	2.66	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-3	3.00	10	10	Brown, Stiff to very stiff, Silty clay of low plasticity	CL		10	53	29	6	1	1	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Medium dense, Silty sand with clay	SM-SC		5	33	53	4	2	3	0	25	20	5	-	1.81	16.85	1.55	2.65	DST	0.10	27	-	-	-	-	-	-	-	-	-
SPT-5	6.00	22	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	25	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-	Brown, Dense, Silty sand	SM		0	21	68	6	1	4	0	-	Nil	NP	-	1.81	16.13	1.56	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-7	9.00	30	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	35	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		29-10-2021	to	29-10-2021	10+718 Minor Bridge	BH-CL	2.50 m	10.00 m	709831.671 m	3124117.642 m	(+)193.997 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	12	22		SM		0	18	76	6	0	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	28	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-	Brown, Loose, Silty sand with clay	SM-SC		5	36	50	7	1	1	0	25	20	5	-	1.72	16.23	1.48	2.65	DST	0.10	26	-	-	-	-	-	-	-	-	-
SPT-3	3.00	7	9		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	8	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Medium dense, Silty sand with clay	SM-SC		6	32	51	6	2	3	0	26	20	6	-	1.83	18.10	1.55	2.65	DST	0.11	27	-	-	-	-	-	-	-	-	-
SPT-5	6.00	20	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	26	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		8	52	30	5	2	3	0	28	21	7	-	1.87	20.64	1.55	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-7	9.00	25	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	29	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		29-10-2021	to	29-10-2021	10+749 Minor Bridge	BH-CL	2.60 m	10.00 m	709801.215 m	3124111.993 m	(+)194.893 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	11	20		SM		0	16	76	7	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	18	26	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		7	53	33	4	2	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		8	53	30	6	1	2	0	28	21	7	-	1.79	15.41	1.55	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-3	3.00	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	18	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Medium dense, Silty sand	SP-SM		0	12	78	6	1	2	1	-	Nil	NP	-	1.79	16.20	1.54	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-5	6.00	18	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	22	19		SM		0	22	68	4	3	3	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		6	51	31	7	1	4	0	26	20	6	-	1.86	19.74	1.55	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-7	9.00	21	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	25	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		08-10-2021	to	10-10-2021	10+859 Major Bridge	BH-A1_(R)	2.99 m	40.00 m	709761.805 m	3124103.149 m	(+)195.206 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		4	43	44	5	2	2	0	25	20	5	-	1.69	14.11	1.48	2.65	DST	0.11	25	-	-	-	-	-	-	-	-	-
SPT-2	4.00	10	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		5	32	50	9	3	1	0	26	21	5	-	1.77	16.24	1.52	2.64	DST	0.09	26	-	-	-	-	-	-	-	-	-
SPT-3	7.00	13	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	9.00	16	16		SM-SC		5	32	54	4	3	2	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	10.00	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	55	19	9	2	3	0	33	22	11	-	1.98	23.77	1.60	2.68	UUT	1.06	5	-	-	-	0.675	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	9.49 7.58 6.11 4.58	2.05 1.40 0.96 0.58	0.123
SPT-6	13.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		CL		10	66	19	1	2	2	0	30	20	10	-	1.99	23.48	1.61	2.67	UUT	1.23	5	-	-	-	-	-	-	-	-	-
SPT-7	16.00	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-		CL		11	55	21	5	3	4	1	32	21	11	-	2.01	22.69	1.64	2.68	UUT	1.62	4	-	-	-	-	-	-	-	-	-
SPT-8	19.00	49	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		CL		11	56	22	4	2	5	0	31	20	11	-	2.03	21.07	1.68	2.67	UUT	2.40	4	-	-	-	-	-	-	-	-	-
SPT-9	22.00	66	66		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	75	75		CL		12	54	18	5	4	7	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	91	91		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

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		08-10-2021	to	10-10-2021	10+859 Major Bridge	BH-A1_(R)	2.99 m	40.00 m	709761.805 m	3124103.149 m	(+)195.206 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	26.50	100 (23cm)	100 (23cm)	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.00	61	28	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	49	31	5	1	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	31.00	100 (29cm)	-		ML-CL		6	51	29	4	4	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	34.00	100 (22cm)	-		ML-CL		7	48	30	5	3	7	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	35.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	37.00	96	34		ML-CL		7	48	27	7	2	9	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	38.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-21	40.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

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		06-10-2021	to	07-10-2021	10+859 Major Bridge	BH-A1	2.95 m	40.00 m	709723.114 m	3124097.508 m	(+)194.772 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	19	73	6	2	0	0	-	Nil	NP	-	1.69	12.84	1.50	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.25	9	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	4.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	4.50	13	15	Brown, Medium dense, Silty sand with clay	SM-SC		4	36	53	4	2	1	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	5.50	13	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	7.00	-	-		SM-SC		5	37	56	2	0	0	0	26	21	5	-	1.77	16.38	1.52	2.65	DST	0.08	27	-	-	-	-	-	-	-	-
SPT-4	8.50	13	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	10.00	-	-	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		11	57	21	4	3	4	0	31	20	11	-	1.99	24.11	1.60	2.68	UUT	1.02	5	-	-	-	-	-	-	-	-	-
SPT-5	11.50	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	13.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.50	26	26		CL		10	58	23	5	1	3	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	14.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	16.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	52	24	7	0	6	0	33	22	11	-	2.04	20.84	1.69	2.68	UUT	2.61	5	-	-	-	0.585	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	15.37 9.45 6.93 5.25	1.27 0.83 0.45 0.33	0.066
SPT-8	17.50	84	84		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	19.00	-	-		CL		12	50	22	4	3	9	0	34	23	11	-	2.04	20.90	1.69	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	84	84		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	100 (20cm)	100 (20cm)		CL		10	50	26	5	2	7	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	100 (27cm)	100 (27cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE
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SOIL CHARACTERISTICS

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							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	25.00	92	92	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	51	21	3	4	8	2	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	26.50	59	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	28.00	-	-		CL		11	49	19	7	3	11	0	31	20	11	-	2.05	20.38	1.70	2.67	UUT	2.80	4	-	-	-	-	-	-	-	-	-
SPT-14	29.50	90	90		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	31.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	31.50	97	37		ML-CL		7	49	33	2	0	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	32.50	89	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	34.00	-	-		ML-CL		6	51	30	4	2	7	0	26	20	6	-	1.97	19.24	1.65	2.66	DST	0.18	30	-	-	-	-	-	-	-	-	-
SPT-17	35.50	100 (28cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	37.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	38.50	95 (23cm)	-		ML-CL		7	47	26	5	4	11	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	40.00	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Filled up strata	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	31	49	Brown, Loose to medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	22	75	2	1	0	0	-	Nil	NP	-	1.70	13.34	1.50	2.62	DST	0.00	28	-	-	-	-	-	-	-	-	-
SPT-2	4.00	10	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	5.50	-	-		SM		0	24	68	4	3	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	6.00	13	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	7.00	19	18		SM		0	23	65	6	4	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	9.00	25	21		SM		0	23	70	3	2	2	0	0	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	10.00	21	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	11.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	59	18	5	2	5	0	32	21	11	-	1.99	24.15	1.60	2.68	UUT	1.06	5	-	-	-	-	-	-	-	-	-
SPT-7	13.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	14.50	-	-		CL		12	55	22	3	4	3	1	33	22	11	-	1.99	24.40	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	16.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	17.50	-	-		CL		10	53	26	4	3	4	0	30	20	10	-	1.99	23.74	1.61	2.67	UUT	1.16	5	-	-	-	-	-	-	-	-	-
SPT-9	19.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	20.50	-	-		CL		11	54	20	7	2	6	0	32	21	11	-	2.01	22.61	1.64	2.68	UUT	1.65	4	-	-	-	-	-	-	-	-	-
SPT-10	22.00	49	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	23.50	-	-		CL		12	52	22	6	1	4	3	33	22	11	-	2.01	22.44	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		06-10-2021	to	09-10-2021	10+859 Major Bridge	BH-P1	3.35 m	40.00 m	709681.945 m	3124089.603 m	(+)195.316 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	25.00	54	54	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	26.50	-	-		CL		11	50	24	7	3	4	1	33	22	11	-	2.00	23.40	1.62	2.68	UUT	1.34	5	-	-	-	-	-	-	-	-	-
SPT-12	28.00	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	29.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	49	28	5	2	8	0	28	21	7	-	1.96	19.26	1.64	2.66	DST	0.19	29	-	-	-	-	-	-	-	-	-
SPT-13	31.00	75	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	32.50	95	37		ML-CL		6	49	30	7	1	7	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	34.00	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	35.50	85	32		ML-CL		7	49	27	4	3	10	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	37.00	93	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	38.50	99	35		ML-CL		7	49	29	3	4	7	1	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	40.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-11-2021	to	21-11-2021	10+859 Major Bridge	BH-A2	5.60 m	40.00 m	709602.681 m	3124072.923 m	(+)195.247 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	19	78	2	1	0	0	-	Nil	NP	-	1.67	12.60	1.48	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.50	8	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	18	75	4	2	1	0	-	Nil	NP	-	1.69	12.96	1.50	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	11	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	16	75	6	1	2	0	-	Nil	NP	-	1.71	13.74	1.50	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-3	8.50	14	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		SM		0	20	73	4	2	1	0	-	Nil	NP	-	1.71	14.60	1.49	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	12	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Medium dense, Silty sand with clay	SM-SC		4	36	50	5	3	2	0	25	20	5	-	1.79	17.69	1.52	2.65	DST	0.11	27	-	-	-	-	-	-	-	-
SPT-5	14.50	21	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	54	21	4	3	6	0	33	22	11	-	2.01	22.10	1.65	2.67	UUT	1.88	5	-	-	-	-	-	-	-	-
SPT-6	17.50	57	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		CL		11	59	19	3	2	5	1	32	21	11	-	2.01	22.60	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	22.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.45	57	57		CL		12	53	23	3	2	7	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	64	64		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	68	68		CL		13	48	22	5	3	9	0	34	23	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	75	75		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-11-2021	to	21-11-2021	10+859 Major Bridge	BH-A2	5.60 m	40.00 m	709602.681 m	3124072.923 m	(+)195.247 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	72	72	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	78	32	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	49	28	5	2	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	31.00	84	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	32.50	81	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	34.00	87	33		ML-CL		8	44	31	4	3	10	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.50	93	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	37.00	96	34		ML-CL		7	45	30	5	4	8	1	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	38.50	100	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	40.00	100 (28cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							13-11-2021	to	13-11-2021	17+625 Major Bridge	BH-A1	3.00 m	30.00 m	704882.319 m	3119823.851 m	(+)191.597 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS-1	0.00	-	-	Yellowish brown, Very loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	48	38	6	1	1	0	26	20	6	-	1.66	15.11	1.44	2.66	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	3	4		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Yellowish brown, Medium, Sandy silt of low plasticity	ML-CL		7	53	32	5	1	2	0	26	20	6	-	1.79	18.40	1.51	2.67	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-2	5.50	12	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	54	30	6	2	1	0	27	20	7	-	1.80	19.10	1.51	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	14	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		6	49	31	9	3	2	0	26	20	6	-	1.80	19.18	1.51	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	13	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Yellowish brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	53	28	5	1	7	0	26	20	6	-	1.90	18.79	1.60	2.66	DST	0.19	28	-	-	-	-	-	-	-	-	-
SPT-5	14.50	59	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	45	29	8	3	6	2	27	20	7	-	1.90	18.95	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	52	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		10	51	23	6	1	9	0	32	21	11	-	2.04	21.46	1.68	2.68	UUT	2.41	5	-	-	-	0.595	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.66 7.05 5.34 4.14	1.26 0.95 0.58 0.41	0.0830
SPT-7	20.50	71	71		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	76	76		CL		12	43	25	4	6	8	2	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	82	82		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		CL		11	45	26	5	2	11	0	32	21	11	-	2.02	22.57	1.65	2.67	UUT	1.76	6	-	-	-	-	-	-	-	-	-
SPT-10	26.50	55	55		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		13-11-2021	to	13-11-2021	17+625 Major Bridge	BH-A1	3.00 m	30.00 m	704882.319 m	3119823.851 m	(+)191.597 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-9	28.00	-	-	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		12	44	25	8	1	10	0	33	22	11	-	2.04	22.41	1.67	2.68	UUT	2.05	5	-	-	-	-	-	-	-	-
SPT-11	29.50	64	64		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		13-11-2021	to	14-11-2021	17+625 Major Bridge	BH-A2	3.05 m	30.00 m	704873.896 m	3119805.101 m	(+)191.814 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Yellowish brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	53	33	6	1	1	0	27	20	7	-	1.74	15.37	1.51	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-2	4.00	12	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Yellowish brown, Medium dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		8	48	33	6	2	3	0	28	21	7	-	1.83	18.64	1.54	2.67	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-3	7.00	20	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	51	30	4	3	5	0	27	20	7	-	1.88	19.10	1.58	2.66	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-4	10.00	36	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		7	45	31	6	4	7	0	27	21	6	-	1.90	19.78	1.59	2.66	DST	0.21	28	-	-	-	-	-	-	-	-	-
SPT-5	13.00	45	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		6	48	27	11	1	6	1	26	20	6	-	1.91	19.60	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	46	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		7	48	28	9	1	7	0	26	19	7	-	1.91	19.14	1.60	2.67	DST	0.18	29	-	-	-	-	-	-	-	-	-
SPT-7	19.00	52	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		8	47	27	7	3	8	0	28	21	7	-	1.91	19.30	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	49	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		10	51	24	6	1	8	0	30	20	10	-	2.03	21.74	1.67	2.68	UUT	2.21	5	-	-	-	-	-	-	-	-	-
SPT-9	25.00	69	69		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		CL		12	42	26	5	3	12	0	32	21	11	-	2.04	20.80	1.69	2.67	UUT	2.58	6	-	-	-	-	-	-	-	-	-
SPT-10	28.00	83	83		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		13-11-2021	to	14-11-2021	17+625 Major Bridge	BH-A2	3.05 m	30.00 m	704873.896 m	3119805.101 m	(+)191.814 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	29.50	92	92	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		11	45	25	7	2	10	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							08-10-2021	to	09-10-2021	17+872 Major Bridge		BH-A1		0.95 m		30.00 m		704759.612 m			3119597.349 m			(+)191.318 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Brownish grey, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	5		CL		12	64	18	3	2	1	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		11	70	15	2	1	1	0	32	21	11	-	1.87	28.13	1.46	2.68	UUT	0.26	5	-	-	-	0.835	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.01 5.71 5.04 4.40	2.54 1.90 1.20 0.78	0.1760
SPT-2	4.00	8	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brownish grey, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL		7	52	33	5	2	1	0	26	19	7	-	1.88	21.40	1.55	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	22	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		6	55	30	5	1	2	1	27	21	6	-	1.89	21.28	1.56	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	30	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		7	54	28	3	4	4	0	27	20	7	-	1.91	20.98	1.58	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-5	13.00	39	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		8	50	31	4	2	5	0	28	21	7	-	1.92	20.56	1.59	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	42	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brownish grey, Hard, Silty clay of low plasticity with gravel	CL		12	56	15	6	4	7	0	33	22	11	-	2.06	21.30	1.70	2.67	UUT	3.16	4	-	-	-	-	-	-	-	-	-
SPT-7	19.00	100 (23cm)	100 (23cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	100 (21cm)	100 (21cm)		CL		11	53	20	3	4	9	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	100 (20cm)	100 (20cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	100 (26cm)	100 (26cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	100 (24cm)	100 (24cm)		CL		12	56	17	4	3	6	2	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	100 (28cm)	100 (28cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		08-10-2021	to	09-10-2021	17+872 Major Bridge	BH-A1	0.95 m	30.00 m	704759.612 m	3119597.349 m	(+)191.318 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	28.00	100 (26cm)	100 (26cm)	Brownish grey, Hard, Silty clay of low plasticity with gravel	CL		10	51	19	7	3	10	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.80	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							08-10-2021	to	09-10-2021	17+872 Major Bridge	BH-A2	1.00 m	30.00 m	704753.576 m	3119588.153 m	(+)191.150 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Brownish grey, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		14	61	18	4	1	1	1	34	23	11	-	1.92	26.43	1.52	2.68	UUT	0.56	5	-	-	-	-	-	-	-	-	-
SPT-1	2.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		12	56	22	5	2	3	0	33	22	11	-	1.96	25.38	1.56	2.67	UUT	0.75	4	-	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brownish grey, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL		8	50	30	2	8	2	0	28	21	7	-	1.88	21.34	1.55	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	20	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	55	24	2	9	3	0	27	20	7	-	1.88	21.25	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	26	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		8	54	28	4	2	4	0	28	21	7	-	1.91	20.76	1.58	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-5	14.50	38	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-	Brownish grey, Hard, Silty clay of low plasticity with gravel	CL		11	56	21	5	1	6	0	32	21	11	-	2.03	22.16	1.66	2.68	UUT	2.02	5	-	-	-	-	-	-	-	-	-
SPT-6	17.50	63	63		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		CL		13	46	20	7	4	10	0	34	23	11	-	2.05	20.60	1.70	2.68	UUT	3.15	4	-	-	-	-	-	-	-	-	-
SPT-7	20.50	100 (30cm)	100 (30cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	100 (23cm)	100 (23cm)		CL		12	59	19	2	0	8	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	100 (20cm)	100 (20cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	100 (26cm)	100 (26cm)		CL		11	52	21	2	5	7	2	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	100 (25cm)	100 (25cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		08-10-2021	to	09-10-2021	17+872 Major Bridge	BH-A2	1.00 m	30.00 m	704753.576 m	3119588.153 m	(+)191.150 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	100 (24cm)	100 (24cm)	Brownish grey, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (27cm)	100 (27cm)		CL		12	50	23	3	2	10	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	29.92	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-12-2021	to	20-12-2021	New Ch. 19+010 IMT Sohna Station	BH-PLT-07	0.60 m	12.00 m	704417.312 m	3119187.740 m	(+)190.138 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Medium, Blackish, Silty clay with low Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	0.75	-	-		CL		8	64	19	6	3	0	0	32	21	11	-	1.80	21.42	1.48	2.68	UUT	0.19	7	-	-	-	-	-	-	-	-	-
SPT-1	1.50	5	5		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	2.25	10	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	16	19	Medium Dense, Brownish Sandy Silt	ML-CL		6	59	19	12	4	0	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	3.75	22	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.50	-	-		ML-CL		7	51	19	15	8	0	0	25	19	6	-	1.82	17.25	1.55	2.65	DST	0.12	23	-	-	-	-	-	-	-	-	-
SPT-5	6.00	30	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.50	-	-		ML-CL		8	67	14	11	0	0	0	24	18	6	-	1.85	18.45	1.56	2.65	DST	0.16	24	-	-	-	-	-	-	-	-	-
SPT-6	9.00	38	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.50	-	-		ML-CL		6	46	19	22	5	2	0	23	18	5	-	1.89	19.68	1.58	2.65	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-7	12.00	51	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-11-2021	to	15-11-2021	18+750 Major Bridge	BH-A1	1.22 m	30.00 m	704113.173 m	3119029.392 m	(+)190.420 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Yellowish brown, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	7	7		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		12	62	20	5	1	0	0	33	22	11	-	1.88	28.76	1.46	2.68	UUT	0.25	5	-	-	-	-	-	-	-	-	-
SPT-2	4.00	24	23	Yellowish brown, Medium dense, Silty sand	SM		0	25	68	3	2	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	23	66	7	1	2	1	-	Nil	NP	-	1.84	16.34	1.58	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-3	7.00	29	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Yellowish brown, Stiff, Silty clay of low plasticity	CL		12	49	28	8	1	2	0	33	22	11	-	1.92	26.22	1.52	2.67	UUT	0.49	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	14	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		10	50	27	6	4	3	0	30	20	10	-	1.92	26.14	1.52	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	66	38	Yellowish brown, Very dense, Silty sand with clay	SM-SC		5	36	47	5	3	4	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Yellowish brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		11	51	25	3	5	5	0	31	20	11	-	1.98	23.16	1.61	2.68	UUT	1.15	6	-	-	-	-	-	-	-	-	-
SPT-6	16.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		11	53	23	6	1	6	0	31	21	10	-	1.98	22.89	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	37	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		12	47	24	3	6	6	2	32	21	11	-	1.99	21.78	1.63	2.67	UUT	1.52	5	-	-	-	-	-	-	-	-	-
SPT-8	22.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		CL		10	51	25	4	2	8	0	31	21	10	-	2.01	20.46	1.67	2.68	UUT	2.03	6	-	-	-	0.605	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.60 6.39 5.27 4.07	1.64 0.95 0.77 0.42	0.0860
SPT-9	25.00	65	65		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		CL		12	46	26	4	1	11	0	32	21	11	-	2.03	20.10	1.69	2.69	UUT	2.52	5	-	-	-	-	-	-	-	-	-
SPT-10	28.00	78	78		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

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		14-11-2021	to	15-11-2021	18+750 Major Bridge	BH-A1	1.22 m	30.00 m	704113.173 m	3119029.392 m	(+)190.420 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	29.50	84	84	Yellowish brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		11	45	24	8	2	10	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		14-11-2021	to	15-11-2021	18+750 Major Bridge	BH-A2	1.50 m	30.00 m	704095.090 m	3119020.849 m	(+)190.095 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Yellowish brown, Stiff to very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		11	53	30	5	1	0	0	31	21	10	-	1.91	26.40	1.51	2.68	UUT	0.45	5	-	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		10	52	26	7	3	2	0	31	20	11	-	1.93	26.19	1.53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	17	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		12	52	28	6	1	1	0	33	22	11	-	1.91	27.10	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	11	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		11	54	27	3	2	3	0	32	21	11	-	1.95	25.76	1.55	2.67	UUT	0.69	5	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Yellowish brown, Hard, Silty clay of low plasticity with gravel	CL		10	53	26	5	2	4	0	30	21	9	-	1.98	23.89	1.60	2.68	UUT	1.03	6	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		12	47	23	9	3	6	0	33	22	11	-	2.00	23.27	1.62	2.67	UUT	1.36	5	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	19.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.50	54	54		CL		11	51	24	4	2	8	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	22.00	-	-		CL		13	39	28	3	7	10	0	34	23	11	-	2.02	22.40	1.65	2.68	UUT	1.75	5	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		CL		12	47	26	6	1	8	0	33	22	11	-	2.04	22.04	1.67	2.68	UUT	2.20	6	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	58	58		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-11-2021	to	15-11-2021	18+750 Major Bridge	BH-A2	1.50 m	30.00 m	704095.090 m	3119020.849 m	(+)190.095 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	75	75	Yellowish brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	70	70		CL		11	47	20	7	4	11	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							14-11-2021	to	15-11-2021	19+500 Major Bridge		BH-A1		0.60 m		40.00 m		703426.871 m			3118866.702 m			(+)190.997 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		13	70	11	5	1	0	0	34	23	11	-	1.86	27.56	1.46	2.67	UUT	0.29	5	-	-	-	-	-	-	-	-	-
SPT-1	2.50	8	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	4.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	4.50	16	18		SM		0	18	72	5	3	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	5.50	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	7.00	-	-		SM		0	24	68	6	1	1	0	-	Nil	NP	-	1.78	16.32	1.53	2.62	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-4	8.50	17	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	10.00	-	-	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		12	51	26	7	2	2	0	33	22	11	-	1.95	25.74	1.55	2.68	UUT	0.70	5	-	-	-	-	-	-	-	-	-
SPT-5	11.50	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	13.00	-	-		CL		10	54	28	6	1	1	0	31	21	10	-	1.95	25.60	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	14.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	16.00	-	-		CL		11	46	32	4	3	4	0	32	21	11	-	1.99	23.80	1.61	2.67	UUT	1.12	4	-	-	-	-	-	-	-	-	-
SPT-7	17.50	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	19.00	-	-		CL		13	50	24	5	3	5	0	34	23	11	-	2.01	22.64	1.64	2.67	UUT	1.58	5	-	-	-	-	-	-	-	-	-
SPT-8	20.50	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	22.00	-	-		CL		12	45	30	5	1	7	0	33	22	11	-	2.02	21.96	1.66	2.68	UUT	2.02	4	-	-	-	-	-	-	-	-	-
SPT-9	23.50	63	63		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		CL		11	47	28	6	2	6	0	31	20	11	-	2.03	20.30	1.69	2.67	UUT	2.58	4	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

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		14-11-2021	to	15-11-2021	19+500 Major Bridge	BH-A1	0.60 m	40.00 m	703426.871 m	3118866.702 m	(+)190.997 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	26.50	78	78	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	28.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.50	83	83		CL		10	50	28	5	2	5	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	90	90		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	31.00	100 (29cm)	-	Brown, Very dense, Silty sand with gravel	SM-SC		6	32	51	7	1	3	0	25	19	6	-	1.98	18.50	1.67	2.65	DST+	0.13	32	-	-	-	-	-	-	-	-	-	-
SPT-14	32.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	34.00	100 (25cm)	-		SM-SC		5	36	50	6	2	1	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	35.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	37.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	38.50	100 (24cm)	-		SM-SC		6	34	51	6	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	40.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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							08-10-2021	to	10-10-2021	19+500 Major Bridge	BH-P1	1.85 m	40.00 m	703375.297 m	3118862.655 m	(+)191.964 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	6	6		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		11	56	28	3	1	1	0	32	22	10	-	1.86	28.11	1.45	2.68	UUT	0.22	5	-	-	-	-	-	-	-	-	-
SPT-2	4.00	15	15	Brown, Stiff to very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		12	59	24	2	1	2	0	34	23	11	-	1.93	27.13	1.52	2.67	UUT	0.52	5	-	-	-	-	-	-	-	-	-
SPT-3	7.00	14	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		10	57	23	4	3	3	0	31	20	11	-	1.94	26.85	1.53	2.68	UUT	0.60	4	-	-	-	0.750	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.04 6.84 5.53 4.84	2.31 1.64 1.13 0.68	0.150
SPT-4	10.00	17	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		11	57	20	6	2	4	0	33	22	11	-	1.96	25.54	1.56	2.68	UUT	0.76	4	-	-	-	-	-	-	-	-	-
SPT-5	13.00	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	53	23	5	3	4	0	33	22	11	-	1.99	24.16	1.60	2.67	UUT	1.12	5	-	-	-	-	-	-	-	-	-
SPT-6	16.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		11	55	21	4	4	5	0	32	21	11	-	2.00	24.10	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	53	20	6	2	7	0	33	22	11	-	2.04	21.24	1.68	2.69	UUT	2.41	4	-	-	-	-	-	-	-	-	-
SPT-8	22.00	75	75		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		CL		13	53	19	4	3	6	2	34	23	11	-	2.04	21.38	1.68	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	70	70		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		08-10-2021	to	10-10-2021	19+500 Major Bridge	BH-P1	1.85 m	40.00 m	703375.297 m	3118862.655 m	(+)191.964 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	26.95	75	75	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	51	23	3	3	10	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.00	82	82		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	100 (22cm)	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	44	34	5	3	6	0	28	21	7	-	1.96	18.50	1.65	2.66	DST+	0.18	30	-	-	-	-	-	-	-	-	-
SPT-13	31.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	32.50	78	78	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	55	20	5	1	9	0	31	21	10	-	2.04	21.00	1.69	2.68	UUT+	2.52	4	-	-	-	-	-	-	-	-	-
SPT-15	34.00	68	68		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	35.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	35.95	82	82		CL		11	53	22	5	1	7	1	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	37.00	73	73		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	38.50	97	97		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	40.00	92	92		CL		11	51	21	6	3	8	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		09-10-2021	to	10-10-2021	19+500 Major Bridge	BH-A2	1.60 m	40.00 m	703323.723 m	3118858.609 m	(+)191.063 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		11	59	19	5	4	2	0	32	21	11	-	1.95	26.70	1.54	2.68	UUT	0.63	5	-	-	-	-	-	-	-	-	-
SPT-1	2.50	18	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		12	61	16	7	1	3	0	34	23	11	-	1.95	26.55	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Medium stiff, Silty clay of low plasticity	CL		12	61	20	4	3	0	0	33	22	11	-	1.87	28.13	1.46	2.69	UUT	0.30	5	-	-	-	-	-	-	-	-	-
SPT-3	8.50	8	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		13	56	19	3	3	6	0	34	22	12	-	2.02	22.20	1.65	2.68	UUT	1.85	4	-	-	-	-	-	-	-	-	-
SPT-4	11.50	58	58		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		12	52	21	6	2	5	2	33	22	11	-	2.02	22.16	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	56	56		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		15	52	17	5	3	8	0	34	23	11	-	2.04	21.15	1.68	2.67	UUT	3.12	4	-	-	-	-	-	-	-	-	-
SPT-6	17.50	100 (25cm)	100 (25cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	100 (18cm)	100 (18cm)		CL		11	57	20	5	2	5	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	75	75		CL		12	51	23	4	3	6	1	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	100 (19cm)	100 (19cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	100 (25cm)	100 (25cm)		CL		10	51	22	5	2	10	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	100 (23cm)	100 (23cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							09-10-2021	to	10-10-2021	19+500 Major Bridge	BH-A2	1.60 m	40.00 m	703323.723 m	3118858.609 m	(+)191.063 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	28.00	100 (23cm)	100 (23cm)	Brown, Hard, Silty clay of low plasticity with gravel	CL		9	53	26	2	3	7	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	100 (23cm)	100 (23cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	31.00	>100	-		CL		12	54	23	3	2	6	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	32.50	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	34.00	73	73		CL		11	47	26	5	3	8	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	35.50	81	81		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	37.00	-	-		CL		14	47	24	5	2	5	3	34	23	11	-	2.03	21.60	1.67	2.68	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	38.50	98	98		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	40.00	100 (19cm)	100 (19cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		12-11-2021	to	12-11-2021	19+715 Major Bridge	BH-A1	0.85 m	30.00 m	703175.974 m	3118849.670 m	(+)190.645 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Greyish brown, Soft to medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	4	4		CL		12	64	14	8	2	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		13	62	18	5	1	1	0	34	23	11	-	1.85	27.60	1.45	2.67	UUT	0.22	5	-	-	-	-	-	-	-	-	-	-
SPT-2	4.00	7	7		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Greyish brown, Medium dense, Silty sand	SM		0	20	71	6	1	2	0	-	Nil	NP	-	1.76	14.61	1.54	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	18	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	9.00	20	20	Greyish brown, Very stiff, Silty clay of low plasticity	CL		10	50	27	8	3	2	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	10.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.50	-	-		CL		11	52	28	5	1	3	0	32	21	11	-	1.96	25.51	1.56	2.67	UUT	0.75	5	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		CL		12	51	25	3	5	4	0	33	22	11	-	1.97	24.82	1.58	2.68	UUT	0.92	5	-	-	-	-	-	-	-	-	-	-
SPT-7	16.00	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-	Greyish brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		7	51	31	3	2	6	0	27	20	7	-	1.89	19.40	1.58	2.66	DST	0.21	27	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	41	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		6	49	30	6	1	8	0	26	20	6	-	1.91	19.12	1.60	2.67	DST	0.19	28	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	54	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	23.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	24.00	60	30		ML-CL		8	48	29	3	4	7	1	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		12-11-2021	to	12-11-2021	19+715 Major Bridge	BH-A1	0.85 m	30.00 m	703175.974 m	3118849.670 m	(+)190.645 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	25.00	95	95	Greyish brown, Hard, Silty clay of low plasticity with gravel	CL		11	47	25	6	1	10	0	31	21	10	-	2.04	21.00	1.69	2.68	UUT+	2.59	6	-	-	-	-	-	-	-	-
SPT-12	26.50	77	77		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.00	81	81		CL		12	46	23	4	3	12	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	100 (20cm)	100 (20cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-	Greyish brown, Medium stiff, Silty clay of high plasticity	CI		16	65	13	5	1	0	0	38	24	14	-	1.85	28.70	1.44	2.70	UUT	0.18	5	-	-	-	-	-	-	-	-	-
SPT-1	2.50	5	5		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	25	67	5	2	1	0	-	Nil	NP	-	1.74	14.60	1.52	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	5.50	13	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	7.00	-	-	Greyish brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.50	16	17		SM		0	19	71	7	1	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	8.50	10	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	10.00	-	-		ML-CL		7	49	32	5	3	4	0	27	20	7	-	1.89	19.40	1.58	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-5	11.50	36	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	13.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.50	35	24	Greyish brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		6	50	31	3	4	4	2	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	14.50	40	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	16.00	-	-		ML-CL		8	47	30	8	2	5	0	28	21	7	-	1.89	19.14	1.59	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-8	17.50	40	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	19.00	-	-		CL		12	53	20	5	2	8	0	33	22	11	-	2.02	22.36	1.65	2.68	UUT	1.83	6	-	-	-	-	-	-	-	-	-
SPT-9	20.50	54	54	Greyish brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	22.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.50	57	57		CL		11	44	26	7	3	7	2	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		13-11-2021	to	14-11-2021	19+715 Major Bridge	BH-P1	0.80 m	30.00 m	703164.075 m	3118849.544 m	(+)190.671 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	23.50	61	61	Greyish brown, Hard, Silty clay of low plasticity with gravel	CL		13	48	20	6	2	11	0	34	23	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	25.50	68	68		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	26.50	75	75		CL		12	45	25	2	6	10	0	33	22	11	-	2.03	21.00	1.68	2.68	UUT+	2.41	5	-	-	-	-	-	-	-	-
UDS*	28.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	28.50	84	84		CL		11	49	23	3	2	12	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	29.50	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							14-11-2021	to	16-11-2021	19+715 Major Bridge	BH-A2	0.45 m	30.00 m	703152.175 m	3118849.568 m	(+)190.592 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Greyish brown, Stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	9		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		13	60	18	7	1	1	0	34	23	11	-	1.87	28.16	1.46	2.67	UUT	0.31	5	-	-	-	0.825	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.52 7.50 6.86 5.68	2.45 1.86 1.18 0.75	0.1730
SPT-2	4.00	6	6		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		12	53	23	10	2	0	0	33	22	11	-	1.92	27.35	1.51	2.68	UUT	0.49	4	-	-	-	-	-	-	-	-
SPT-3	7.00	14	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	9.00	21	19	Greyish brown, Medium dense, Silty sand	SM		0	25	68	7	0	0	0	-	Nil	NP	-	1.81	16.50	1.55	2.62	DST+	0.00	30	-	-	-	-	-	-	-	-
SPT-5	10.00	29	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	11.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	12.00	37	26	Greyish brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		7	48	26	12	3	4	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	13.00	32	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	14.50	-	-		ML-CL		8	46	31	11	0	4	0	28	21	7	-	1.88	19.78	1.57	2.66	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-8	16.00	31	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	17.50	-	-	Greyish brown, Hard, Silty clay of low plasticity with gravel	CL		13	57	16	6	2	6	0	34	23	11	-	2.01	23.06	1.63	2.67	UUT	1.48	5	-	-	-	-	-	-	-	-
SPT-9	19.00	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	20.50	-	-		CL		11	52	20	7	4	6	0	31	20	11	-	2.01	22.10	1.65	2.68	UUT	1.85	4	-	-	-	-	-	-	-	-
SPT-10	22.00	56	56		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	23.50	-	-		CL		11	44	25	10	2	8	0	32	21	11	-	2.02	21.16	1.67	2.67	UUT	2.24	5	-	-	-	-	-	-	-	-
SPT-11	25.00	66	66		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-11-2021	to	16-11-2021	19+715 Major Bridge	BH-A2	0.45 m	30.00 m	703152.175 m	3118849.568 m	(+)190.592 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS*	26.50	-	-	Greyish brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	27.00	73	73		CL		12	49	19	6	3	11	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.00	83	83		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	30.00	88	58		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEG TEST HOUSE
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SOIL CHARACTERISTICS

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		13-11-2021	to	14-11-2021	20+300 Major Bridge	BH-A1	1.00 m	40.00 m	702617.165 m	3118908.161 m	(+)190.950 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	18	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	51	31	9	2	1	0	27	20	7	-	1.87	19.78	1.56	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-2	4.00	20	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Dense, Silty sand with clay & gravel	SM-SC		5	34	48	5	3	5	0	25	20	5	-	1.87	17.16	1.60	2.65	DST	0.11	30	-	-	-	-	-	-	-	-	-
SPT-3	7.00	38	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard with gravel Silty clay of low plasticity	CL		11	51	22	8	2	5	1	32	21	11	-	2.00	22.90	1.63	2.67	UUT	1.52	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		12	51	23	6	2	6	0	33	22	11	-	2.02	22.14	1.65	2.68	UUT	1.70	6	-	-	-	-	-	-	-	-	-
SPT-5	13.00	53	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		12	53	22	3	2	8	0	32	21	11	-	2.02	22.20	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	53	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		13	54	20	5	1	7	0	34	23	11	-	2.02	22.22	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	18.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	59	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		11	48	21	8	3	9	0	32	21	11	-	2.02	21.66	1.66	2.68	UUT	1.97	5	-	-	-	-	-	-	-	-	-
SPT-9	22.00	72	72		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	23.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	24.00	57	57		CL		10	53	24	4	1	6	2	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.50	61	61		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

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		13-11-2021	to	14-11-2021	20+300 Major Bridge	BH-A1	1.00 m	40.00 m	702617.165 m	3118908.161 m	(+)190.950 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-8	26.50	-	-	Brown, Hard with gravel Silty clay of low plasticity	CL		13	48	23	5	3	8	0	34	23	11	-	2.02	21.80	1.66	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	55	55		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	30.00	61	61		CL		12	54	21	3	2	7	1	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	31.00	66	66		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	32.50	-	-		CL		11	52	20	6	2	9	0	31	20	11	-	2.03	21.05	1.68	2.67	UUT	2.35	6	-	-	-	-	-	-	-	-
SPT-15	34.00	71	71		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	35.50	78	78		CL		12	52	19	4	1	12	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	37.00	77	77		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	38.50	100 (25cm)	100 (25cm)		CL		11	47	22	8	2	10	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	40.00	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							09-10-2021	to	11-10-2021	20+300 Major Bridge		BH-P1		2.10 m		40.00 m		702589.211 m			3118911.568 m			(+)191.187 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		11	61	20	3	4	1	0	31	21	10	-	1.87	28.13	1.46	2.68	UUT	0.30	5	-	-	-	-	-	-	-	-	-
SPT-1	2.50	8	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL		8	54	31	3	2	2	0	28	21	7	-	1.85	20.45	1.54	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-2	5.50	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	55	29	6	1	2	0	27	20	7	-	1.85	20.30	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	22	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	54	27	5	4	3	0	26	19	7	-	1.90	20.30	1.58	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-4	11.50	33	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		6	54	28	4	3	5	0	26	20	6	-	1.91	20.65	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	40	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	49	29	6	2	4	2	27	20	7	-	1.90	20.47	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	50	50	Brown, Hard with gravel Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		CL		9	53	28	4	1	5	0	30	20	10	-	2.01	22.67	1.64	2.68	UUT	1.65	4	-	-	-	-	-	-	-	-	-
SPT-7	19.50	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	58	58		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		CL		11	54	22	4	2	7	0	33	21	12	-	2.02	21.18	1.67	2.67	UUT	2.18	5	-	-	-	-	-	-	-	-	-
SPT-9	23.50	68	68		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		CL		12	53	20	3	2	10	0	33	22	11	-	2.05	20.40	1.70	2.68	UUT	3.14	4	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		09-10-2021	to	11-10-2021	20+300 Major Bridge	BH-P1	2.10 m	40.00 m	702589.211 m	3118911.568 m	(+)191.187 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	26.50	100 (20cm)	100 (20cm)	Brown, Hard with gravel Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.00	100 (19cm)	100 (19cm)		CL		11	50	22	4	3	8	2	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	31.50	100 (21cm)	100 (21cm)		CL		11	44	20	4	8	13	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	32.50	100 (21cm)	100 (21cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	34.00	100 (20cm)	100 (20cm)		CL		12	56	18	3	2	9	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	35.50	100 (19cm)	100 (19cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	37.00	100 (19cm)	100 (19cm)		CL		12	48	19	5	3	12	1	34	23	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	38.50	100 (23cm)	100 (23cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	40.00	100 (25cm)	100 (25cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

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							09-10-2021	to	11-10-2021	20+300 Major Bridge	BH-P2	2.25 m	40.00 m	702570.093 m	3118913.897 m	(+)191.622 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	8	8		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		10	58	25	4	2	1	0	30	20	10	-	1.87	28.13	1.46	2.68	UUT	0.29	5	-	-	-	0.835	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	9.39 7.44 6.48 5.14	2.54 1.90 1.31 0.76	0.173
SPT-2	4.00	13	16	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	56	30	3	2	2	0	27	20	7	-	1.84	20.30	1.53	2.66	DST	0.21	25	-	-	-	-	-	-	-	-
SPT-3	7.00	18	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	53	28	5	3	2	1	28	21	7	-	1.86	20.14	1.55	2.66	DST	0.20	26	-	-	-	-	-	-	-	-
SPT-4	10.00	24	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		6	53	30	4	3	4	0	26	20	6	-	1.87	19.88	1.56	2.65	DST	0.19	28	-	-	-	-	-	-	-	-
SPT-5	13.00	33	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	53	27	6	2	5	0	27	20	7	-	1.89	19.80	1.58	2.66	DST	0.20	28	-	-	-	-	-	-	-	-
SPT-6	16.00	45	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		7	45	30	8	4	4	2	28	21	7	-	1.89	19.64	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	51	51	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		10	55	21	4	3	7	0	30	20	10	-	2.02	22.14	1.65	2.68	UUT	1.82	5	-	-	-	-	-	-	-	-
SPT-8	22.00	62	62		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		CL		12	51	18	6	2	11	0	33	22	11	-	2.08	22.10	1.70	2.67	UUT	3.14	4	-	-	-	-	-	-	-	-
SPT-9	25.00	100 (25cm)	100 (25cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	100 (22cm)	100 (22cm)		CL		11	49	22	5	3	9	1	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							09-10-2021	to	11-10-2021	20+300 Major Bridge	BH-P2	2.25 m	40.00 m	702570.093 m	3118913.897 m	(+)191.622 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	100 (21cm)	100 (21cm)	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	>100	-		CL		10	51	23	5	4	7	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	31.00	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	32.50	100 (20cm)	100 (20cm)		CL		10	50	20	6	3	8	3	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	34.00	100 (25cm)	100 (25cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	35.50	>100	-		CL		12	49	16	9	2	12	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	37.00	100 (27cm)	100 (27cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	38.50	100 (24cm)	100 (24cm)		CL		11	49	17	11	4	8	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)				R.L.		Ref. Code					
						15-11-2021	to	17-11-2021	20+300 Major Bridge		BH-A2		2.55 m		40.00 m		702548.989 m		3118916.469 m		(+)191.622 m		SR-544_21-22					
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Stiff to very stiff, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		11	53	30	5	1	0	0	31	21	10	-	1.88	27.36	1.48	2.67	UUT	0.37	5	-	-	-	-	-	-	-	-	-
SPT-1	2.50	10	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		12	52	27	4	3	2	0	32	21	11	-	1.94	25.41	1.55	2.68	UUT	0.70	4	-	-	-	-	-	-	-	-	-
SPT-2	4.50	18	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		11	50	30	6	2	1	0	31	21	10	-	1.94	25.29	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		13	52	24	5	3	3	0	34	23	11	-	1.98	24.49	1.59	2.67	UUT	0.95	5	-	-	-	-	-	-	-	-	-
SPT-4	11.50	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	52	25	6	1	4	0	33	22	11	-	1.98	23.29	1.61	2.67	UUT	1.16	5	-	-	-	-	-	-	-	-	-
SPT-5	14.50	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		10	49	28	7	2	4	0	30	20	10	-	1.98	23.10	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		8	43	38	4	2	5	0	28	21	7	-	1.91	19.56	1.60	2.66	DST	0.21	28	-	-	-	-	-	-	-	-	-
SPT-7	20.50	43	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		6	47	31	7	2	7	0	26	20	6	-	1.91	19.27	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	48	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.50	62	28		ML-CL		7	47	33	4	3	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		15-11-2021	to	17-11-2021	20+300 Major Bridge	BH-A2	2.55 m	40.00 m	702548.989 m	3118916.469 m	(+)191.622 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	26.50	68	30	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	28.00	-	-		ML-CL		6	46	35	3	2	8	0	26	20	6	-	1.93	18.96	1.62	2.66	DST	0.18	30	-	-	-	-	-	-	-	-	-
SPT-11	29.50	80	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	31.00	-	-		ML-CL		7	47	32	4	3	7	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	84	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (30cm)	100 (30cm)	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	41	29	6	1	11	0	33	22	11	-	2.05	20.50	1.70	2.68	UUT+	3.18	4	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (27cm)	100 (27cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (23cm)	100 (23cm)		CL		11	46	28	5	1	9	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	100 (21cm)	100 (21cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

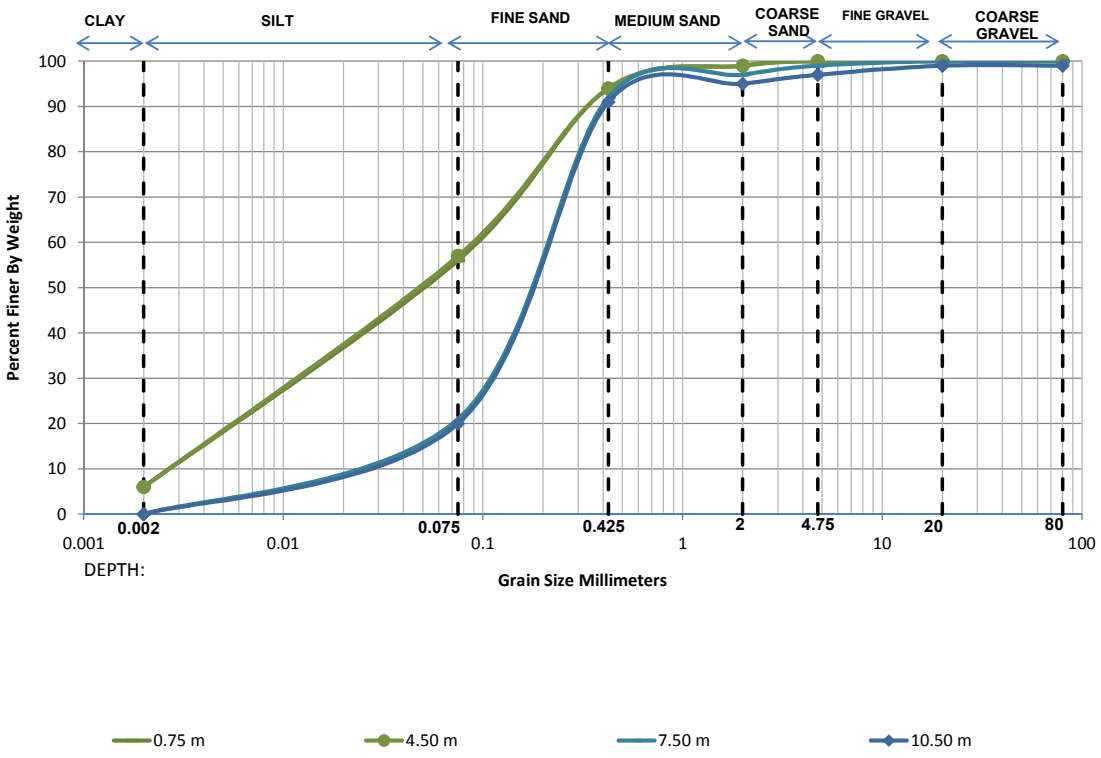
Sr. No	Chainage Old (km)	Chainage New (km)	BH No.	Depth of collected sample (m)	pH	Chlorides (Cl^-)		Sulphate (SO_3^{2-})	
						(mg/kg)	(%)	(mg/kg)	(%)
1.	1+006	1+696	BH-A1	2.50	7.19	80.65	0.0081	29.84	0.0030
2.			BH-A2	23.50	8.23	76.55	0.0076	24.87	0.0025
3.	2+788	3+476	BH-A1	2.50	7.34	74.81	0.0075	29.52	0.0030
4.			BH-A2	23.50	6.54	70.05	0.0070	30.34	0.0030
5.	3+497	4+242	BH-A1	4.00	8.26	66.53	0.0067	31.10	0.0031
6.			BH-P1	23.50	9.30	88.42	0.0088	32.67	0.0033
7.	3+691	4+376	BH-A1	2.50	7.12	80.55	0.0081	20.58	0.0021
8.			BH-A2	19.00	7.50	82.54	0.0083	22.57	0.0023
9.	7+078	7+759	BH-A1	4.00	7.35	71.61	0.0072	28.51	0.0029
10.			BH-A2	20.50	7.54	70.55	0.0071	31.52	0.0032
11.	7+351	8+036	BH-A1	2.50	8.56	73.83	0.0074	32.51	0.0033
12.			BH-A2	19.00	8.65	74.58	0.0075	24.29	0.0025
13.	7+613	8+298	BH-A1	2.50	7.30	74.58	0.0075	21.55	0.0022
14.			BH-A2	19.00	7.56	84.55	0.0085	26.68	0.0027
15.	8+852	9+537	BH-A1	2.50	9.51	88.96	0.0089	29.51	0.0030
16.			BH-A2	22.00	7.20	78.59	0.0079	19.20	0.0019
17.	9+726	10+410	BH-A1	1.00	7.64	84.55	0.0085	24.52	0.0025
18.			BH-A2	26.50	7.13	91.44	0.0090	27.64	0.0028
19.	10+025	10+709	BH-A1	1.00	7.57	78.64	0.0079	19.68	0.0020
20.			BH-A2	17.50	7.15	66.51	0.0067	22.53	0.0023
21.	10+859	11+543	BH-A1	2.50	7.67	89.56	0.0090	28.68	0.0029
22.			BH-A2	25.00	7.83	74.52	0.0075	31.65	0.0032
23.	18+750	19+435	BH-A1	1.00	7.21	88.86	0.0089	22.44	0.0022
24.			BH-A2	25.00	7.65	89.55	0.0090	20.51	0.0021
25.	19+500	20+185	BH-A1	2.50	8.88	78.65	0.0079	14.51	0.0015
26.			BH-A2	25.00	7.68	92.65	0.0093	17.70	0.0018
27.	19+715	20+400	BH-A1	1.00	7.51	90.52	0.0091	19.54	0.0020
28.			BH-A2	35.30	8.20	89.85	0.0090	21.80	0.0022
29.	20+300	20+985	BH-A1	2.50	8.34	84.55	0.0085	24.64	0.0025
30.			BH-A2	25.00	7.65	85.40	0.0085	25.88	0.0026

RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLE

Sr. No	Chainage Old (km)	Chainage New (km)	BH No.	pH	Chlorides (Cl^-) (mg/l)	Sulphate (SO_3^{2-}) (mg/l)
1.	1+006	1+696	BH-P2	8.69	52.81	23.09
2.	2+788	3+476	BH-A1	8.11	39.36	33.21
3.	3+497	4+242	BH-A1	8.85	57.55	24.60
4.	3+691	4+376	BH-A1	8.14	51.00	30.11
5.	7+078	7+759	BH-A2	7.41	32.12	25.77
6.	7+351	8+036	BH-A1	7.91	51.31	28.07
7.	7+613	8+298	BH-A2	7.02	87.21	15.14
8.	8+852	9+537	BH-A2	8.47	70.12	26.45
9.	9+726	10+410	BH-A2	9.44	42.69	26.65
10.	10+025	10+709	BH-A1	8.77	54.10	15.55
11.	10+859	11+543	BH-A2	7.47	59.12	14.65
12.	17+625	18+310	BH-A1	7.11	61.45	18.32
13.	17+872	18+558	BH-A2	7.65	65.27	19.67
14.	18+750	19+435	BH-A1	7.45	66.44	21.74
15.	19+500	20+185	BH-A2	7.49	78.45	22.56
16.	19+715	20+400	BH-A2	6.84	79.44	18.77
17.	20+300	20+985	BH-A1	6.74	81.54	24.77

GRAIN SIZE DISTRIBUTION CURVES

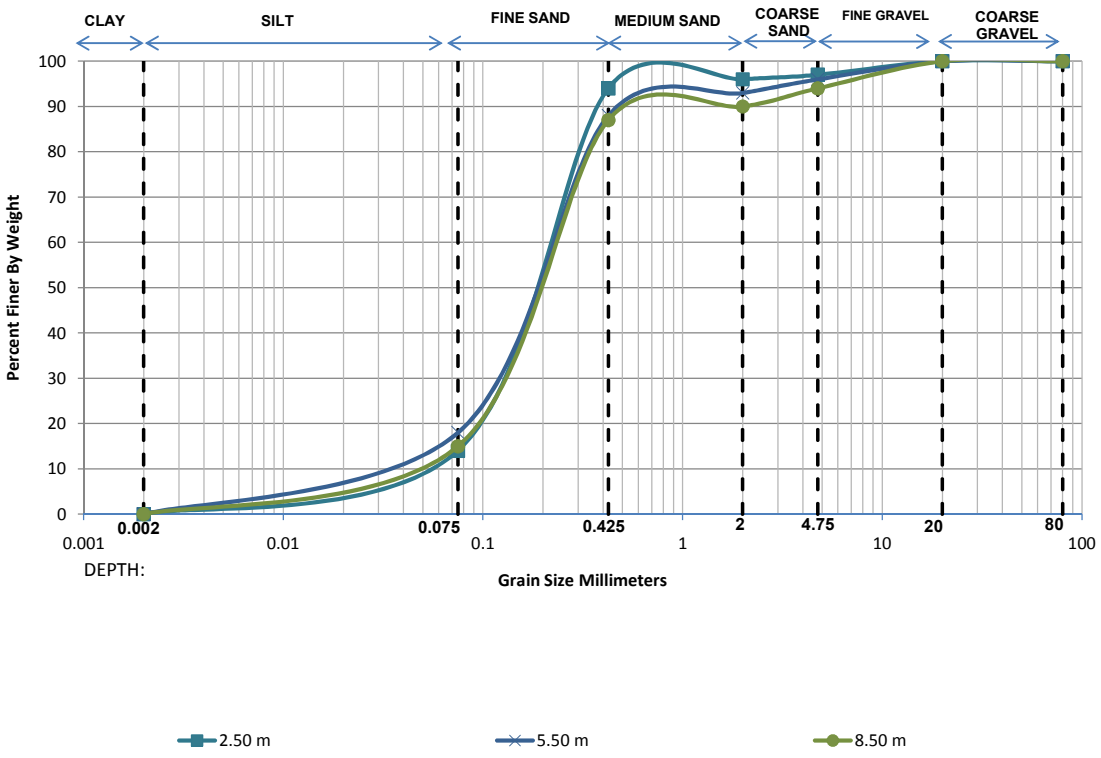
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	New Ch. 0+000 Prithla Station
B.H. No.	BH-PLT-09



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.75 m	6.00	50.00	38.00	5.00	1.00	0.00	0.00	0.0044	0.0247	0.0871	19.71	1.59
4.50 m	6.00	51.00	37.00	5.00	1.00	0.00	0.00	0.0044	0.0241	0.0837	19.05	1.57
7.50 m	0.00	21.00	71.00	5.00	2.00	1.00	0.00	0.0257	0.1088	0.2144	8.33	2.14
10.50 m	0.00	20.00	71.00	4.00	2.00	2.00	0.00	0.0280	0.1131	0.2193	7.83	2.08

GRAIN SIZE DISTRIBUTION CURVES

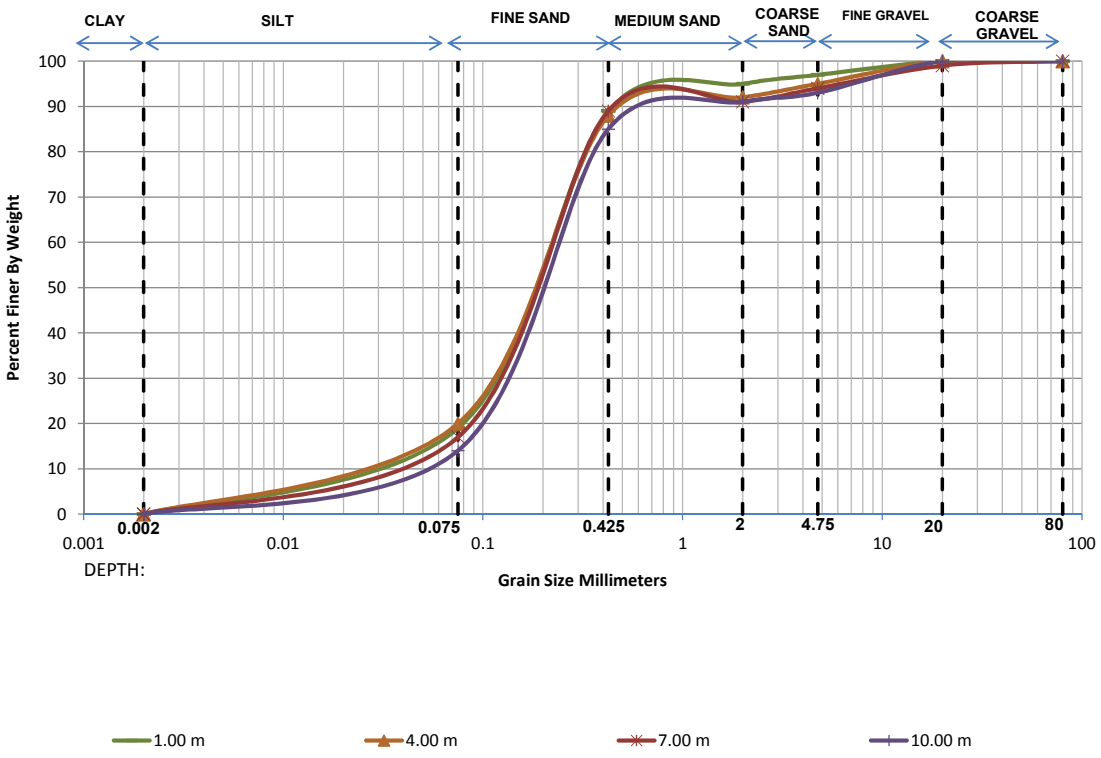
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)0+627 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	14.00	80.00	2.00	1.00	3.00	0.00	0.0508	0.1378	0.2308	4.54	1.62
5.50 m	0.00	18.00	70.00	5.00	3.00	4.00	0.00	0.0335	0.1224	0.2327	6.95	1.92
8.50 m	0.00	15.00	72.00	3.00	4.00	6.00	0.00	0.0453	0.1361	0.2434	5.38	1.68

GRAIN SIZE DISTRIBUTION CURVES

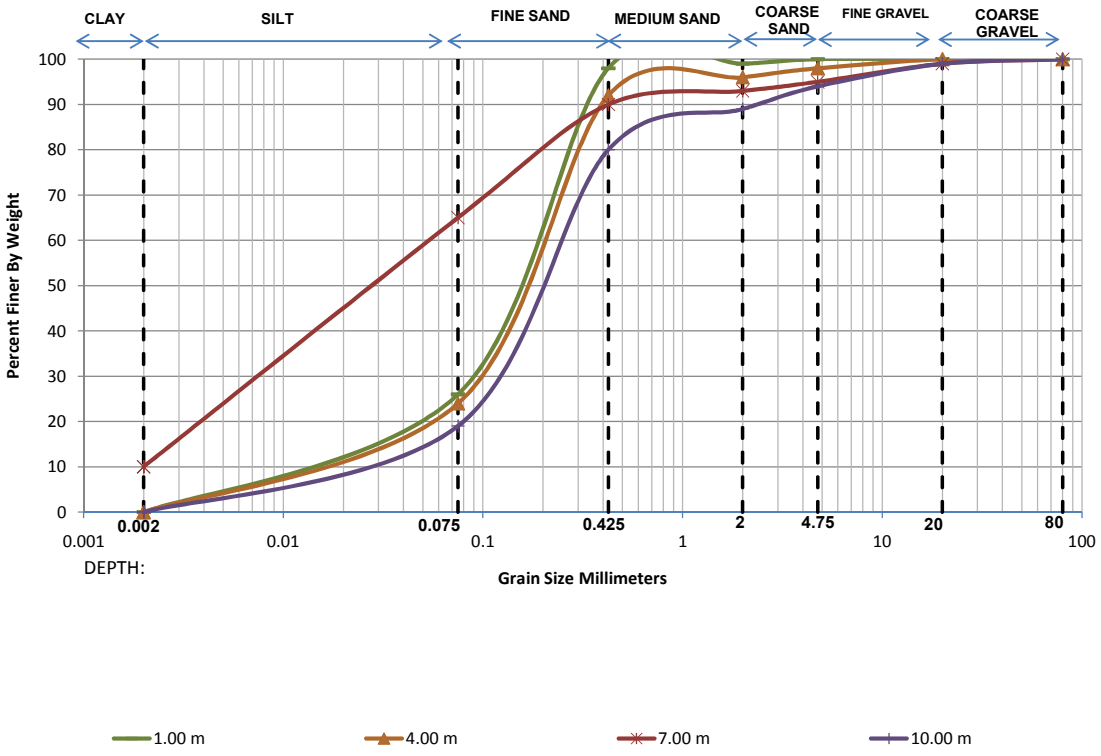
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)0+529 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	19.00	70.00	6.00	2.00	3.00	0.00	0.0305	0.1179	0.2275	7.45	2.00
4.00 m	0.00	20.00	68.00	4.00	3.00	5.00	0.00	0.0278	0.1138	0.2264	8.14	2.06
7.00 m	0.00	17.00	72.00	2.00	3.00	5.00	1.00	0.0370	0.1263	0.2323	6.27	1.86
10.00 m	0.00	14.00	71.00	6.00	2.00	7.00	0.00	0.0502	0.1419	0.2527	5.04	1.59

GRAIN SIZE DISTRIBUTION CURVES

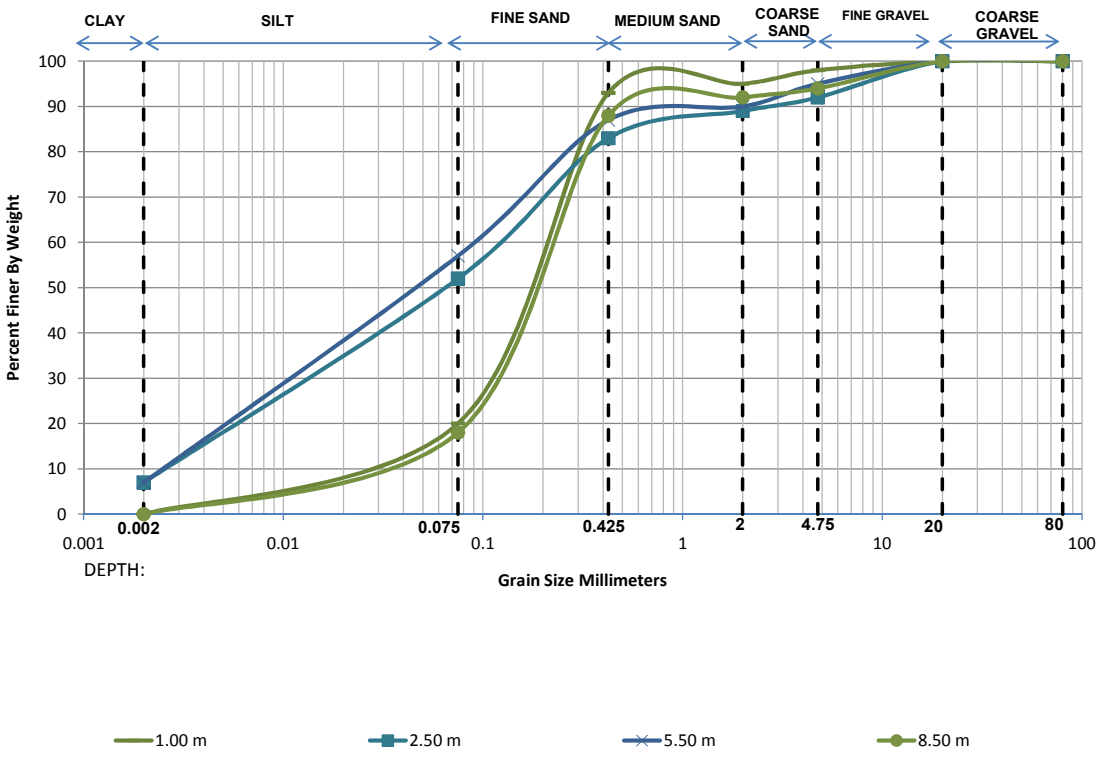
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	(-)0+319 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	26.00	72.00	1.00	1.00	0.00	0.00	0.0177	0.0888	0.1870	10.59	2.39
4.00 m	0.00	24.00	68.00	4.00	2.00	2.00	0.00	0.0202	0.0969	0.2048	10.15	2.27
7.00 m	10.00	55.00	25.00	3.00	2.00	4.00	1.00	0.0020	0.0155	0.0634	31.71	1.90
10.00 m	0.00	19.00	61.00	9.00	5.00	5.00	1.00	0.0299	0.1210	0.2567	8.58	1.91

GRAIN SIZE DISTRIBUTION CURVES

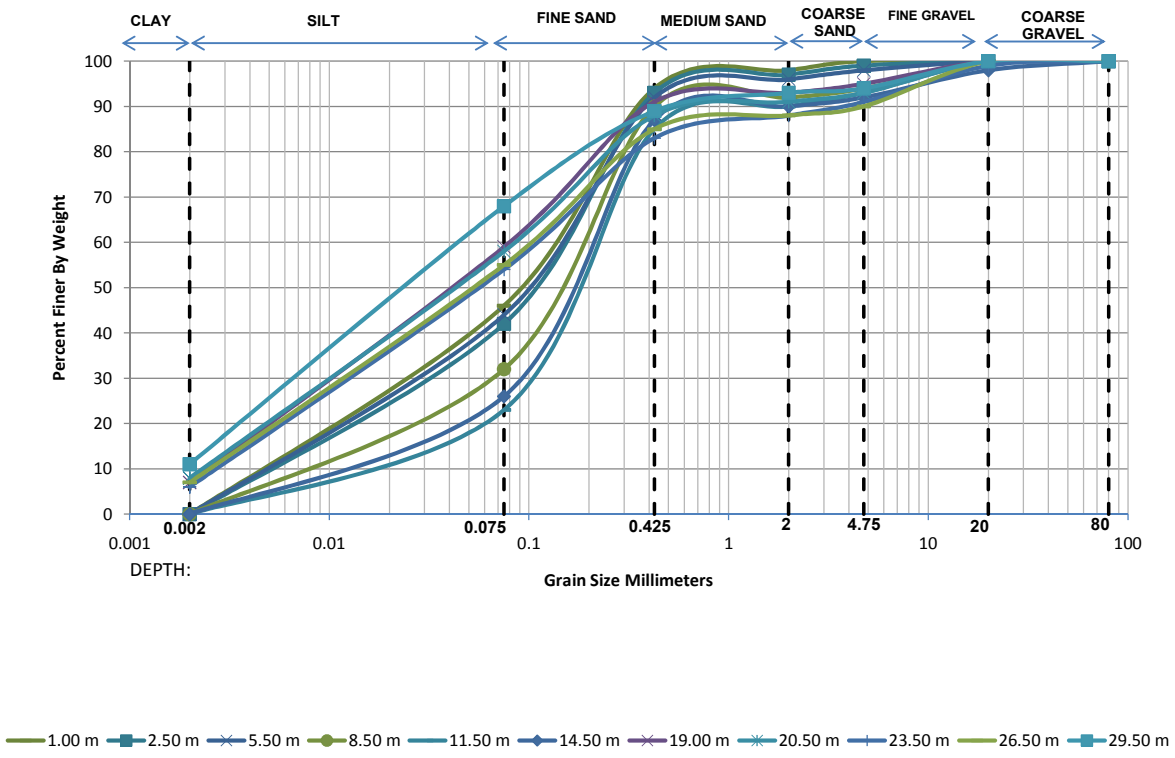
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	0+273 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	20.00	73.00	2.00	3.00	2.00	0.00	0.0281	0.1125	0.2145	7.62	2.10
2.50 m	7.00	45.00	31.00	6.00	3.00	8.00	0.00	0.0037	0.0261	0.1122	30.58	1.65
5.50 m	7.00	50.00	30.00	3.00	5.00	5.00	0.00	0.0036	0.0225	0.0849	23.70	1.66
8.50 m	0.00	18.00	70.00	4.00	2.00	6.00	0.00	0.0335	0.1224	0.2324	6.94	1.92

GRAIN SIZE DISTRIBUTION CURVES

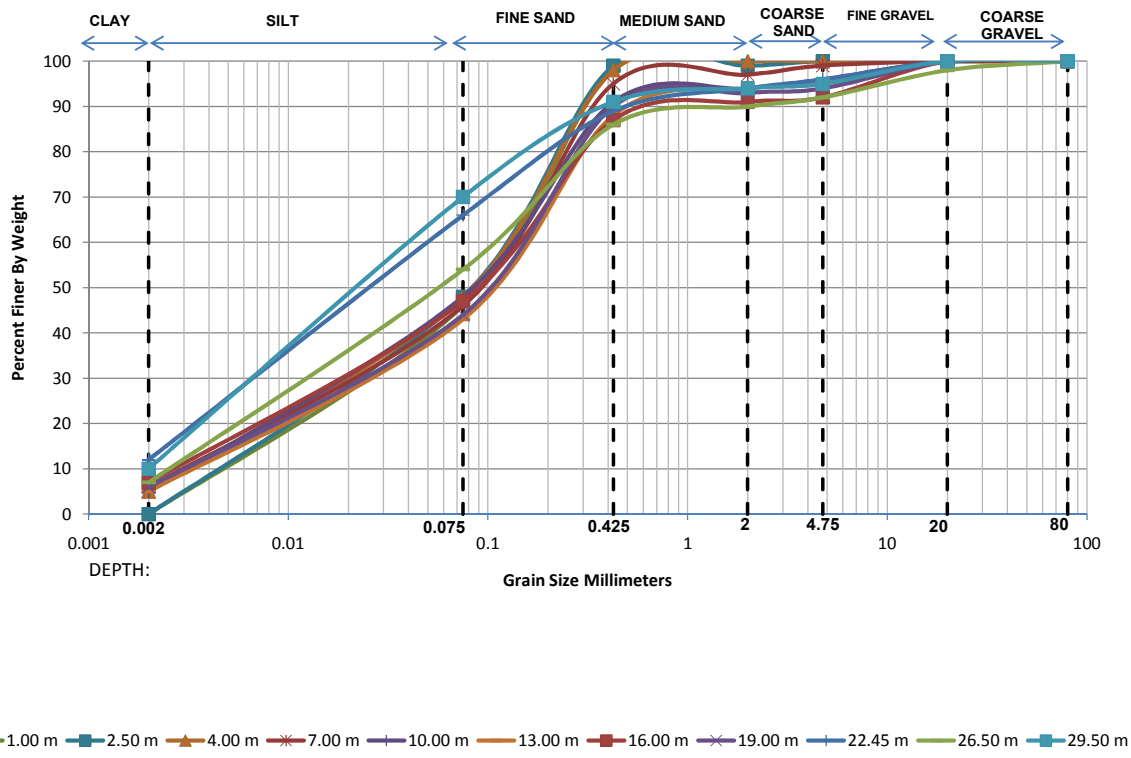
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	1+006 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	46.00	48.00	4.00	2.00	0.00	0.00	0.0064	0.0369	0.1239	19.31	1.71
2.50 m	0.00	42.00	51.00	4.00	2.00	1.00	0.00	0.0074	0.0435	0.1405	18.95	1.82
5.50 m	0.00	44.00	48.00	4.00	2.00	2.00	0.00	0.0069	0.0399	0.1341	19.57	1.74
8.50 m	0.00	32.00	58.00	2.00	2.00	6.00	0.00	0.0118	0.0684	0.1820	15.40	2.17
11.50 m	0.00	23.00	62.00	5.00	3.00	7.00	0.00	0.0214	0.1020	0.2259	10.55	2.15
14.50 m	0.00	26.00	61.00	3.00	2.00	6.00	2.00	0.0172	0.0897	0.2099	12.23	2.23
19.00 m	7.00	52.00	32.00	2.00	2.00	5.00	0.00	0.0036	0.0215	0.0777	21.82	1.67
20.50 m	8.00	50.00	30.00	3.00	2.00	7.00	0.00	0.0029	0.0208	0.0811	27.71	1.83
23.50 m	6.00	48.00	29.00	5.00	3.00	8.00	1.00	0.0044	0.0256	0.1011	22.71	1.45
26.50 m	7.00	48.00	30.00	3.00	2.00	10.00	0.00	0.0036	0.0238	0.0944	26.12	1.66
29.50 m	11.00	57.00	21.00	4.00	1.00	6.00	0.00	-	0.0136	0.0573	-	-

GRAIN SIZE DISTRIBUTION CURVES

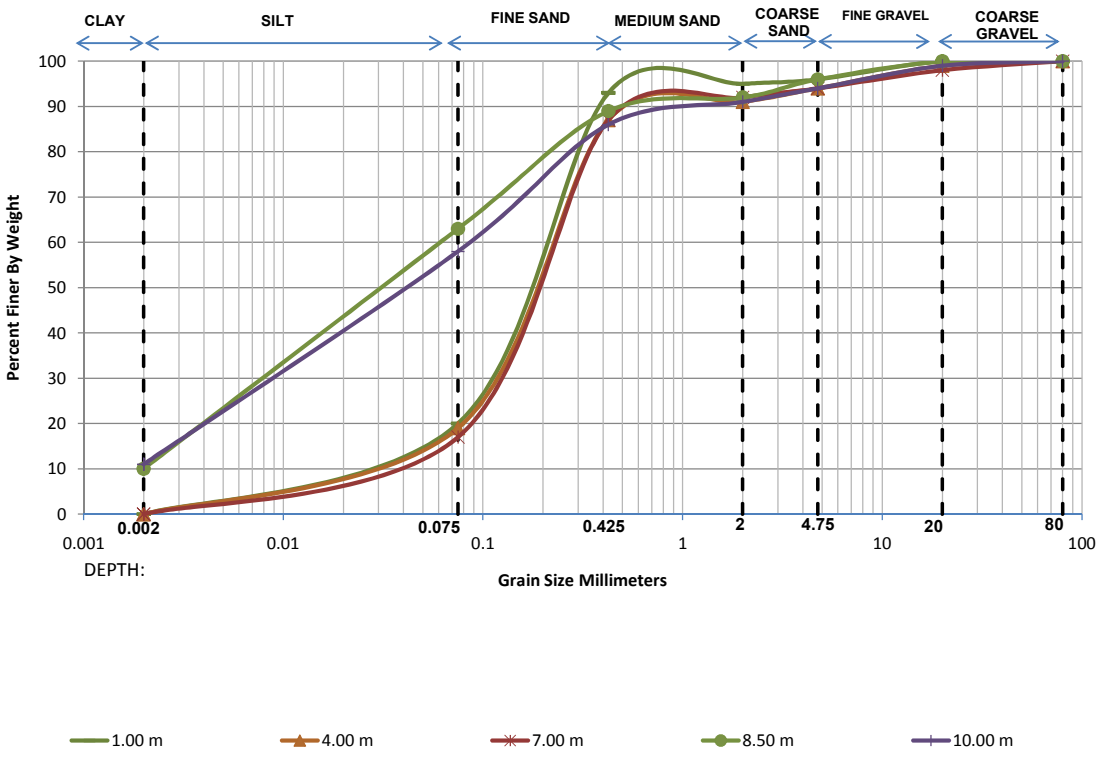
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	1+006 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	46.00	52.00	2.00	0.00	0.00	0.00	0.0065	0.0372	0.1199	18.50	1.78
2.50 m	0.00	48.00	51.00	0.00	1.00	0.00	0.00	0.0061	0.0344	0.1415	23.28	1.38
4.00 m	5.00	43.00	50.00	2.00	0.00	0.00	0.00	0.0059	0.0335	0.1144	19.53	1.68
7.00 m	6.00	40.00	49.00	2.00	2.00	1.00	0.00	0.0048	0.0347	0.1247	25.85	2.00
10.00 m	5.00	43.00	43.00	3.00	2.00	4.00	0.00	0.0058	0.0331	0.1204	20.70	1.56
13.00 m	5.00	38.00	45.00	6.00	1.00	5.00	0.00	0.0062	0.0398	0.1470	23.73	1.74
16.00 m	7.00	40.00	40.00	4.00	1.00	8.00	0.00	0.0038	0.0317	0.1309	34.37	2.02
19.00 m	6.00	38.00	46.00	3.00	1.00	6.00	0.00	0.0049	0.0373	0.1390	28.25	2.03
22.45 m	12.00	54.00	23.00	5.00	2.00	4.00	0.00	-	0.0134	0.0609	-	-
26.50 m	7.00	47.00	32.00	4.00	2.00	6.00	2.00	0.0036	0.0246	0.0986	27.13	1.69
29.50 m	10.00	60.00	21.00	3.00	1.00	5.00	0.00	0.0020	0.0139	0.0543	27.16	1.78

GRAIN SIZE DISTRIBUTION CURVES

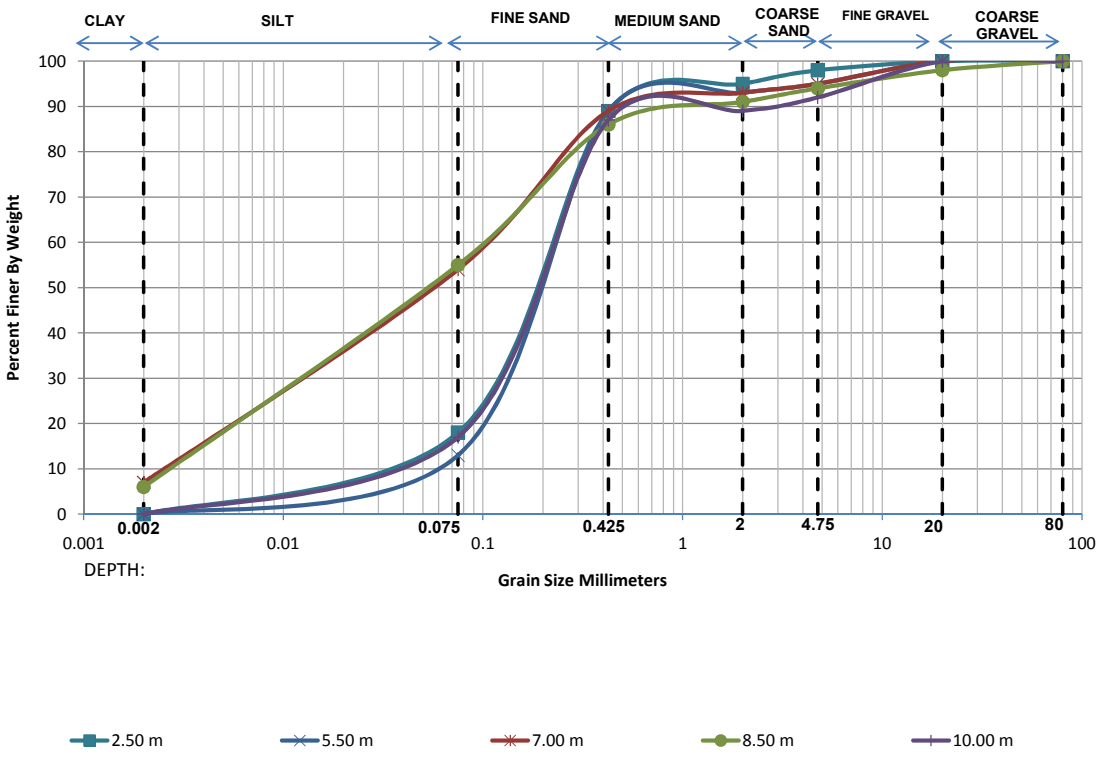
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	1+333 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	20.00	73.00	2.00	1.00	4.00	0.00	0.0281	0.1125	0.2145	7.62	2.10
4.00 m	0.00	19.00	68.00	4.00	3.00	5.00	1.00	0.0304	0.1184	0.2320	7.63	1.99
7.00 m	0.00	17.00	70.00	5.00	2.00	4.00	2.00	0.0369	0.1272	0.2382	6.46	1.84
8.50 m	10.00	53.00	26.00	3.00	4.00	4.00	0.00	0.0020	0.0163	0.0677	33.85	1.96
10.00 m	11.00	47.00	28.00	5.00	3.00	5.00	1.00	-	0.0177	0.0817	-	-

GRAIN SIZE DISTRIBUTION CURVES

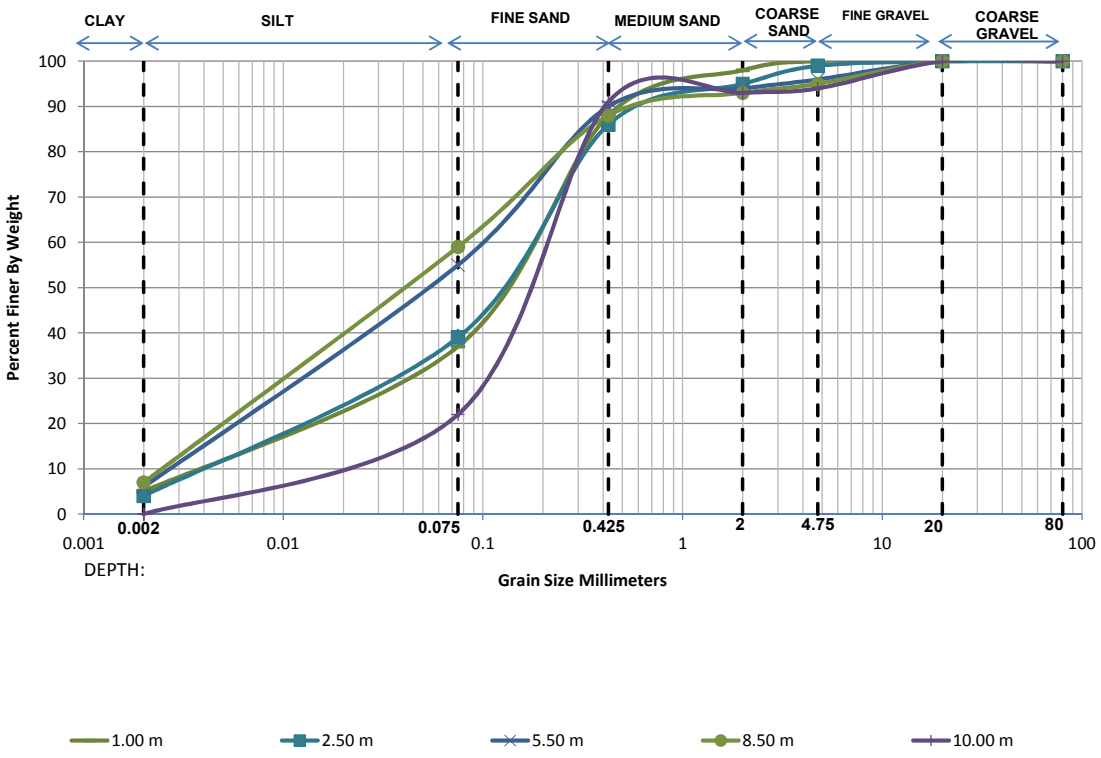
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	1+811 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	18.00	71.00	6.00	3.00	2.00	0.00	0.0336	0.1222	0.2305	6.87	1.93
5.50 m	0.00	13.00	76.00	4.00	2.00	5.00	0.00	0.0561	0.1447	0.2447	4.36	1.52
7.00 m	7.00	47.00	35.00	4.00	2.00	5.00	0.00	0.0036	0.0248	0.0968	26.58	1.74
8.50 m	6.00	49.00	31.00	5.00	3.00	4.00	2.00	0.0044	0.0250	0.0939	21.20	1.50
10.00 m	0.00	17.00	70.00	2.00	3.00	8.00	0.00	0.0369	0.1270	0.2373	6.44	1.84

GRAIN SIZE DISTRIBUTION CURVES

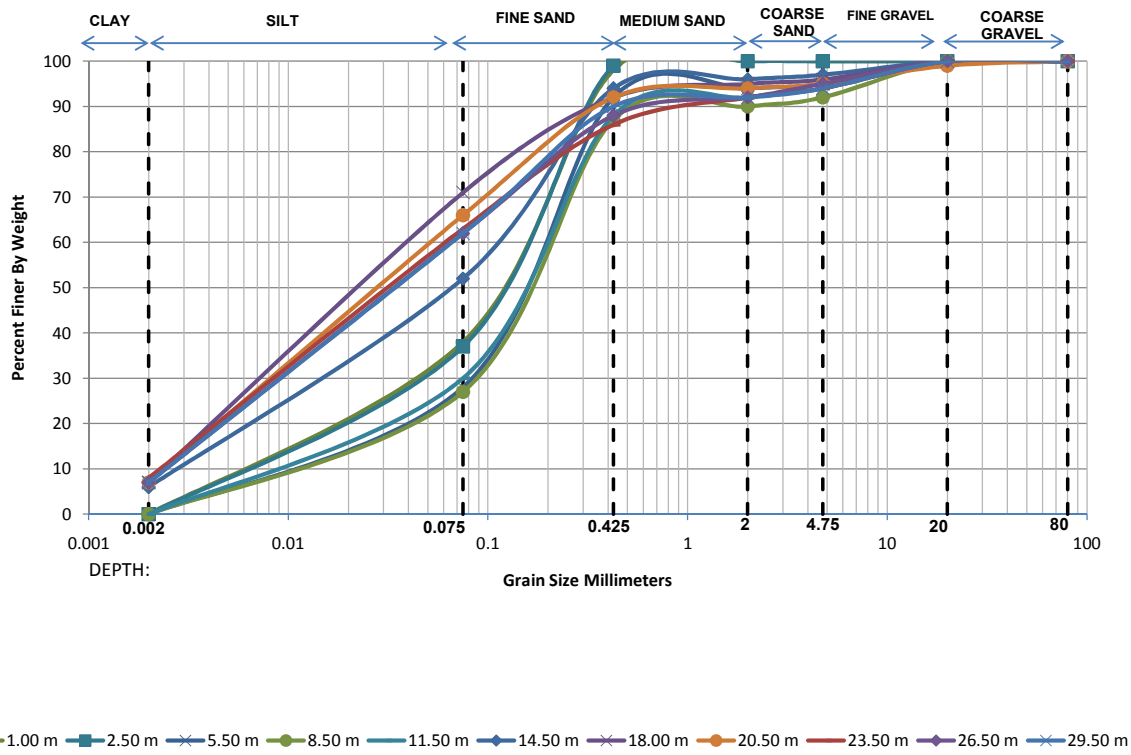
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	2+472 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	5.00	32.00	51.00	10.00	2.00	0.00	0.00	0.0070	0.0522	0.1732	24.90	2.26
2.50 m	4.00	35.00	47.00	9.00	4.00	1.00	0.00	0.0082	0.0482	0.1690	20.49	1.67
5.50 m	6.00	49.00	35.00	4.00	2.00	4.00	0.00	0.0044	0.0252	0.0920	20.71	1.56
8.50 m	7.00	52.00	29.00	5.00	2.00	5.00	0.00	0.0036	0.0213	0.0778	21.88	1.65
10.00 m	0.00	22.00	69.00	2.00	1.00	6.00	0.00	0.0236	0.1048	0.2125	9.01	2.19

GRAIN SIZE DISTRIBUTION CURVES

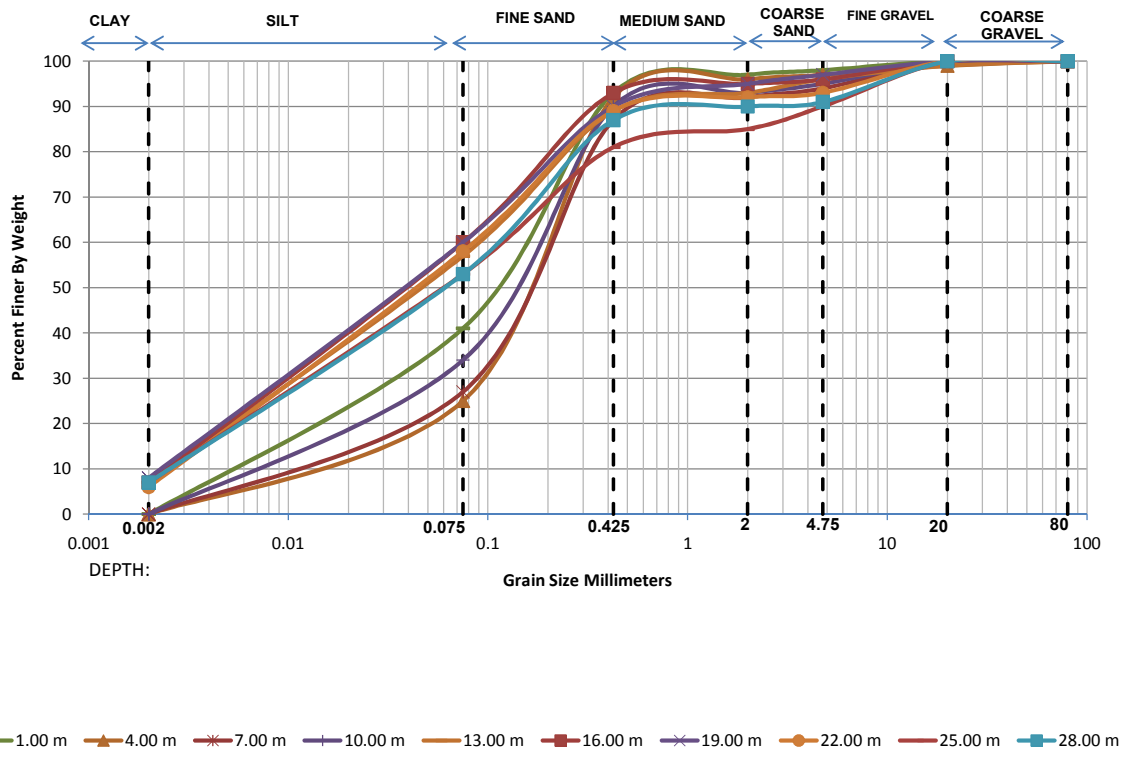
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	2+788 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	38.00	60.00	2.00	0.00	0.00	0.00	0.0089	0.0522	0.1480	16.63	2.07
2.50 m	0.00	37.00	62.00	1.00	0.00	0.00	0.00	0.0093	0.0547	0.1500	16.05	2.13
5.50 m	0.00	28.00	64.00	2.00	1.00	5.00	0.00	0.0152	0.0820	0.1914	12.61	2.31
8.50 m	0.00	27.00	60.00	3.00	2.00	8.00	0.00	0.0160	0.0859	0.2066	12.91	2.23
11.50 m	0.00	30.00	58.00	4.00	2.00	6.00	0.00	0.0132	0.0750	0.1943	14.70	2.19
14.50 m	6.00	46.00	42.00	2.00	1.00	3.00	0.00	0.0046	0.0279	0.1019	22.39	1.68
18.00 m	7.00	64.00	21.00	3.00	1.00	4.00	0.00	0.0034	0.0165	0.0539	15.73	1.48
20.50 m	7.00	59.00	26.00	2.00	1.00	4.00	1.00	0.0035	0.0182	0.0622	17.90	1.54
23.50 m	8.00	55.00	23.00	6.00	2.00	6.00	0.00	0.0029	0.0181	0.0679	23.47	1.67
26.50 m	7.00	55.00	26.00	4.00	3.00	5.00	0.00	0.0035	0.0198	0.0703	19.99	1.58
29.50 m	7.00	55.00	28.00	2.00	2.00	6.00	0.00	0.0035	0.0199	0.0703	19.98	1.59

GRAIN SIZE DISTRIBUTION CURVES

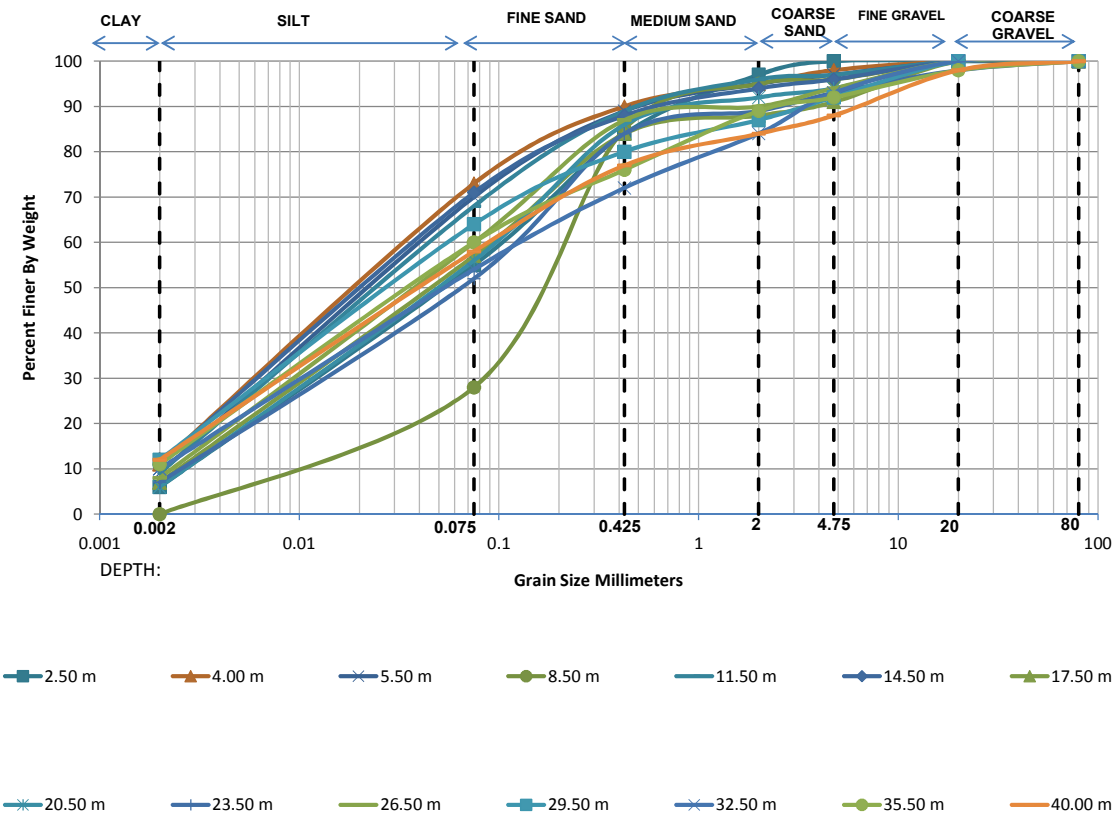
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	2+788 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	41.00	52.00	4.00	1.00	2.00	0.00	0.0077	0.0455	0.1443	18.70	1.86
4.00 m	0.00	25.00	67.00	4.00	1.00	2.00	1.00	0.0187	0.0930	0.2016	10.78	2.30
7.00 m	0.00	27.00	60.00	5.00	2.00	6.00	0.00	0.0160	0.0859	0.2073	12.95	2.22
10.00 m	0.00	34.00	56.00	3.00	2.00	5.00	0.00	0.0106	0.0623	0.1752	16.54	2.09
13.00 m	7.00	50.00	32.00	4.00	3.00	3.00	1.00	0.0036	0.0226	0.0846	23.57	1.69
16.00 m	7.00	53.00	33.00	2.00	1.00	4.00	0.00	0.0035	0.0210	0.0750	21.14	1.66
19.00 m	8.00	52.00	30.00	5.00	2.00	3.00	0.00	0.0029	0.0198	0.0750	25.73	1.79
22.00 m	6.00	52.00	31.00	3.00	1.00	7.00	0.00	0.0044	0.0232	0.0809	18.57	1.52
25.00 m	7.00	46.00	28.00	4.00	5.00	10.00	0.00	0.0036	0.0251	0.1090	29.89	1.58
28.00 m	7.00	46.00	34.00	3.00	1.00	9.00	0.00	0.0037	0.0255	0.1024	28.01	1.73

GRAIN SIZE DISTRIBUTION CURVES

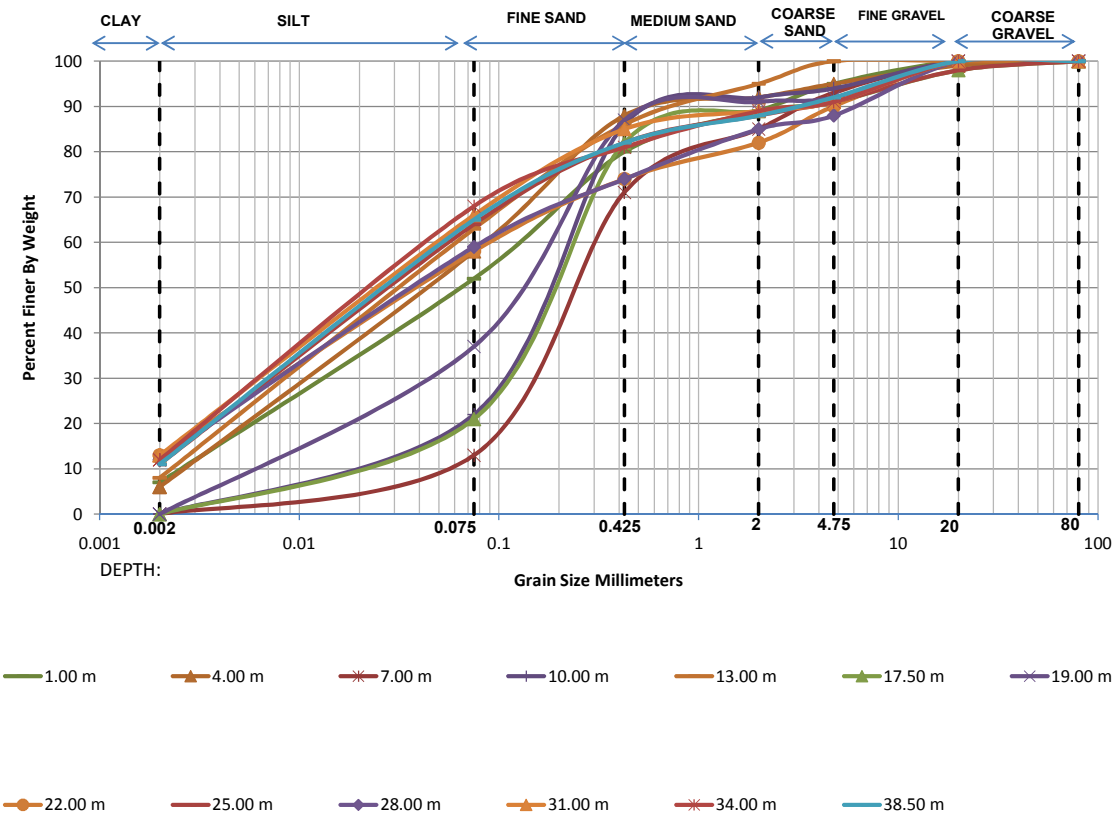
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	3+497 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	49.00	29.00	13.00	3.00	0.00	0.00	0.0044	0.0249	0.0960	21.72	1.46
4.00 m	11.00	62.00	17.00	5.00	3.00	2.00	0.00	-	0.0122	0.0493	-	-
5.50 m	9.00	61.00	19.00	6.00	2.00	3.00	0.00	0.0024	0.0147	0.0546	22.88	1.67
8.50 m	0.00	28.00	57.00	10.00	1.00	4.00	0.00	0.0149	0.0823	0.2115	14.21	2.15
11.50 m	9.00	59.00	21.00	7.00	1.00	3.00	0.00	0.0024	0.0154	0.0579	24.26	1.70
14.50 m	11.00	60.00	17.00	6.00	2.00	4.00	0.00	-	0.0127	0.0522	-	-
17.50 m	7.00	50.00	27.00	4.00	3.00	9.00	0.00	0.0036	0.0223	0.0858	23.97	1.63
20.50 m	6.00	50.00	30.00	6.00	2.00	6.00	0.00	0.0044	0.0243	0.0895	20.33	1.50
23.50 m	7.00	45.00	32.00	5.00	4.00	5.00	2.00	0.0037	0.0261	0.1107	30.14	1.68
26.50 m	8.00	52.00	27.00	3.00	4.00	6.00	0.00	0.0029	0.0196	0.0750	25.75	1.77
29.50 m	12.00	52.00	16.00	7.00	5.00	8.00	0.00	-	0.0137	0.0649	-	-
32.50 m	10.00	44.00	18.00	12.00	9.00	7.00	0.00	0.0020	0.0205	0.1287	64.37	1.63
35.50 m	11.00	49.00	16.00	13.00	3.00	6.00	2.00	-	0.0161	0.0750	-	-
40.00 m	12.00	46.00	19.00	7.00	4.00	10.00	2.00	-	0.0163	0.0841	-	-

GRAIN SIZE DISTRIBUTION CURVES

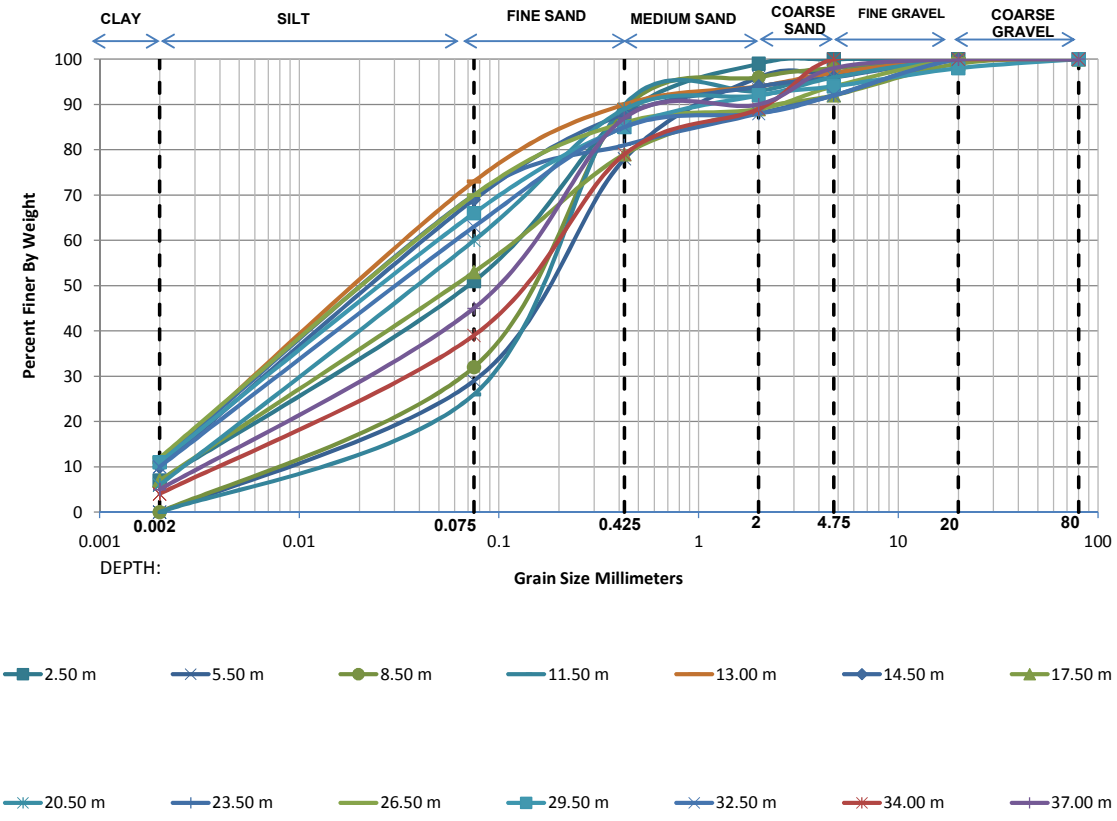
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	3+497 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	45.00	28.00	9.00	6.00	5.00	0.00	0.0037	0.0259	0.1180	32.21	1.55
4.00 m	6.00	52.00	30.00	4.00	3.00	4.00	1.00	0.0044	0.0231	0.0810	18.61	1.51
7.00 m	0.00	13.00	58.00	14.00	8.00	7.00	0.00	0.0548	0.1567	0.3191	5.82	1.40
10.00 m	0.00	22.00	64.00	6.00	2.00	6.00	0.00	0.0233	0.1060	0.2263	9.72	2.13
13.00 m	8.00	55.00	23.00	9.00	5.00	0.00	0.00	0.0029	0.0181	0.0679	23.47	1.67
17.50 m	0.00	21.00	61.00	7.00	2.00	7.00	2.00	0.0251	0.1113	0.2426	9.67	2.03
19.00 m	0.00	37.00	50.00	4.00	1.00	8.00	0.00	0.0090	0.0540	0.1711	18.92	1.88
22.00 m	13.00	45.00	16.00	8.00	8.00	10.00	0.00	-	0.0152	0.0861	-	-
25.00 m	11.00	53.00	18.00	6.00	3.00	7.00	2.00	-	0.0147	0.0651	-	-
28.00 m	12.00	47.00	15.00	11.00	3.00	12.00	0.00	-	0.0156	0.0795	-	-
31.00 m	13.00	53.00	19.00	4.00	2.00	9.00	0.00	-	0.0124	0.0605	-	-
34.00 m	12.00	56.00	13.00	8.00	2.00	9.00	0.00	-	0.0125	0.0566	-	-
38.50 m	11.00	54.00	17.00	6.00	4.00	8.00	0.00	-	0.0143	0.0629	-	-

GRAIN SIZE DISTRIBUTION CURVES

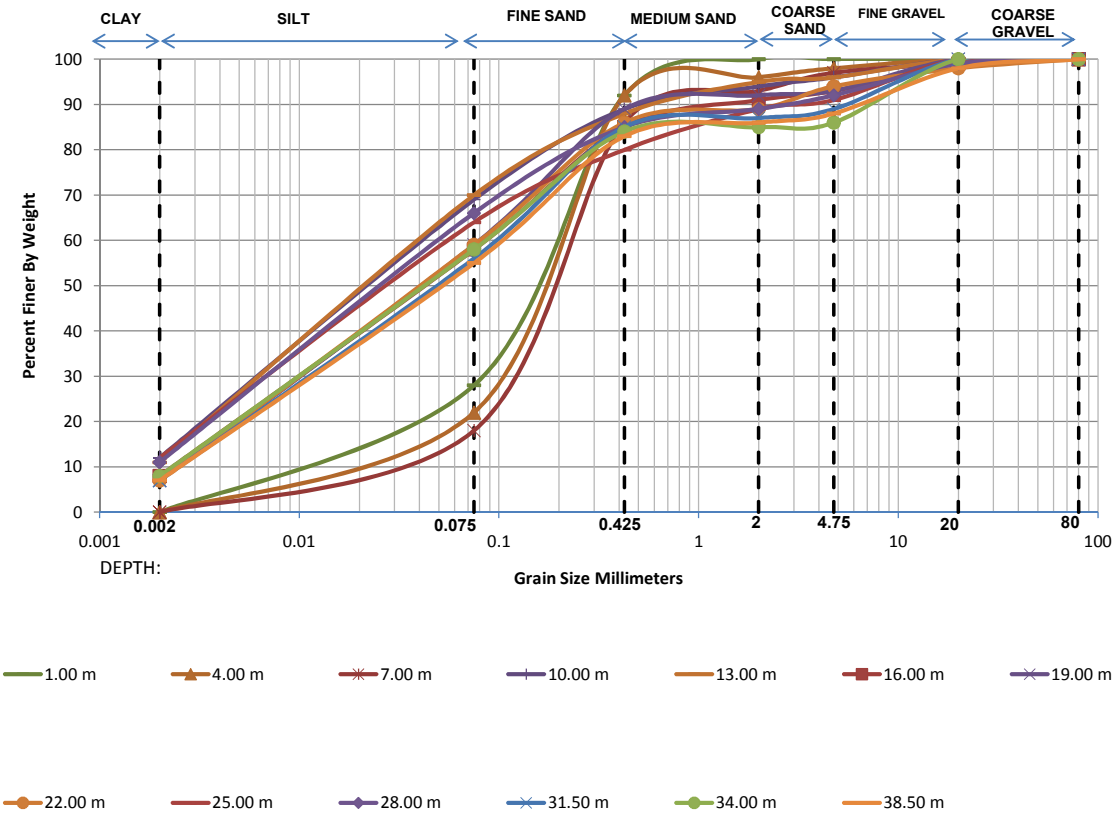
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	3+497 Major Bridge
B.H. No.	BH-P2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	44.00	37.00	11.00	1.00	0.00	0.00	0.0037	0.0273	0.1122	30.30	1.80
5.50 m	0.00	29.00	49.00	18.00	1.00	3.00	0.00	0.0136	0.0787	0.2384	17.47	1.91
8.50 m	0.00	32.00	57.00	7.00	2.00	2.00	0.00	0.0118	0.0683	0.1859	15.77	2.13
11.50 m	0.00	26.00	64.00	3.00	4.00	3.00	0.00	0.0173	0.0894	0.2025	11.70	2.28
13.00 m	11.00	62.00	17.00	4.00	3.00	3.00	0.00	-	0.0122	0.0493	-	-
14.50 m	10.00	59.00	19.00	6.00	2.00	4.00	0.00	0.0020	0.0141	0.0558	27.92	1.78
17.50 m	7.00	46.00	26.00	10.00	3.00	7.00	1.00	0.0036	0.0250	0.1139	31.28	1.50
20.50 m	6.00	54.00	29.00	3.00	4.00	4.00	0.00	0.0043	0.0220	0.0750	17.40	1.50
23.50 m	11.00	59.00	11.00	7.00	4.00	8.00	0.00	-	0.0127	0.0534	-	-
26.50 m	12.00	58.00	16.00	3.00	5.00	6.00	0.00	-	0.0121	0.0534	-	-
29.50 m	11.00	55.00	19.00	7.00	2.00	4.00	2.00	-	0.0141	0.0610	-	-
32.50 m	10.00	53.00	22.00	3.00	4.00	8.00	0.00	0.0020	0.0161	0.0676	33.81	1.93
34.00 m	4.00	35.00	40.00	10.00	11.00	0.00	0.00	0.0082	0.0477	0.1923	23.58	1.45
37.00 m	5.00	40.00	42.00	3.00	8.00	2.00	0.00	0.0060	0.0367	0.1391	23.14	1.61

GRAIN SIZE DISTRIBUTION CURVES

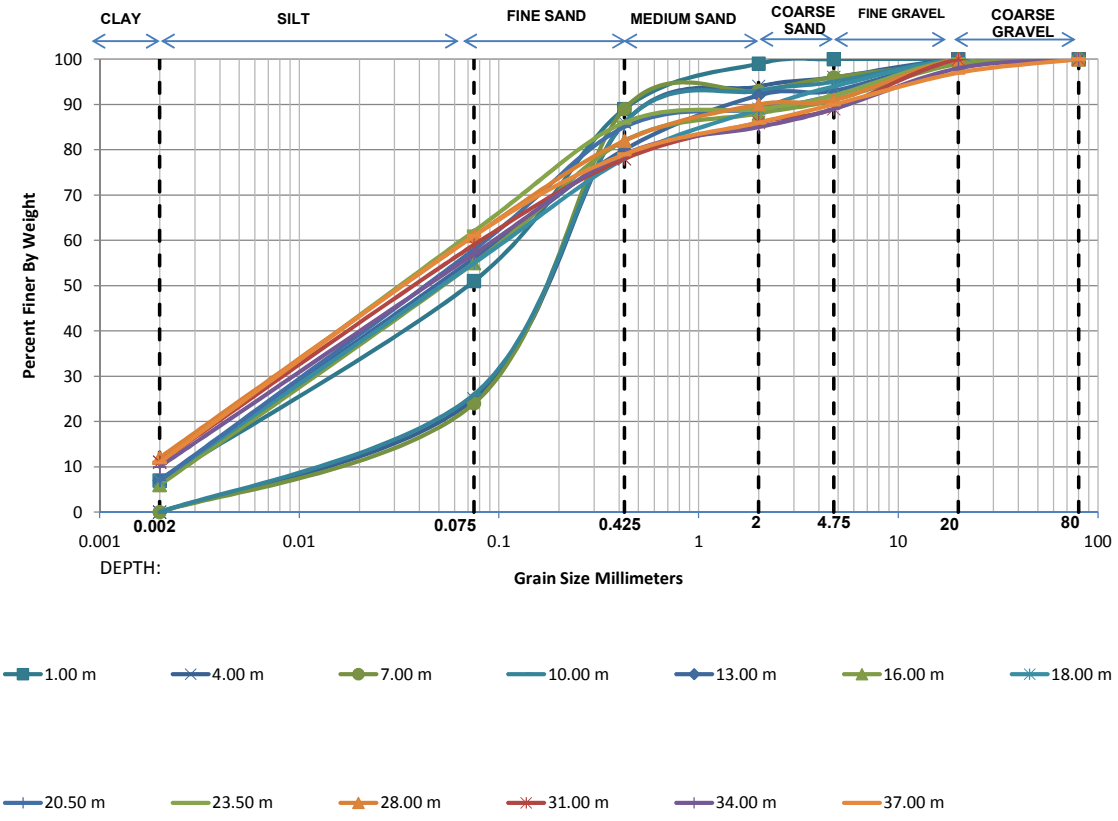
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	3+497 Major Bridge
B.H. No.	BH-P3



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	28.00	64.00	8.00	0.00	0.00	0.00	0.0152	0.0820	0.1931	12.72	2.29
4.00 m	0.00	22.00	70.00	4.00	2.00	2.00	0.00	0.0236	0.1047	0.2110	8.92	2.20
7.00 m	0.00	18.00	68.00	7.00	4.00	2.00	1.00	0.0334	0.1232	0.2387	7.15	1.91
10.00 m	12.00	57.00	20.00	5.00	2.00	4.00	0.00	-	0.0124	0.0552	-	-
13.00 m	11.00	59.00	18.00	7.00	1.00	4.00	0.00	-	0.0130	0.0538	-	-
16.00 m	8.00	50.00	27.00	6.00	2.00	6.00	1.00	0.0029	0.0207	0.0816	27.88	1.79
19.00 m	7.00	52.00	30.00	3.00	1.00	7.00	0.00	0.0036	0.0214	0.0777	21.86	1.65
22.00 m	7.00	52.00	27.00	3.00	5.00	4.00	2.00	0.0036	0.0212	0.0779	21.91	1.63
25.00 m	12.00	52.00	16.00	9.00	2.00	9.00	0.00	-	0.0137	0.0649	-	-
28.00 m	11.00	55.00	19.00	4.00	3.00	7.00	1.00	-	0.0141	0.0610	-	-
31.50 m	7.00	49.00	29.00	2.00	2.00	11.00	0.00	0.0036	0.0231	0.0897	24.94	1.65
34.00 m	8.00	50.00	26.00	1.00	1.00	14.00	0.00	0.0029	0.0206	0.0816	27.89	1.78
38.50 m	7.00	48.00	28.00	3.00	2.00	10.00	2.00	0.0036	0.0237	0.0957	26.51	1.62

GRAIN SIZE DISTRIBUTION CURVES

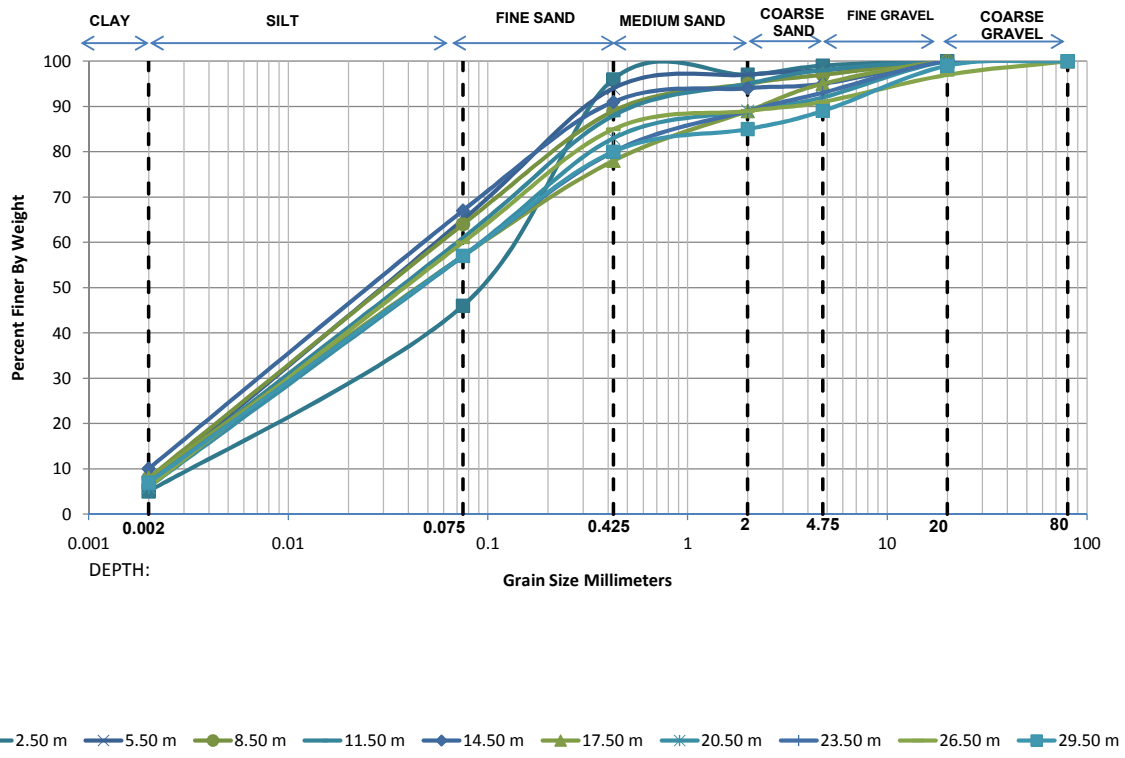
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	3+497 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	44.00	38.00	10.00	1.00	0.00	0.00	0.0037	0.0274	0.1110	29.96	1.83
4.00 m	0.00	25.00	61.00	8.00	2.00	4.00	0.00	0.0184	0.0938	0.2176	11.82	2.20
7.00 m	0.00	24.00	65.00	4.00	3.00	3.00	1.00	0.0200	0.0973	0.2115	10.57	2.24
10.00 m	0.00	26.00	60.00	7.00	2.00	5.00	0.00	0.0171	0.0898	0.2141	12.50	2.20
13.00 m	7.00	49.00	24.00	12.00	1.00	7.00	0.00	0.0036	0.0228	0.0939	26.15	1.54
16.00 m	6.00	49.00	27.00	6.00	3.00	8.00	1.00	0.0044	0.0248	0.0968	21.92	1.43
18.00 m	7.00	48.00	23.00	11.00	5.00	6.00	0.00	0.0036	0.0233	0.1025	28.45	1.48
20.50 m	7.00	51.00	27.00	4.00	3.00	8.00	0.00	0.0036	0.0218	0.0815	22.84	1.63
23.50 m	11.00	51.00	24.00	3.00	3.00	8.00	0.00	-	0.0157	0.0699	-	-
28.00 m	12.00	49.00	21.00	8.00	1.00	9.00	0.00	-	0.0150	0.0723	-	-
31.00 m	11.00	48.00	19.00	8.00	3.00	11.00	0.00	-	0.0167	0.0786	-	-
34.00 m	10.00	47.00	22.00	6.00	4.00	9.00	2.00	0.0020	0.0189	0.0885	44.24	2.02
37.00 m	11.00	50.00	18.00	7.00	4.00	7.00	3.00	-	0.0158	0.0723	-	-

GRAIN SIZE DISTRIBUTION CURVES

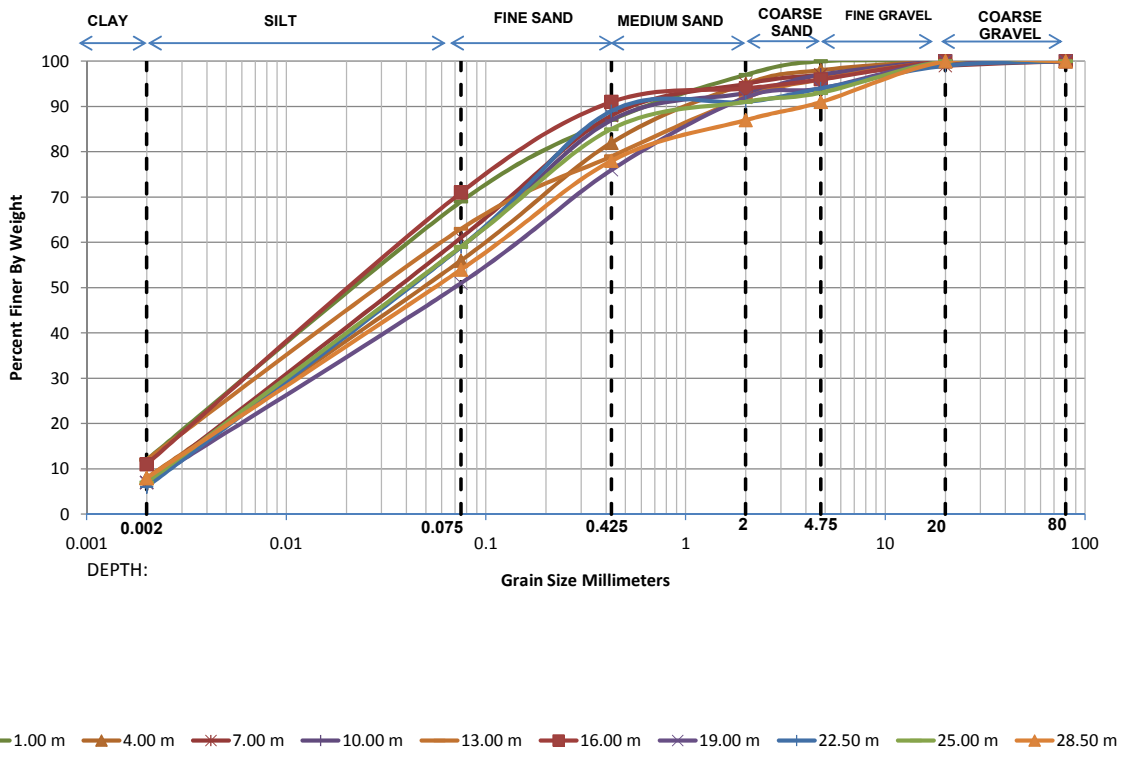
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	3+691 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	41.00	50.00	1.00	2.00	1.00	0.00	0.0060	0.0359	0.1232	20.57	1.75
5.50 m	7.00	58.00	29.00	3.00	1.00	2.00	0.00	0.0035	0.0187	0.0641	18.39	1.56
8.50 m	8.00	56.00	25.00	6.00	2.00	3.00	0.00	0.0029	0.0178	0.0658	22.79	1.67
11.50 m	7.00	54.00	27.00	7.00	3.00	2.00	0.00	0.0035	0.0203	0.0726	20.57	1.60
14.50 m	10.00	57.00	24.00	3.00	1.00	5.00	0.00	0.0020	0.0148	0.0595	29.77	1.85
17.50 m	8.00	49.00	21.00	11.00	6.00	5.00	0.00	0.0029	0.0209	0.0894	30.54	1.67
20.50 m	6.00	51.00	26.00	6.00	3.00	8.00	0.00	0.0044	0.0234	0.0861	19.73	1.46
23.50 m	7.00	50.00	23.00	9.00	4.00	7.00	0.00	0.0036	0.0221	0.0878	24.58	1.56
26.50 m	6.00	54.00	25.00	4.00	2.00	6.00	3.00	0.0043	0.0218	0.0750	17.44	1.47
29.50 m	7.00	50.00	23.00	5.00	4.00	10.00	1.00	0.0036	0.0221	0.0875	24.48	1.56

GRAIN SIZE DISTRIBUTION CURVES

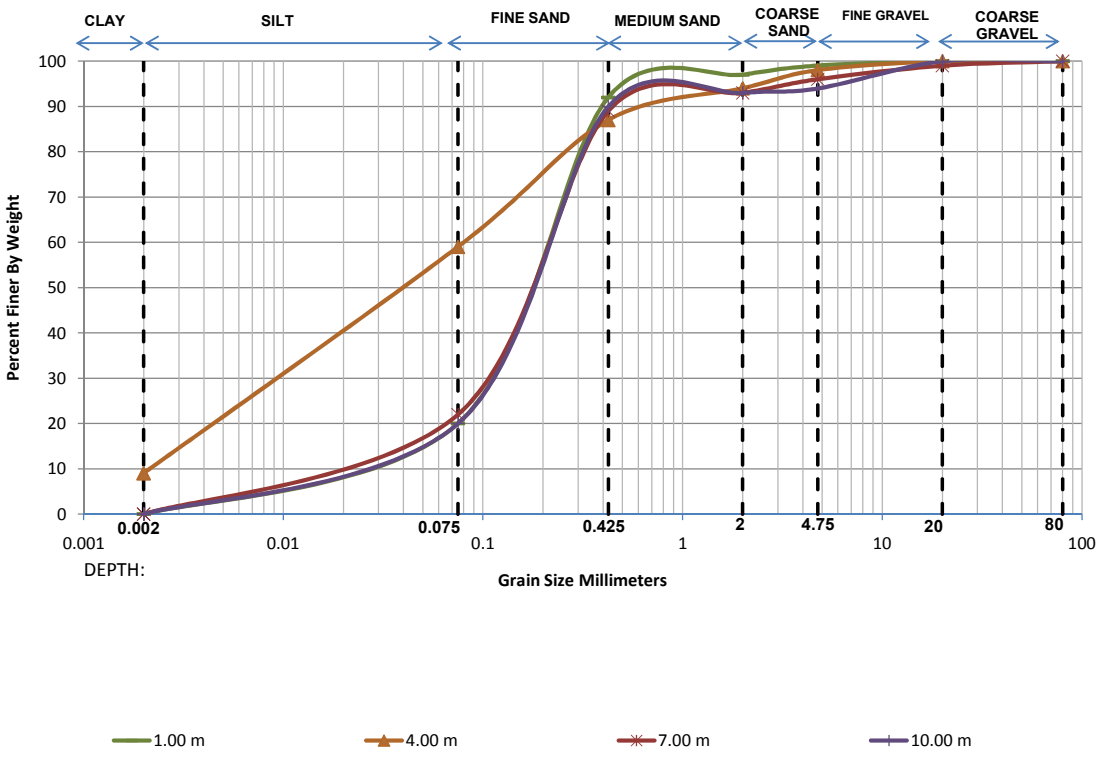
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	3+691 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	12.00	57.00	18.00	10.00	3.00	0.00	0.00	-	0.0124	0.0551	-	-
4.00 m	8.00	48.00	26.00	13.00	3.00	2.00	0.00	0.0029	0.0218	0.0925	31.47	1.75
7.00 m	7.00	54.00	27.00	7.00	2.00	2.00	1.00	0.0035	0.0203	0.0726	20.57	1.60
10.00 m	7.00	52.00	28.00	6.00	4.00	3.00	0.00	0.0036	0.0213	0.0778	21.90	1.64
13.00 m	12.00	51.00	16.00	13.00	4.00	4.00	0.00	-	0.0141	0.0672	-	-
16.00 m	11.00	60.00	20.00	3.00	2.00	4.00	0.00	-	0.0128	0.0524	-	-
19.00 m	7.00	44.00	25.00	16.00	2.00	6.00	0.00	0.0037	0.0265	0.1385	37.68	1.38
22.50 m	6.00	53.00	30.00	2.00	3.00	5.00	1.00	0.0043	0.0226	0.0777	17.94	1.51
25.00 m	7.00	52.00	26.00	6.00	2.00	7.00	0.00	0.0036	0.0212	0.0779	21.94	1.62
28.50 m	8.00	46.00	24.00	9.00	4.00	9.00	0.00	0.0030	0.0230	0.1091	36.92	1.64

GRAIN SIZE DISTRIBUTION CURVES

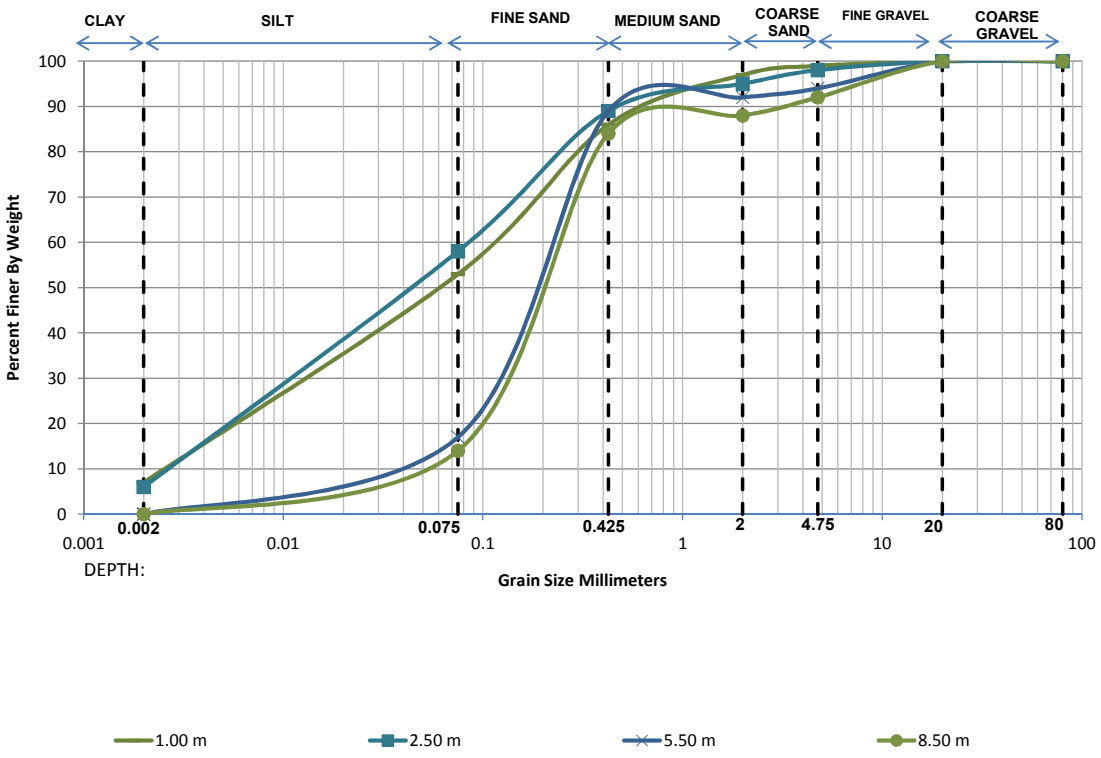
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	4+174 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	20.00	72.00	5.00	2.00	1.00	0.00	0.0281	0.1128	0.2174	7.74	2.09
4.00 m	9.00	50.00	28.00	7.00	4.00	2.00	0.00	0.0024	0.0192	0.0779	32.39	1.96
7.00 m	0.00	22.00	67.00	4.00	3.00	3.00	1.00	0.0235	0.1053	0.2178	9.28	2.17
10.00 m	0.00	20.00	70.00	3.00	1.00	6.00	0.00	0.0280	0.1133	0.2212	7.91	2.07

GRAIN SIZE DISTRIBUTION CURVES

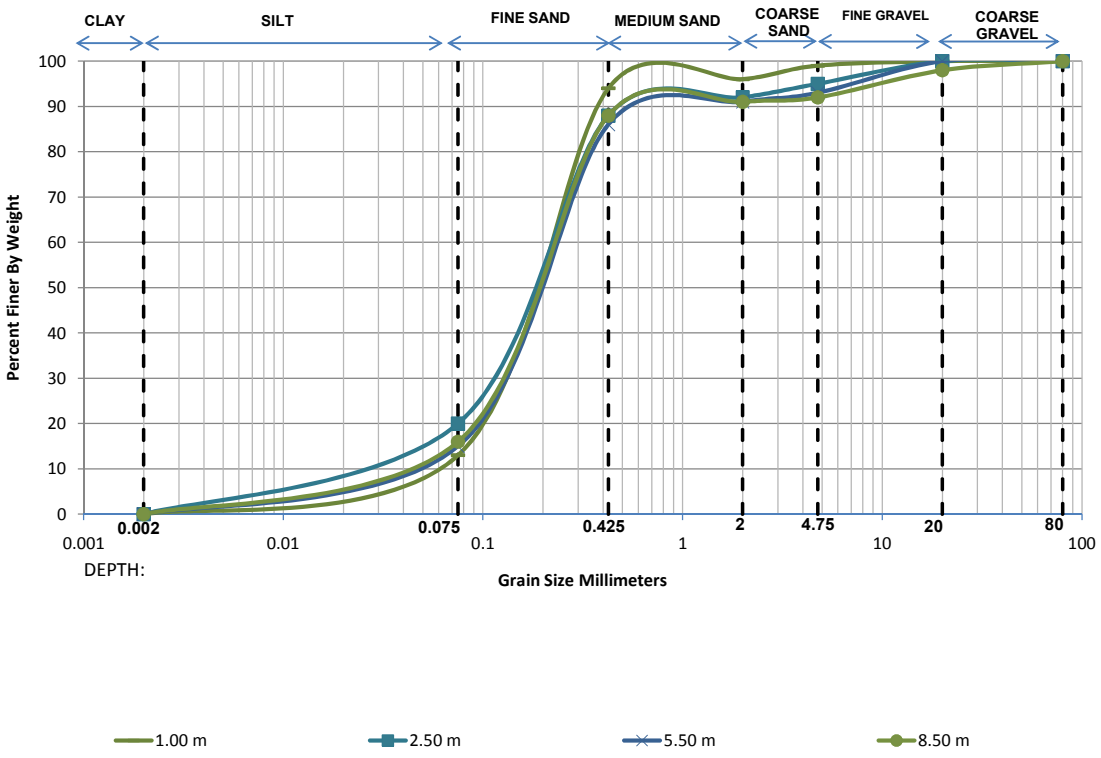
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	4+207 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	46.00	33.00	11.00	2.00	1.00	0.00	0.0037	0.0254	0.1045	28.58	1.69
2.50 m	6.00	52.00	31.00	6.00	3.00	2.00	0.00	0.0044	0.0232	0.0809	18.58	1.52
5.50 m	0.00	17.00	72.00	3.00	2.00	6.00	0.00	0.0370	0.1264	0.2326	6.28	1.86
8.50 m	0.00	14.00	70.00	4.00	4.00	8.00	0.00	0.0501	0.1422	0.2550	5.09	1.58

GRAIN SIZE DISTRIBUTION CURVES

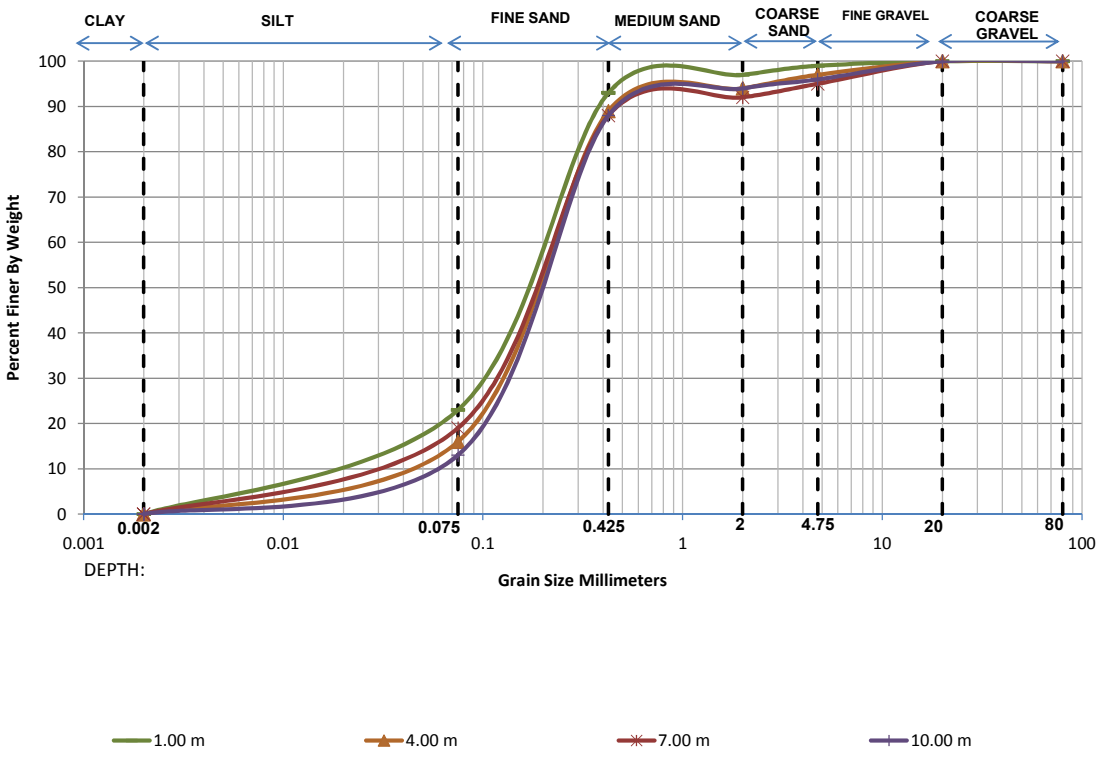
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	4+655 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	13.00	81.00	2.00	3.00	1.00	0.00	0.0565	0.1424	0.2338	4.14	1.54
2.50 m	0.00	20.00	68.00	4.00	3.00	5.00	0.00	0.0278	0.1138	0.2264	8.14	2.06
5.50 m	0.00	15.00	71.00	5.00	2.00	7.00	0.00	0.0452	0.1367	0.2467	5.46	1.68
8.50 m	0.00	16.00	72.00	3.00	1.00	6.00	2.00	0.0409	0.1312	0.2380	5.82	1.77

GRAIN SIZE DISTRIBUTION CURVES

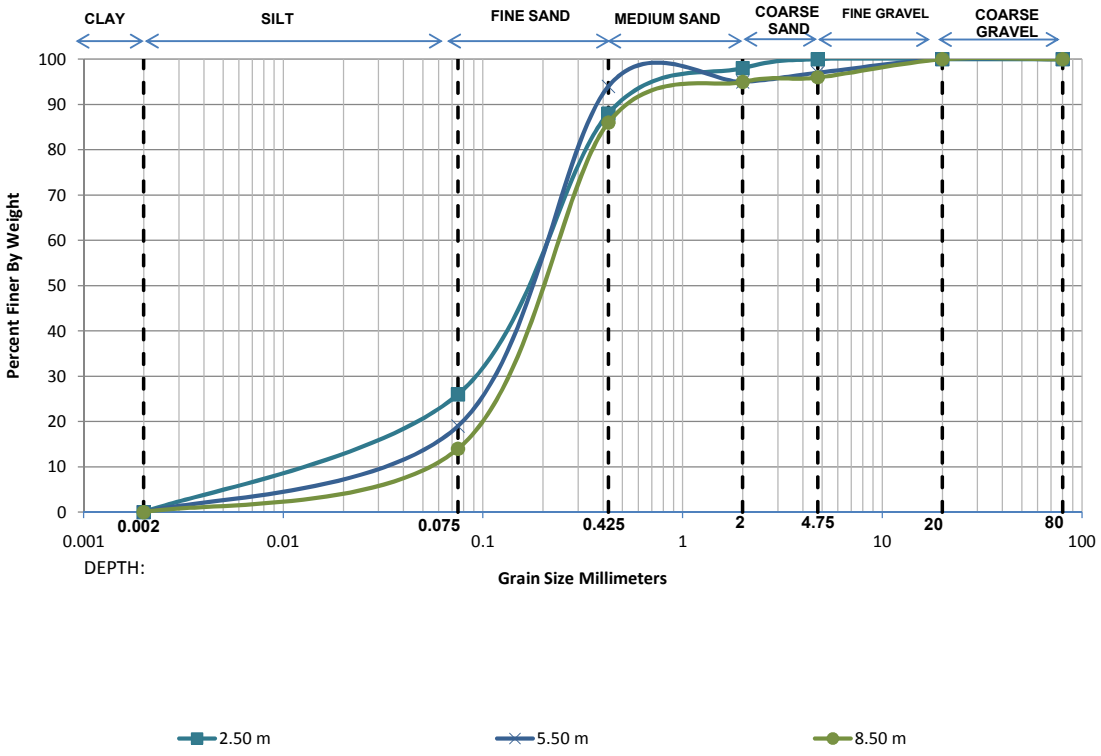
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	5+119 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	23.00	70.00	4.00	2.00	1.00	0.00	0.0219	0.1006	0.2059	9.42	2.25
4.00 m	0.00	16.00	73.00	5.00	3.00	3.00	0.00	0.0409	0.1309	0.2361	5.77	1.77
7.00 m	0.00	19.00	69.00	4.00	3.00	5.00	0.00	0.0305	0.1181	0.2294	7.53	1.99
10.00 m	0.00	13.00	75.00	6.00	2.00	4.00	0.00	0.0561	0.1453	0.2476	4.42	1.52

GRAIN SIZE DISTRIBUTION CURVES

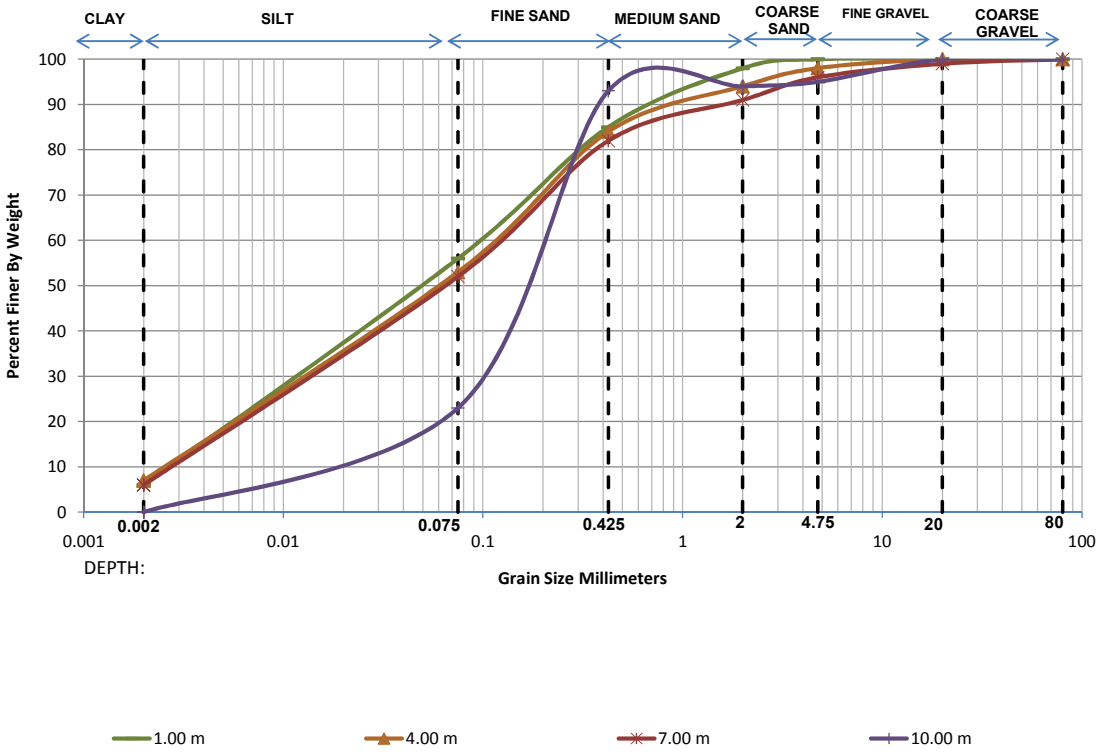
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	5+730 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	26.00	62.00	10.00	2.00	0.00	0.00	0.0172	0.0897	0.2095	12.17	2.23
5.50 m	0.00	19.00	75.00	1.00	2.00	3.00	0.00	0.0309	0.1163	0.2154	6.98	2.03
8.50 m	0.00	14.00	72.00	9.00	1.00	4.00	0.00	0.0503	0.1417	0.2508	4.99	1.59

GRAIN SIZE DISTRIBUTION CURVES

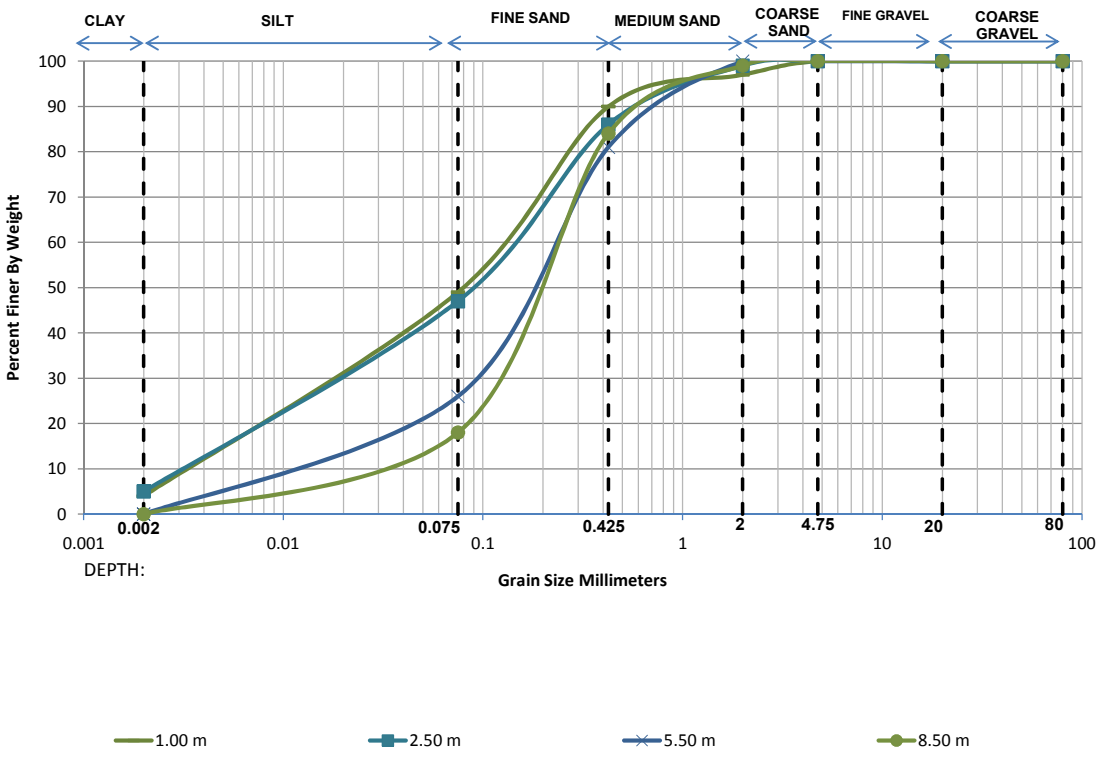
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	6+197 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	50.00	29.00	13.00	2.00	0.00	0.00	0.0044	0.0242	0.0904	20.57	1.48
4.00 m	7.00	46.00	31.00	10.00	4.00	2.00	0.00	0.0037	0.0253	0.1064	29.13	1.65
7.00 m	6.00	46.00	30.00	9.00	5.00	3.00	1.00	0.0045	0.0272	0.1142	25.32	1.43
10.00 m	0.00	23.00	70.00	1.00	1.00	5.00	0.00	0.0219	0.1005	0.2050	9.38	2.26

GRAIN SIZE DISTRIBUTION CURVES

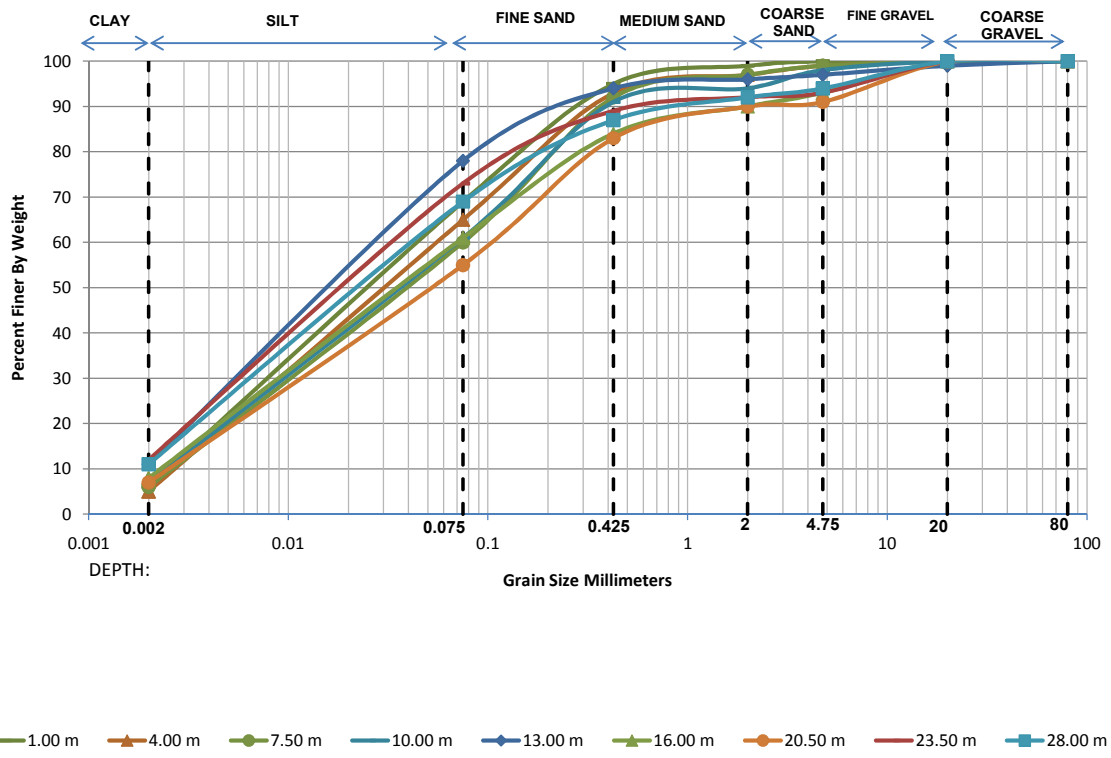
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	6+877 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	4.00	45.00	41.00	7.00	3.00	0.00	0.00	0.0071	0.0332	0.1176	16.56	1.32
2.50 m	5.00	42.00	39.00	13.00	1.00	0.00	0.00	0.0059	0.0339	0.1343	22.94	1.46
5.50 m	0.00	26.00	55.00	19.00	0.00	0.00	0.00	0.0169	0.0905	0.2353	13.95	2.06
8.50 m	0.00	18.00	66.00	15.00	1.00	0.00	0.00	0.0332	0.1244	0.2472	7.44	1.88

GRAIN SIZE DISTRIBUTION CURVES

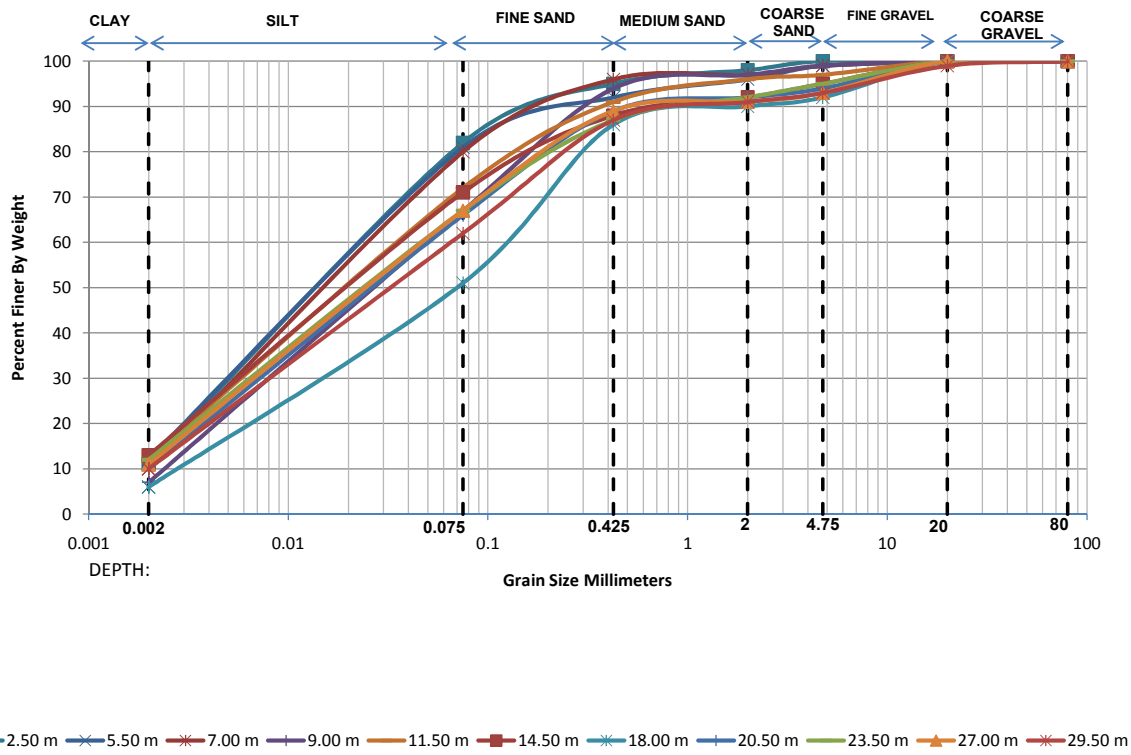
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+078 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	63.00	26.00	4.00	1.00	0.00	0.00	0.0042	0.0184	0.0574	13.82	1.42
4.00 m	5.00	60.00	28.00	4.00	2.00	1.00	0.00	0.0051	0.0211	0.0645	12.60	1.35
7.50 m	6.00	54.00	32.00	5.00	2.00	1.00	0.00	0.0043	0.0221	0.0750	17.38	1.51
10.00 m	7.00	54.00	30.00	3.00	4.00	2.00	0.00	0.0035	0.0204	0.0726	20.56	1.62
13.00 m	11.00	67.00	16.00	2.00	1.00	2.00	1.00	-	0.0113	0.0431	-	-
16.00 m	8.00	53.00	23.00	6.00	3.00	7.00	0.00	0.0029	0.0190	0.0725	24.96	1.71
20.50 m	7.00	48.00	28.00	7.00	1.00	9.00	0.00	0.0036	0.0237	0.0963	26.66	1.61
23.50 m	12.00	61.00	16.00	3.00	1.00	7.00	0.00	-	0.0114	0.0488	-	-
28.00 m	11.00	58.00	18.00	5.00	2.00	6.00	0.00	-	0.0132	0.0555	-	-

GRAIN SIZE DISTRIBUTION CURVES

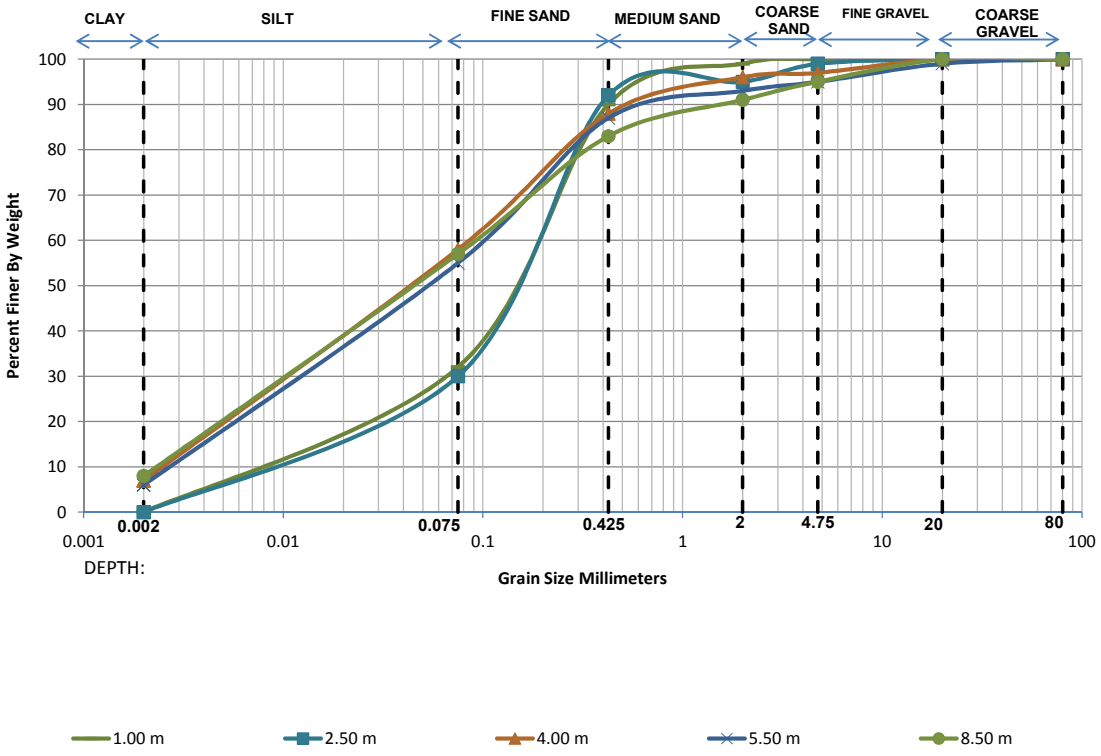
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+078 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	11.00	71.00	13.00	3.00	2.00	0.00	0.00	-	0.0107	0.0390	-	-
5.50 m	12.00	69.00	11.00	4.00	3.00	1.00	0.00	-	0.0100	0.0393	-	-
7.00 m	10.00	70.00	16.00	1.00	2.00	1.00	0.00	0.0020	0.0118	0.0416	20.79	1.67
9.00 m	7.00	60.00	27.00	3.00	2.00	1.00	0.00	0.0035	0.0179	0.0604	17.44	1.53
11.50 m	12.00	60.00	19.00	5.00	1.00	3.00	0.00	-	0.0117	0.0504	-	-
14.50 m	13.00	58.00	17.00	4.00	3.00	5.00	0.00	-	0.0111	0.0514	-	-
18.00 m	6.00	45.00	35.00	4.00	2.00	8.00	0.00	0.0046	0.0284	0.1129	24.75	1.56
20.50 m	10.00	56.00	23.00	3.00	2.00	6.00	0.00	0.0020	0.0151	0.0614	30.69	1.86
23.50 m	12.00	55.00	20.00	5.00	3.00	5.00	0.00	-	0.0130	0.0588	-	-
27.00 m	11.00	56.00	22.00	2.00	2.00	7.00	0.00	-	0.0139	0.0592	-	-
29.50 m	10.00	52.00	25.00	4.00	2.00	6.00	1.00	0.0020	0.0167	0.0700	35.00	1.98

GRAIN SIZE DISTRIBUTION CURVES

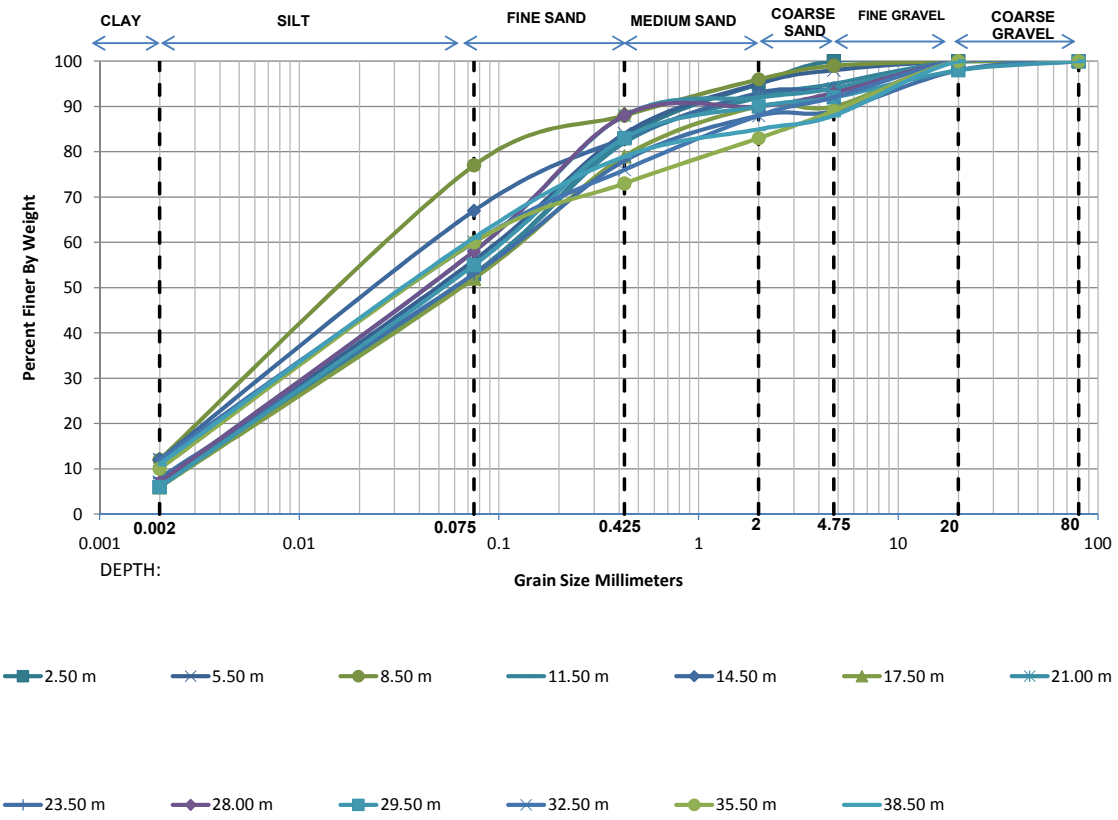
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+256 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	32.00	58.00	9.00	1.00	0.00	0.00	0.0118	0.0684	0.1842	15.59	2.15
2.50 m	0.00	30.00	62.00	3.00	4.00	1.00	0.00	0.0134	0.0750	0.1850	13.84	2.27
4.00 m	7.00	51.00	30.00	8.00	1.00	3.00	0.00	0.0036	0.0219	0.0812	22.73	1.66
5.50 m	6.00	49.00	32.00	6.00	2.00	4.00	1.00	0.0044	0.0251	0.0935	21.09	1.52
8.50 m	8.00	49.00	26.00	8.00	4.00	5.00	0.00	0.0029	0.0212	0.0865	29.49	1.77

GRAIN SIZE DISTRIBUTION CURVES

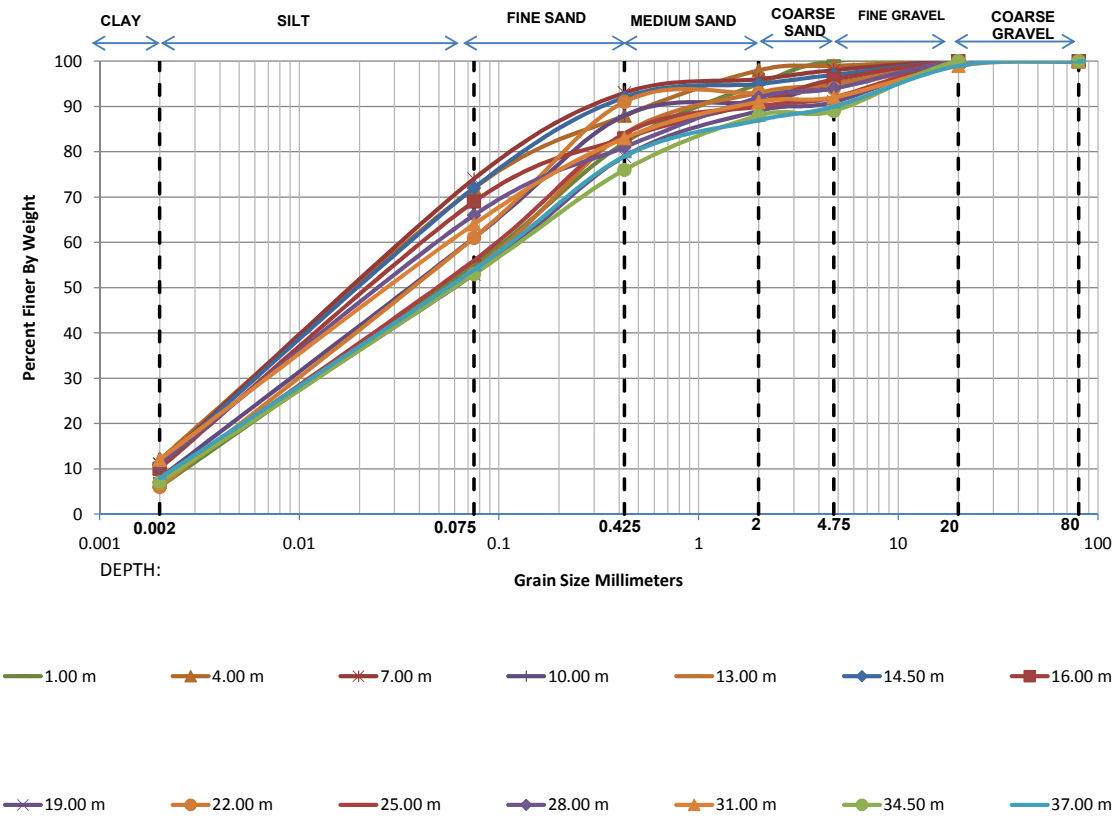
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+351 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	47.00	30.00	12.00	5.00	0.00	0.00	0.0045	0.0264	0.1077	24.04	1.44
5.50 m	7.00	49.00	28.00	11.00	3.00	2.00	0.00	0.0036	0.0230	0.0909	25.29	1.62
8.50 m	12.00	65.00	11.00	8.00	3.00	1.00	0.00	-	0.0106	0.0435	-	-
11.50 m	7.00	46.00	29.00	10.00	3.00	5.00	0.00	0.0036	0.0252	0.1089	29.86	1.59
14.50 m	12.00	55.00	16.00	10.00	1.00	6.00	0.00	-	0.0128	0.0586	-	-
17.50 m	6.00	46.00	27.00	11.00	0.00	10.00	0.00	0.0045	0.0270	0.1205	26.79	1.34
21.00 m	7.00	51.00	30.00	4.00	2.00	6.00	0.00	0.0036	0.0219	0.0811	22.71	1.66
23.50 m	8.00	45.00	25.00	10.00	1.00	9.00	2.00	0.0030	0.0238	0.1162	39.21	1.64
28.00 m	7.00	51.00	30.00	2.00	3.00	7.00	0.00	0.0036	0.0219	0.0810	22.70	1.66
29.50 m	6.00	49.00	28.00	7.00	2.00	6.00	2.00	0.0044	0.0248	0.0961	21.75	1.45
32.50 m	12.00	48.00	16.00	12.00	4.00	8.00	0.00	-	0.0152	0.0750	-	-
35.50 m	10.00	50.00	13.00	10.00	6.00	11.00	0.00	0.0020	0.0169	0.0750	37.50	1.91
38.50 m	11.00	50.00	18.00	6.00	3.00	12.00	0.00	-	0.0158	0.0723	-	-

GRAIN SIZE DISTRIBUTION CURVES

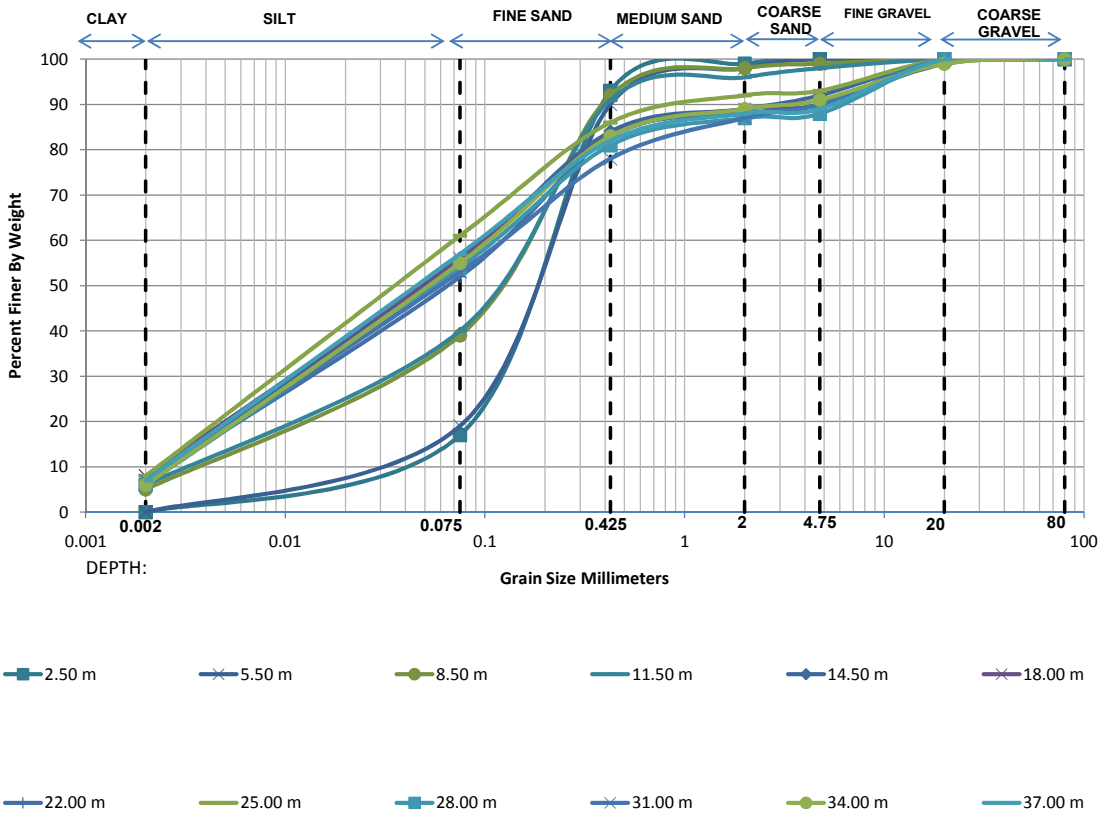
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+351 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	49.00	27.00	13.00	5.00	0.00	0.00	0.0044	0.0248	0.0978	22.14	1.42
4.00 m	12.00	60.00	16.00	10.00	1.00	1.00	0.00	-	0.0116	0.0503	-	-
7.00 m	11.00	63.00	19.00	3.00	2.00	2.00	0.00	-	0.0121	0.0481	-	-
10.00 m	8.00	53.00	27.00	3.00	4.00	5.00	0.00	0.0029	0.0192	0.0725	24.95	1.74
13.00 m	7.00	47.00	30.00	9.00	2.00	5.00	0.00	0.0036	0.0245	0.1009	27.79	1.63
14.50 m	11.00	61.00	20.00	3.00	2.00	3.00	0.00	-	0.0125	0.0509	-	-
16.00 m	10.00	59.00	14.00	8.00	5.00	4.00	0.00	0.0020	0.0139	0.0556	27.79	1.74
19.00 m	8.00	45.00	26.00	10.00	2.00	9.00	0.00	0.0030	0.0239	0.1141	38.49	1.68
22.00 m	6.00	55.00	30.00	2.00	1.00	6.00	0.00	0.0043	0.0216	0.0726	16.93	1.49
25.00 m	7.00	49.00	28.00	6.00	2.00	8.00	0.00	0.0036	0.0230	0.0905	25.17	1.63
28.00 m	11.00	55.00	15.00	11.00	2.00	6.00	0.00	-	0.0139	0.0608	-	-
31.00 m	12.00	52.00	19.00	8.00	1.00	7.00	1.00	-	0.0138	0.0650	-	-
34.50 m	7.00	46.00	23.00	12.00	1.00	11.00	0.00	0.0036	0.0248	0.1218	33.52	1.38
37.00 m	8.00	46.00	25.00	8.00	3.00	9.00	1.00	0.0030	0.0231	0.1071	36.23	1.68

GRAIN SIZE DISTRIBUTION CURVES

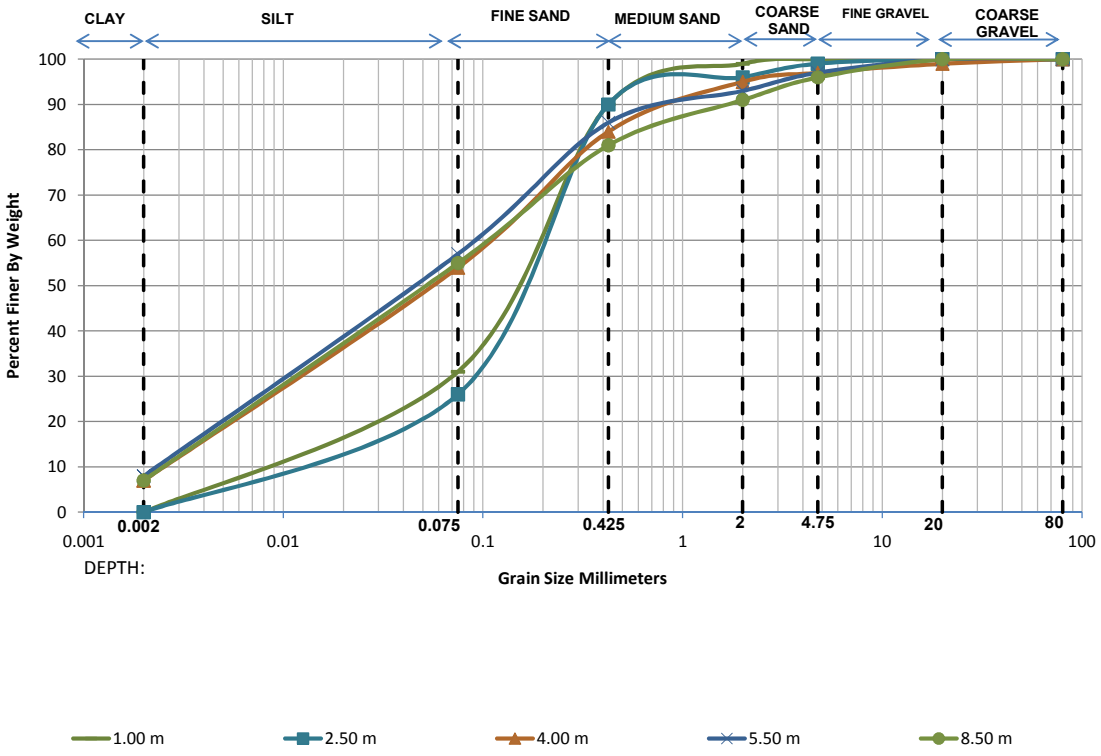
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+351 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	17.00	76.00	6.00	1.00	0.00	0.00	0.0373	0.1252	0.2247	6.03	1.87
5.50 m	0.00	19.00	71.00	8.00	2.00	0.00	0.00	0.0306	0.1177	0.2257	7.37	2.00
8.50 m	5.00	34.00	53.00	6.00	1.00	1.00	0.00	0.0067	0.0478	0.1564	23.37	2.18
11.50 m	6.00	34.00	51.00	5.00	2.00	2.00	0.00	0.0052	0.0447	0.1544	29.51	2.47
14.50 m	7.00	49.00	28.00	5.00	3.00	8.00	0.00	0.0036	0.0230	0.0904	25.15	1.63
18.00 m	8.00	48.00	27.00	6.00	1.00	10.00	0.00	0.0029	0.0219	0.0912	31.01	1.78
22.00 m	7.00	45.00	31.00	5.00	2.00	9.00	1.00	0.0037	0.0261	0.1120	30.52	1.66
25.00 m	8.00	53.00	25.00	6.00	1.00	7.00	0.00	0.0029	0.0191	0.0725	24.96	1.73
28.00 m	6.00	48.00	27.00	6.00	1.00	12.00	0.00	0.0044	0.0254	0.1034	23.28	1.41
31.00 m	7.00	46.00	25.00	9.00	3.00	10.00	0.00	0.0036	0.0249	0.1157	31.80	1.47
34.00 m	6.00	49.00	28.00	6.00	2.00	8.00	1.00	0.0044	0.0248	0.0960	21.72	1.45
37.00 m	7.00	50.00	25.00	6.00	1.00	11.00	0.00	0.0036	0.0222	0.0866	24.22	1.59

GRAIN SIZE DISTRIBUTION CURVES

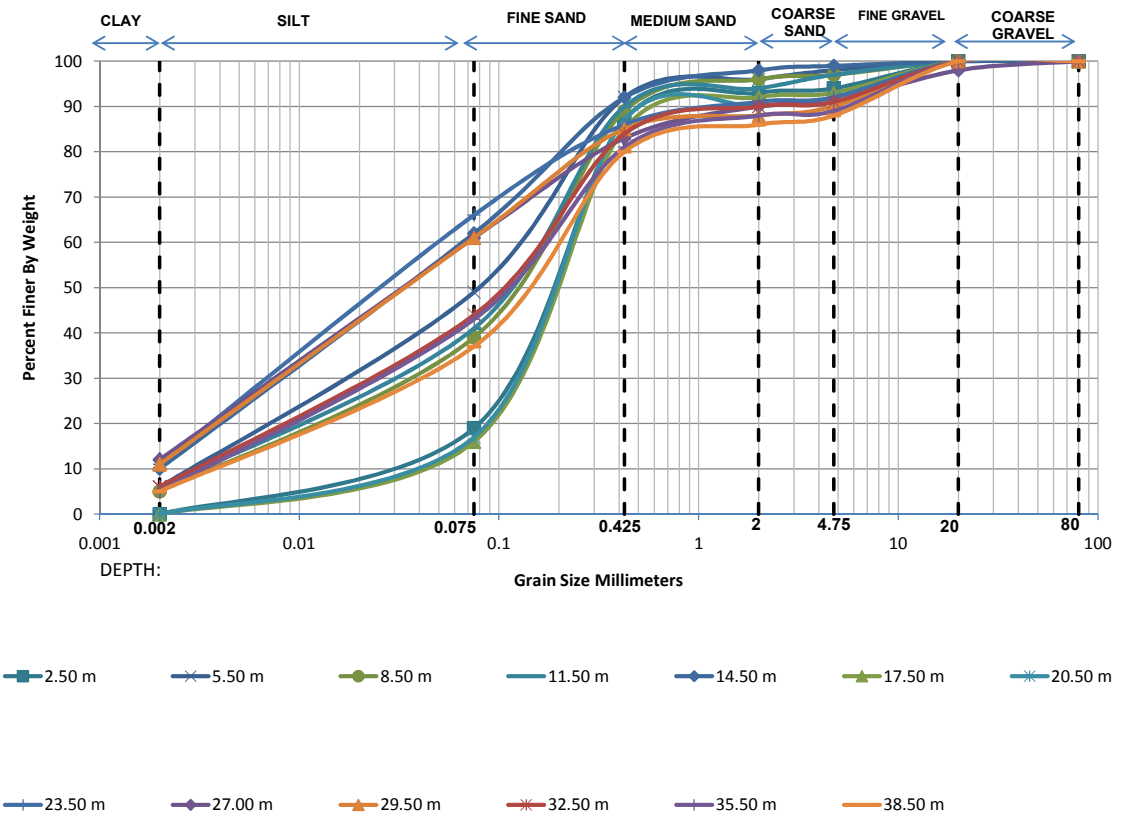
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+457 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	31.00	59.00	9.00	1.00	0.00	0.00	0.0125	0.0716	0.1877	14.99	2.18
2.50 m	0.00	26.00	64.00	6.00	3.00	1.00	0.00	0.0173	0.0895	0.2034	11.75	2.27
4.00 m	7.00	47.00	30.00	11.00	2.00	2.00	1.00	0.0036	0.0245	0.1012	27.87	1.63
5.50 m	8.00	49.00	29.00	7.00	4.00	3.00	0.00	0.0029	0.0214	0.0855	29.12	1.82
8.50 m	7.00	48.00	26.00	10.00	5.00	4.00	0.00	0.0036	0.0235	0.0985	27.30	1.56

GRAIN SIZE DISTRIBUTION CURVES

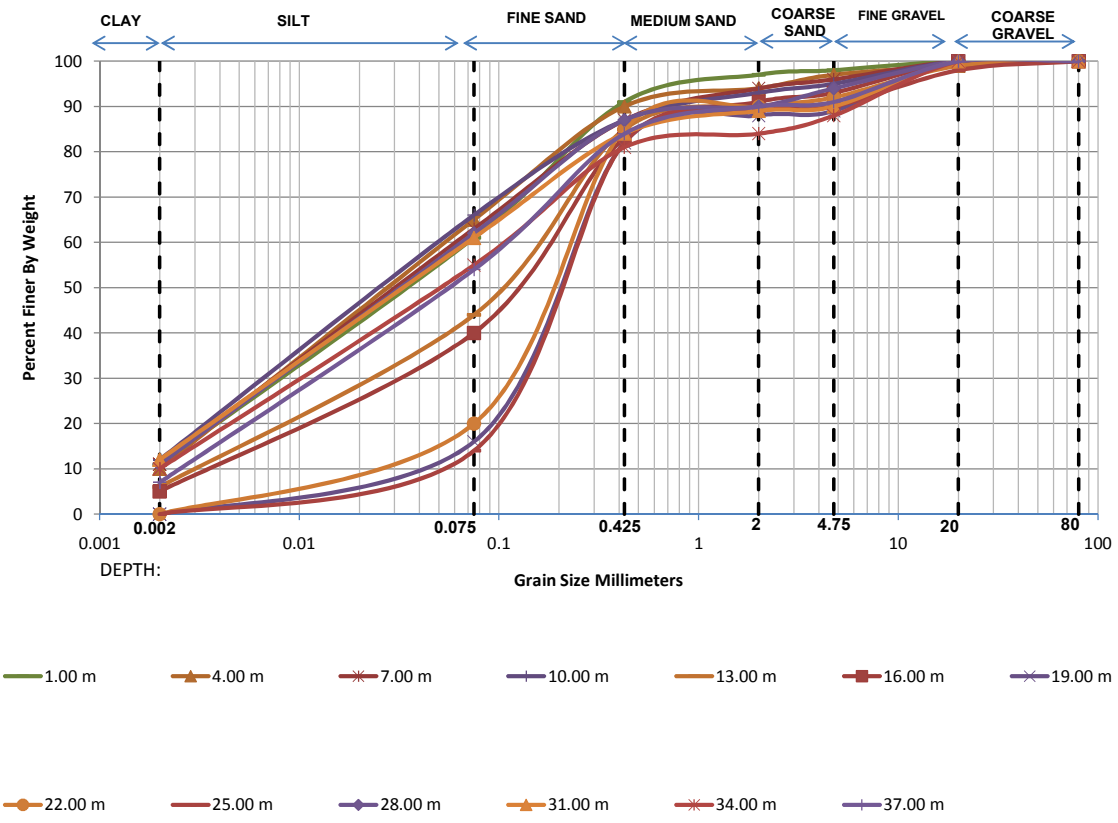
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+613 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	19.00	68.00	6.00	1.00	6.00	0.00	0.0304	0.1185	0.2326	7.65	1.98
5.50 m	6.00	43.00	43.00	4.00	2.00	2.00	0.00	0.0047	0.0308	0.1157	24.81	1.76
8.50 m	5.00	34.00	50.00	7.00	1.00	3.00	0.00	0.0067	0.0476	0.1621	24.33	2.09
11.50 m	6.00	35.00	49.00	4.00	3.00	3.00	0.00	0.0051	0.0426	0.1518	29.53	2.32
14.50 m	10.00	52.00	30.00	6.00	1.00	1.00	0.00	0.0020	0.0169	0.0701	35.04	2.03
17.50 m	0.00	16.00	69.00	7.00	1.00	7.00	0.00	0.0406	0.1326	0.2473	6.09	1.75
20.50 m	0.00	17.00	70.00	3.00	2.00	8.00	0.00	0.0369	0.1271	0.2376	6.44	1.84
23.50 m	11.00	55.00	20.00	5.00	1.00	8.00	0.00	-	0.0141	0.0610	-	-
27.00 m	12.00	49.00	22.00	7.00	1.00	7.00	2.00	-	0.0151	0.0723	-	-
29.50 m	11.00	50.00	24.00	3.00	2.00	10.00	0.00	-	0.0161	0.0724	-	-
32.50 m	6.00	38.00	40.00	6.00	1.00	9.00	0.00	0.0049	0.0368	0.1513	30.95	1.83
35.50 m	5.00	38.00	38.00	7.00	1.00	11.00	0.00	0.0061	0.0393	0.1646	26.81	1.53
38.50 m	5.00	32.00	43.00	6.00	2.00	12.00	0.00	0.0069	0.0516	0.1957	28.51	1.99

GRAIN SIZE DISTRIBUTION CURVES

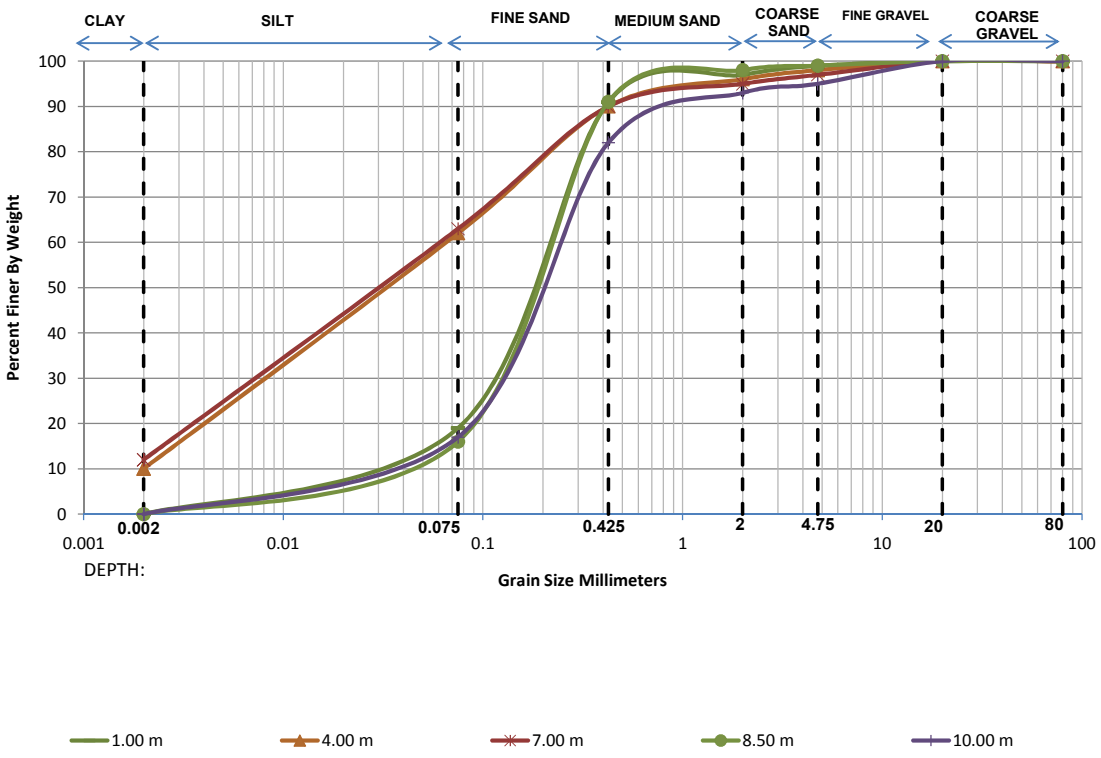
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+613 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	11.00	50.00	30.00	6.00	1.00	2.00	0.00	-	0.0164	0.0724	-	-
4.00 m	10.00	55.00	25.00	4.00	3.00	2.00	1.00	0.0020	0.0155	0.0634	31.71	1.90
7.00 m	11.00	52.00	24.00	7.00	2.00	4.00	0.00	-	0.0153	0.0675	-	-
10.00 m	12.00	54.00	21.00	6.00	2.00	5.00	0.00	-	0.0133	0.0608	-	-
13.00 m	6.00	38.00	41.00	5.00	1.00	9.00	0.00	0.0049	0.0369	0.1487	30.38	1.87
16.00 m	5.00	35.00	43.00	8.00	2.00	7.00	0.00	0.0065	0.0450	0.1729	26.70	1.80
19.00 m	0.00	16.00	66.00	6.00	1.00	11.00	0.00	0.0404	0.1339	0.2566	6.35	1.73
22.00 m	0.00	20.00	65.00	5.00	2.00	7.00	1.00	0.0276	0.1147	0.2350	8.51	2.03
25.00 m	0.00	14.00	68.00	7.00	1.00	8.00	2.00	0.0500	0.1435	0.2624	5.25	1.57
28.00 m	11.00	51.00	25.00	3.00	4.00	6.00	0.00	-	0.0157	0.0699	-	-
31.00 m	12.00	49.00	23.00	5.00	1.00	10.00	0.00	-	0.0151	0.0723	-	-
34.00 m	10.00	45.00	26.00	3.00	4.00	12.00	0.00	0.0020	0.0203	0.0979	48.96	2.11
37.00 m	7.00	47.00	30.00	6.00	1.00	9.00	0.00	0.0036	0.0245	0.1005	27.67	1.64

GRAIN SIZE DISTRIBUTION CURVES

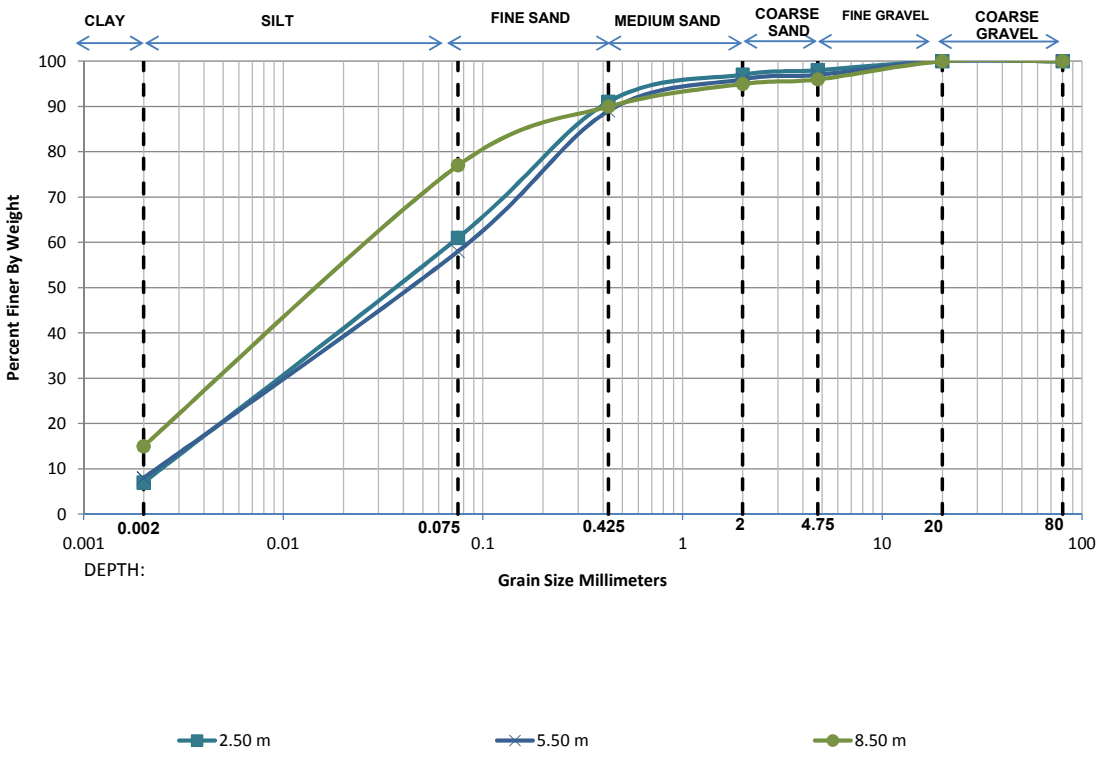
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	7+907 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	19.00	72.00	6.00	2.00	1.00	0.00	0.0307	0.1173	0.2229	7.27	2.01
4.00 m	10.00	52.00	28.00	6.00	2.00	2.00	0.00	0.0020	0.0168	0.0700	35.02	2.01
7.00 m	12.00	51.00	27.00	5.00	2.00	3.00	0.00	-	0.0145	0.0675	-	-
8.50 m	0.00	16.00	75.00	7.00	1.00	1.00	0.00	0.0411	0.1303	0.2322	5.65	1.78
10.00 m	0.00	17.00	65.00	11.00	2.00	5.00	0.00	0.0365	0.1296	0.2555	7.00	1.80

GRAIN SIZE DISTRIBUTION CURVES

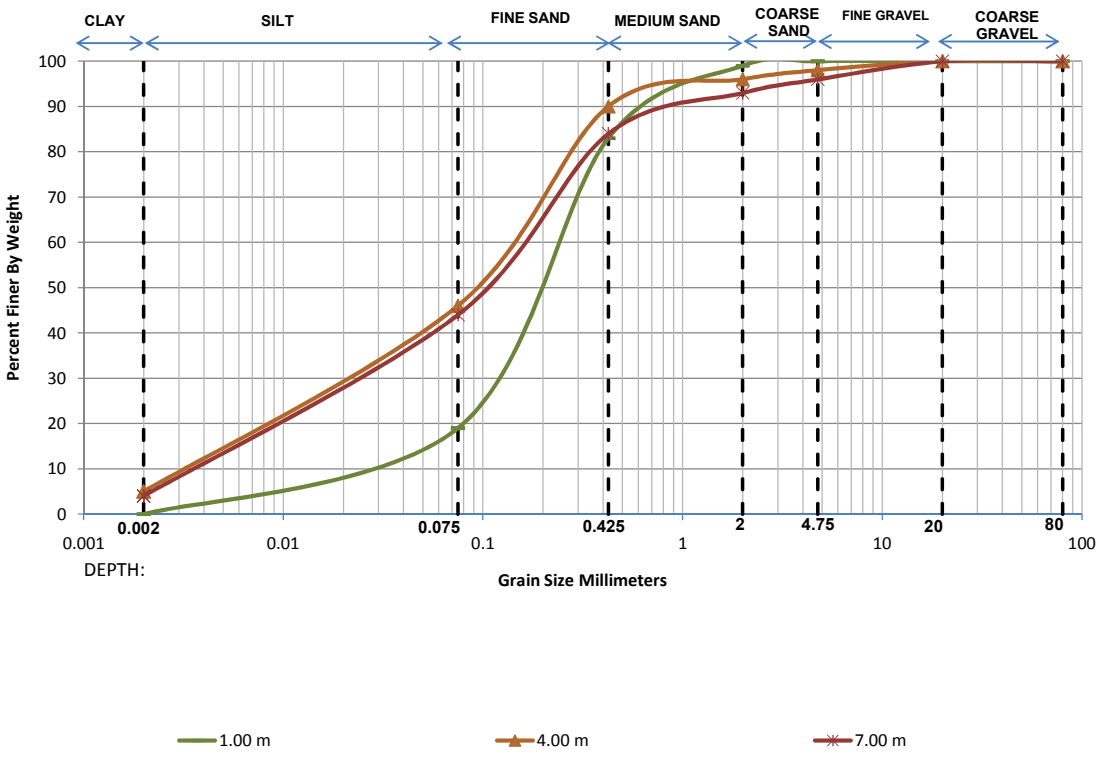
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	8+207 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	54.00	30.00	6.00	1.00	2.00	0.00	0.0035	0.0204	0.0726	20.56	1.62
5.50 m	8.00	50.00	31.00	7.00	1.00	3.00	0.00	0.0029	0.0209	0.0811	27.69	1.84
8.50 m	15.00	62.00	13.00	5.00	1.00	4.00	0.00	-	0.0086	0.0422	-	-

GRAIN SIZE DISTRIBUTION CURVES

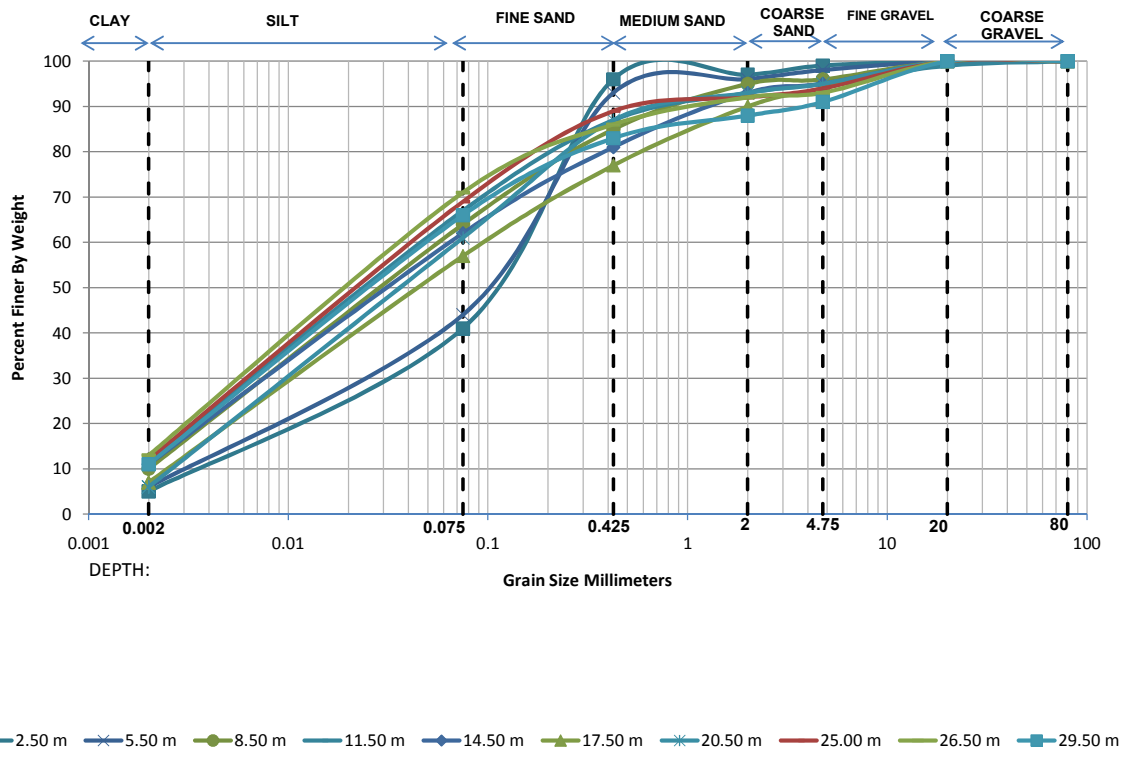
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	8+610 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	19.00	64.00	16.00	1.00	0.00	0.00	0.0301	0.1203	0.2480	8.23	1.94
4.00 m	5.00	41.00	44.00	6.00	2.00	2.00	0.00	0.0060	0.0355	0.1308	21.97	1.62
7.00 m	4.00	40.00	40.00	9.00	3.00	4.00	0.00	0.0075	0.0391	0.1516	20.14	1.34

GRAIN SIZE DISTRIBUTION CURVES

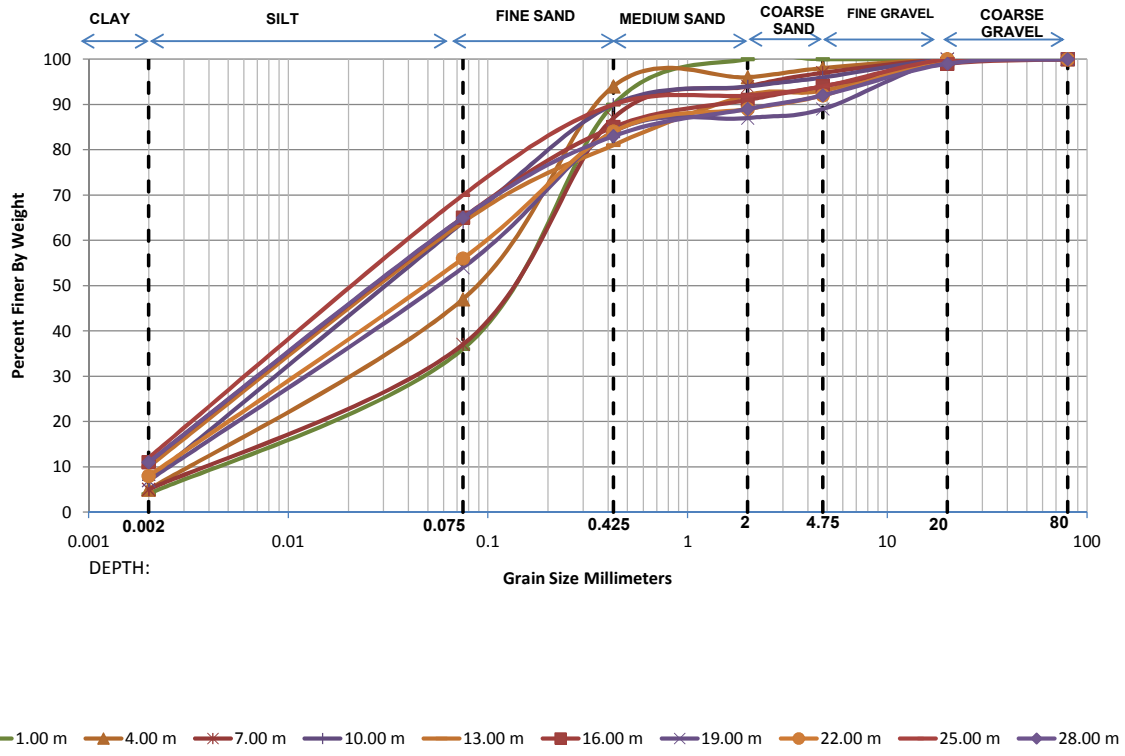
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	8+852 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	36.00	55.00	1.00	2.00	1.00	0.00	0.0065	0.0440	0.1420	21.95	2.10
5.50 m	6.00	38.00	49.00	3.00	2.00	2.00	0.00	0.0049	0.0375	0.1350	27.35	2.11
8.50 m	10.00	54.00	21.00	10.00	1.00	4.00	0.00	0.0020	0.0157	0.0654	32.69	1.89
11.50 m	12.00	55.00	20.00	6.00	2.00	4.00	1.00	-	0.0130	0.0588	-	-
14.50 m	11.00	51.00	19.00	12.00	2.00	5.00	0.00	-	0.0155	0.0698	-	-
17.50 m	7.00	50.00	20.00	13.00	4.00	6.00	0.00	0.0036	0.0219	0.0904	25.34	1.49
20.50 m	6.00	55.00	26.00	6.00	2.00	5.00	0.00	0.0043	0.0214	0.0726	16.95	1.47
25.00 m	12.00	57.00	20.00	3.00	2.00	6.00	0.00	-	0.0124	0.0552	-	-
26.50 m	13.00	58.00	15.00	6.00	1.00	7.00	0.00	-	0.0111	0.0513	-	-
29.50 m	11.00	55.00	17.00	5.00	3.00	9.00	0.00	-	0.0140	0.0609	-	-

GRAIN SIZE DISTRIBUTION CURVES

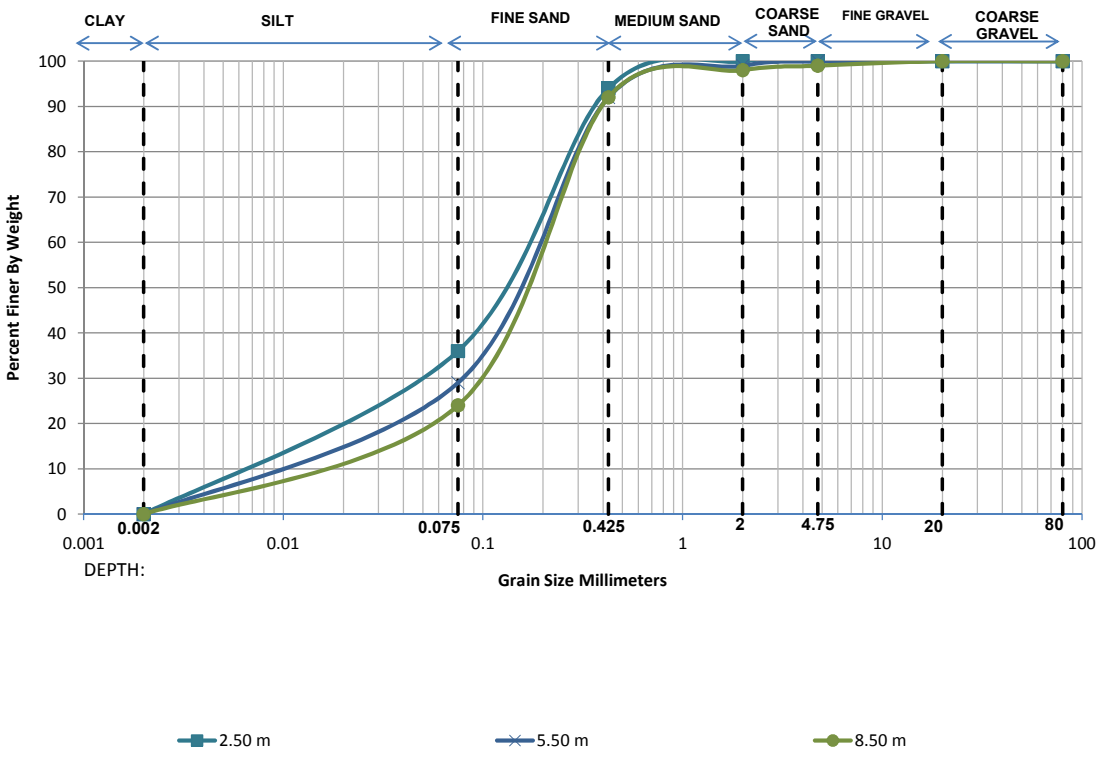
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	8+852 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	4.00	32.00	54.00	10.00	0.00	0.00	0.00	0.0089	0.0556	0.1722	19.34	2.02
4.00 m	5.00	42.00	47.00	2.00	2.00	2.00	0.00	0.0059	0.0345	0.1213	20.55	1.66
7.00 m	5.00	32.00	50.00	7.00	3.00	3.00	0.00	0.0069	0.0522	0.1746	25.14	2.24
10.00 m	7.00	57.00	26.00	4.00	2.00	4.00	0.00	0.0035	0.0189	0.0660	18.89	1.56
13.00 m	10.00	54.00	17.00	11.00	1.00	7.00	0.00	0.0020	0.0156	0.0653	32.63	1.85
16.00 m	11.00	54.00	20.00	6.00	3.00	5.00	1.00	-	0.0144	0.0630	-	-
19.00 m	7.00	47.00	30.00	3.00	2.00	11.00	0.00	0.0036	0.0245	0.1000	27.54	1.65
22.00 m	8.00	48.00	28.00	5.00	3.00	8.00	0.00	0.0029	0.0219	0.0906	30.79	1.80
25.00 m	12.00	58.00	20.00	2.00	2.00	6.00	0.00	-	0.0122	0.0536	-	-
28.00 m	11.00	54.00	18.00	6.00	3.00	7.00	1.00	-	0.0144	0.0630	-	-

GRAIN SIZE DISTRIBUTION CURVES

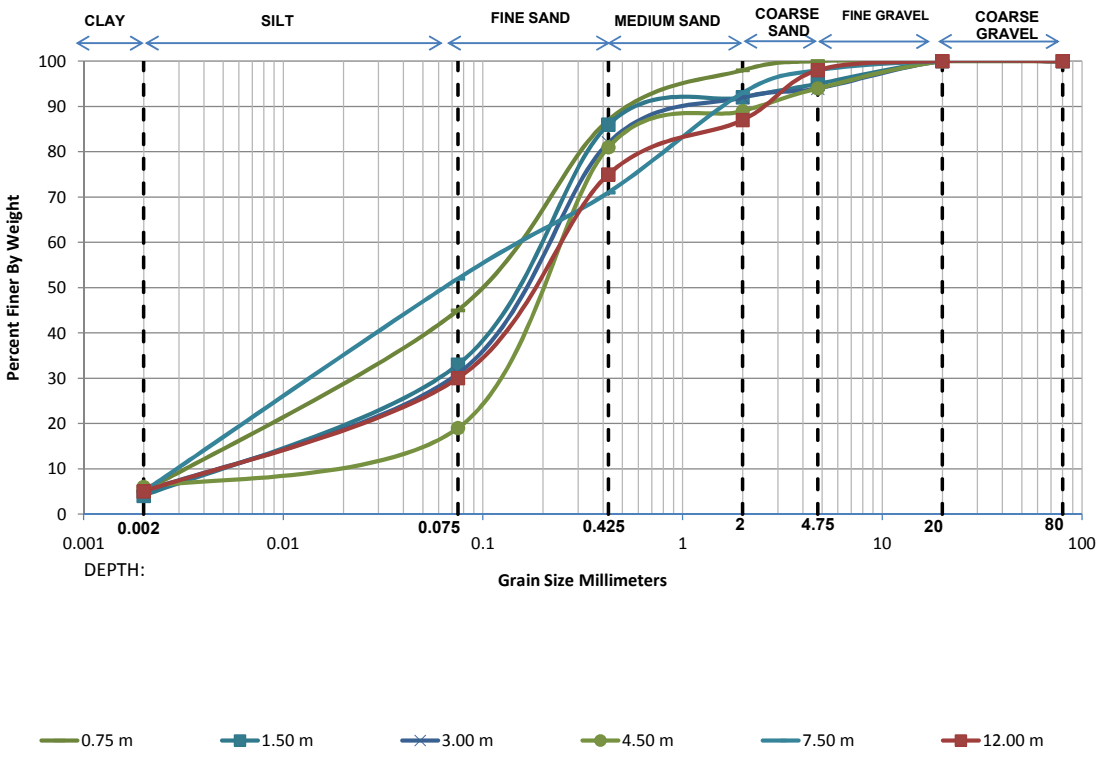
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	8+907 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	36.00	58.00	6.00	0.00	0.00	0.00	0.0097	0.0569	0.1615	16.69	2.07
5.50 m	0.00	29.00	63.00	7.00	1.00	0.00	0.00	0.0142	0.0784	0.1895	13.32	2.28
8.50 m	0.00	24.00	68.00	6.00	1.00	1.00	0.00	0.0202	0.0969	0.2054	10.18	2.27

GRAIN SIZE DISTRIBUTION CURVES

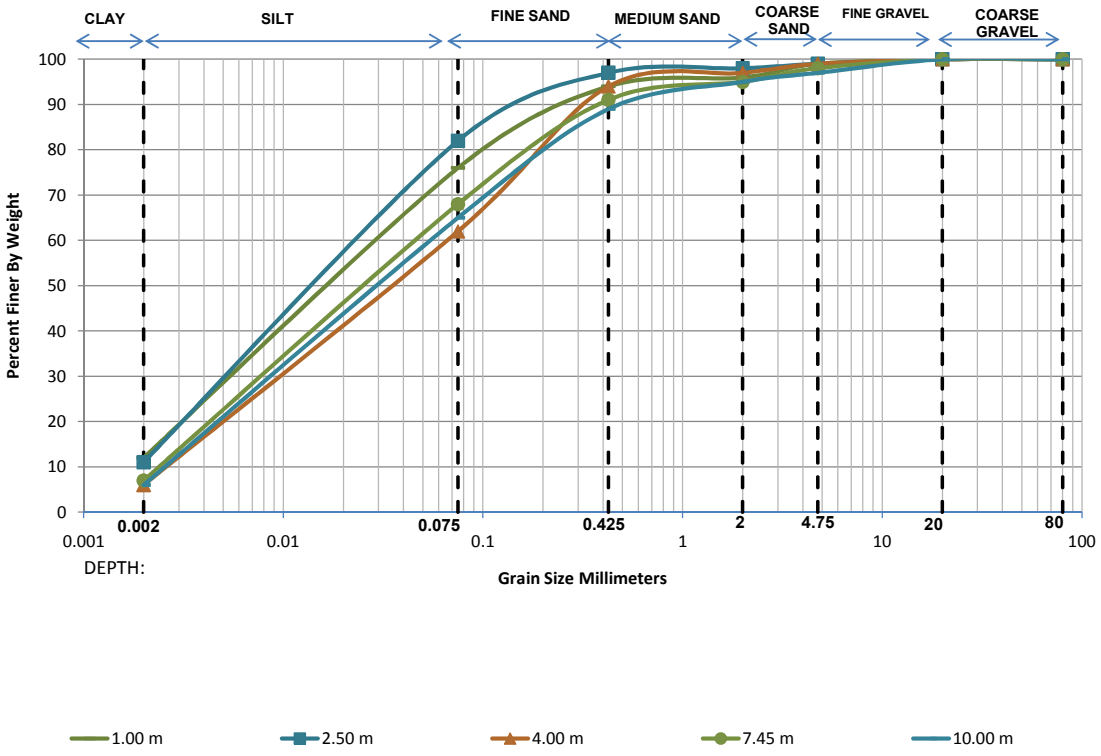
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	New Ch. 10+340 Silani Station
B.H. No.	BH-PLT-08



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.75 m	5.00	40.00	42.00	11.00	2.00	0.00	0.00	0.0060	0.0367	0.1414	23.52	1.58
1.50 m	4.00	29.00	53.00	6.00	3.00	5.00	0.00	0.0096	0.0643	0.1917	19.88	2.23
3.00 m	5.00	26.00	51.00	10.00	2.00	6.00	0.00	0.0082	0.0710	0.2137	25.91	2.86
4.50 m	6.00	13.00	62.00	8.00	5.00	6.00	0.00	0.0149	0.1284	0.2574	17.29	4.30
7.50 m	5.00	47.00	19.00	22.00	5.00	2.00	0.00	0.0055	0.0276	0.1594	29.09	0.87
12.00 m	5.00	25.00	45.00	12.00	11.00	2.00	0.00	0.0084	0.0750	0.2505	29.66	2.66

GRAIN SIZE DISTRIBUTION CURVES

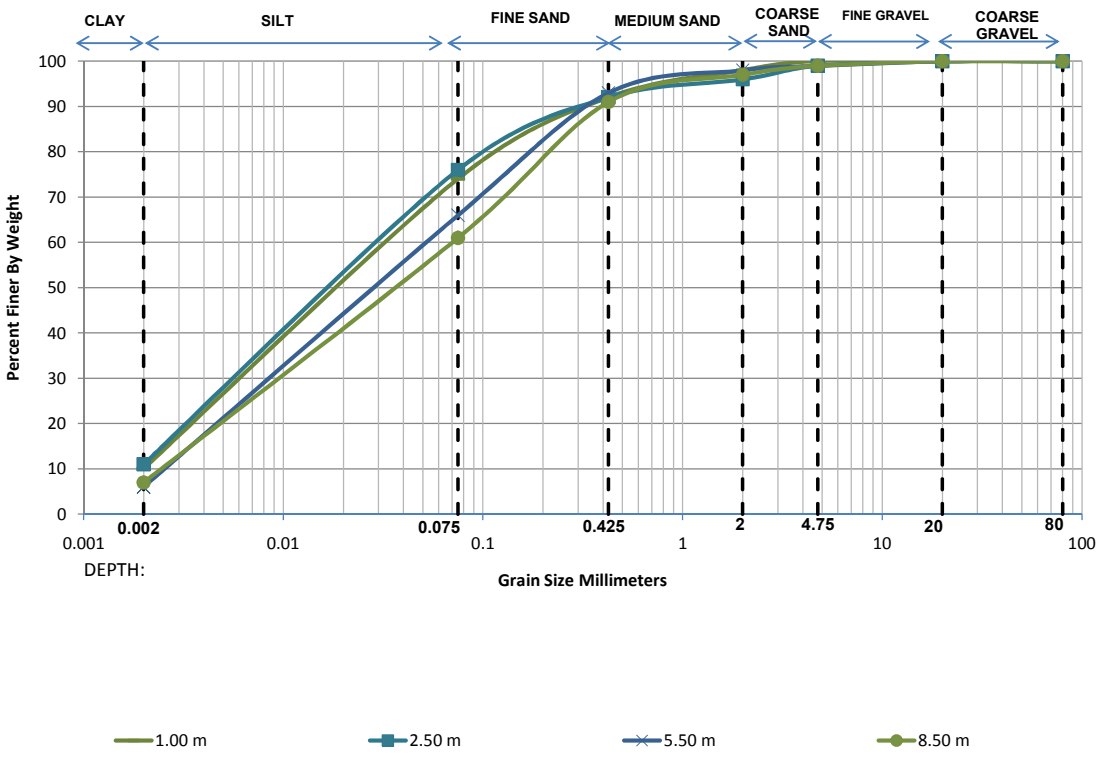
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	9+200 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	12.00	64.00	18.00	2.00	3.00	1.00	0.00	-	0.0109	0.0451	-	-
2.50 m	11.00	71.00	15.00	1.00	1.00	1.00	0.00	-	0.0107	0.0391	-	-
4.00 m	6.00	56.00	32.00	3.00	2.00	1.00	0.00	0.0043	0.0212	0.0704	16.47	1.49
7.45 m	7.00	61.00	23.00	4.00	3.00	2.00	0.00	0.0035	0.0174	0.0586	16.97	1.50
10.00 m	6.00	59.00	24.00	6.00	2.00	3.00	0.00	0.0042	0.0196	0.0642	15.24	1.43

GRAIN SIZE DISTRIBUTION CURVES

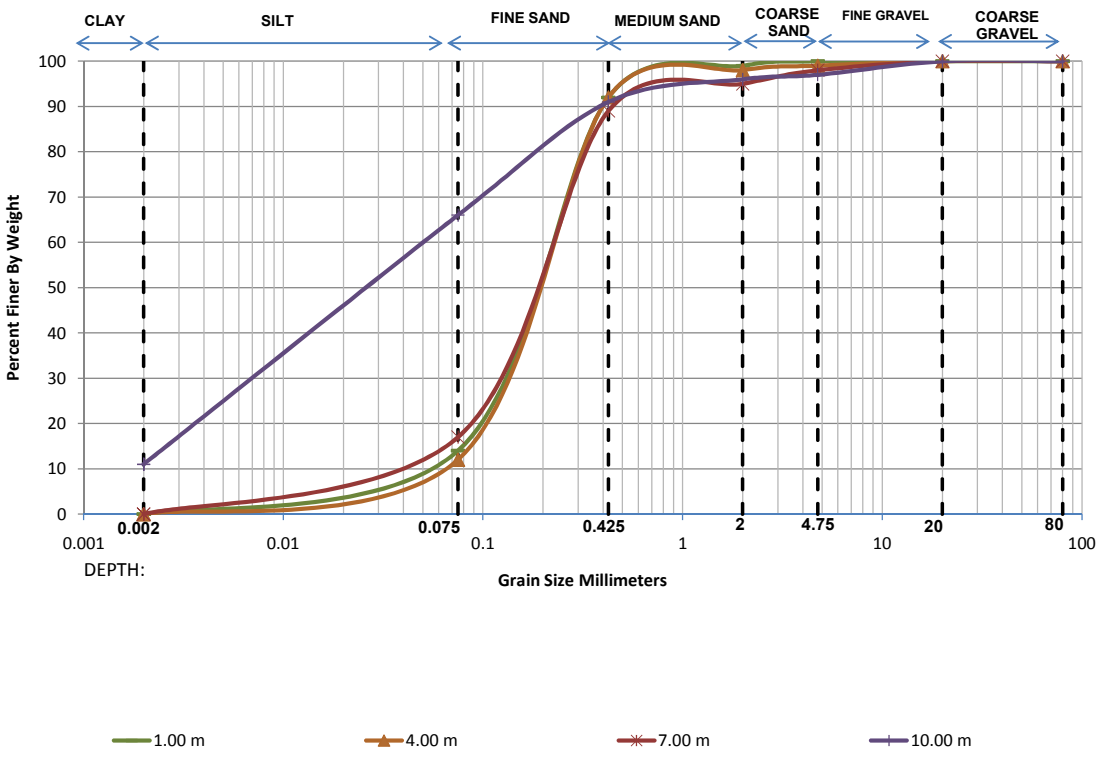
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	9+211 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	10.00	64.00	18.00	6.00	2.00	0.00	0.00	0.0020	0.0129	0.0485	24.23	1.71
2.50 m	11.00	65.00	16.00	4.00	3.00	1.00	0.00	-	0.0116	0.0454	-	-
5.50 m	6.00	60.00	27.00	5.00	1.00	1.00	0.00	0.0042	0.0194	0.0624	14.86	1.44
8.50 m	7.00	54.00	30.00	6.00	2.00	1.00	0.00	0.0035	0.0204	0.0726	20.56	1.62

GRAIN SIZE DISTRIBUTION CURVES

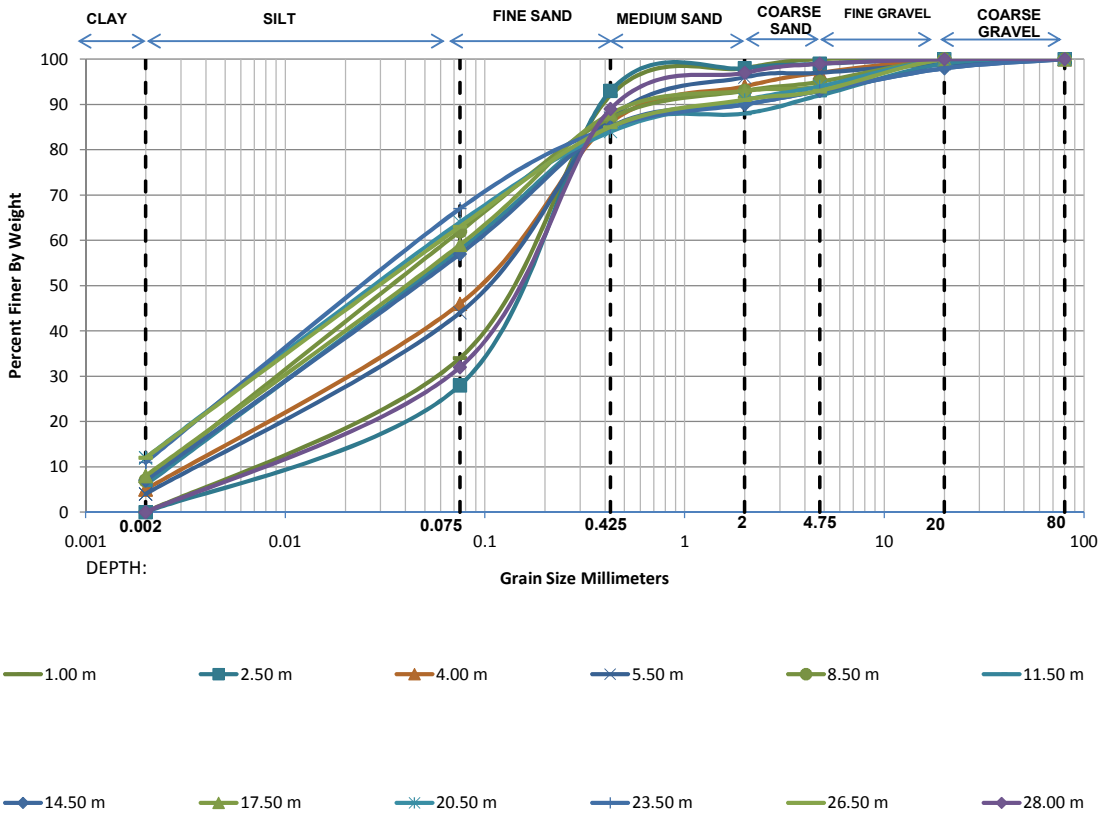
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	9+407 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	14.00	78.00	7.00	1.00	0.00	0.00	0.0507	0.1389	0.2360	4.66	1.61
4.00 m	0.00	12.00	80.00	6.00	1.00	1.00	0.00	0.0625	0.1482	0.2417	3.87	1.45
7.00 m	0.00	17.00	72.00	6.00	3.00	2.00	0.00	0.0370	0.1266	0.2335	6.31	1.85
10.00 m	11.00	55.00	25.00	5.00	1.00	3.00	0.00	-	0.0143	0.0612	-	-

GRAIN SIZE DISTRIBUTION CURVES

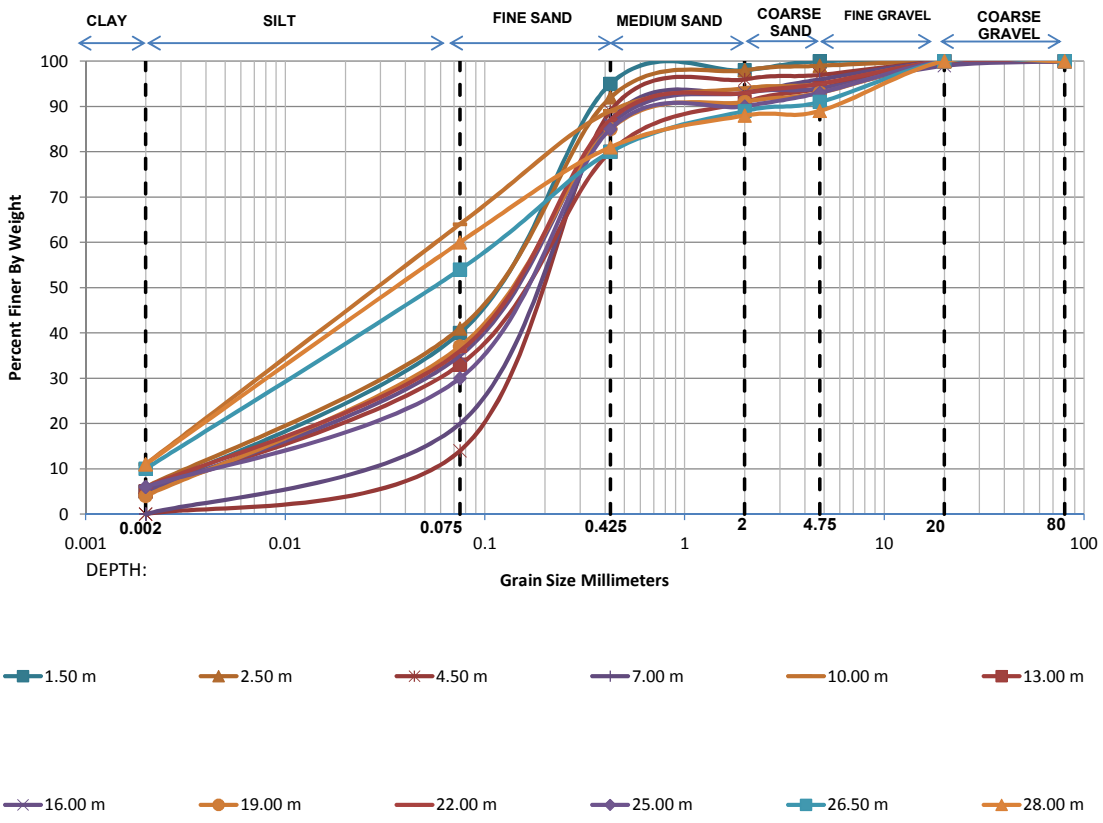
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	9+726 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	34.00	58.00	6.00	2.00	0.00	0.00	0.0107	0.0623	0.1721	16.16	2.12
2.50 m	0.00	28.00	65.00	5.00	1.00	1.00	0.00	0.0152	0.0819	0.1903	12.50	2.32
4.00 m	5.00	41.00	40.00	8.00	3.00	3.00	0.00	0.0059	0.0352	0.1377	23.24	1.52
5.50 m	4.00	40.00	43.00	9.00	1.00	2.00	1.00	0.0076	0.0393	0.1450	19.18	1.41
8.50 m	7.00	55.00	25.00	6.00	2.00	5.00	0.00	0.0035	0.0197	0.0702	19.99	1.57
11.50 m	6.00	52.00	27.00	3.00	4.00	7.00	1.00	0.0043	0.0229	0.0813	18.72	1.49
14.50 m	7.00	50.00	28.00	5.00	3.00	5.00	2.00	0.0036	0.0224	0.0855	23.89	1.64
17.50 m	8.00	51.00	29.00	5.00	1.00	6.00	0.00	0.0029	0.0202	0.0778	26.65	1.80
20.50 m	12.00	52.00	20.00	7.00	3.00	6.00	0.00	-	0.0139	0.0650	-	-
23.50 m	11.00	56.00	18.00	5.00	3.00	5.00	2.00	-	0.0137	0.0590	-	-
26.50 m	12.00	51.00	22.00	6.00	2.00	7.00	0.00	-	0.0143	0.0673	-	-
28.00 m	0.00	32.00	57.00	8.00	2.00	1.00	0.00	0.0118	0.0683	0.1862	15.80	2.13

GRAIN SIZE DISTRIBUTION CURVES

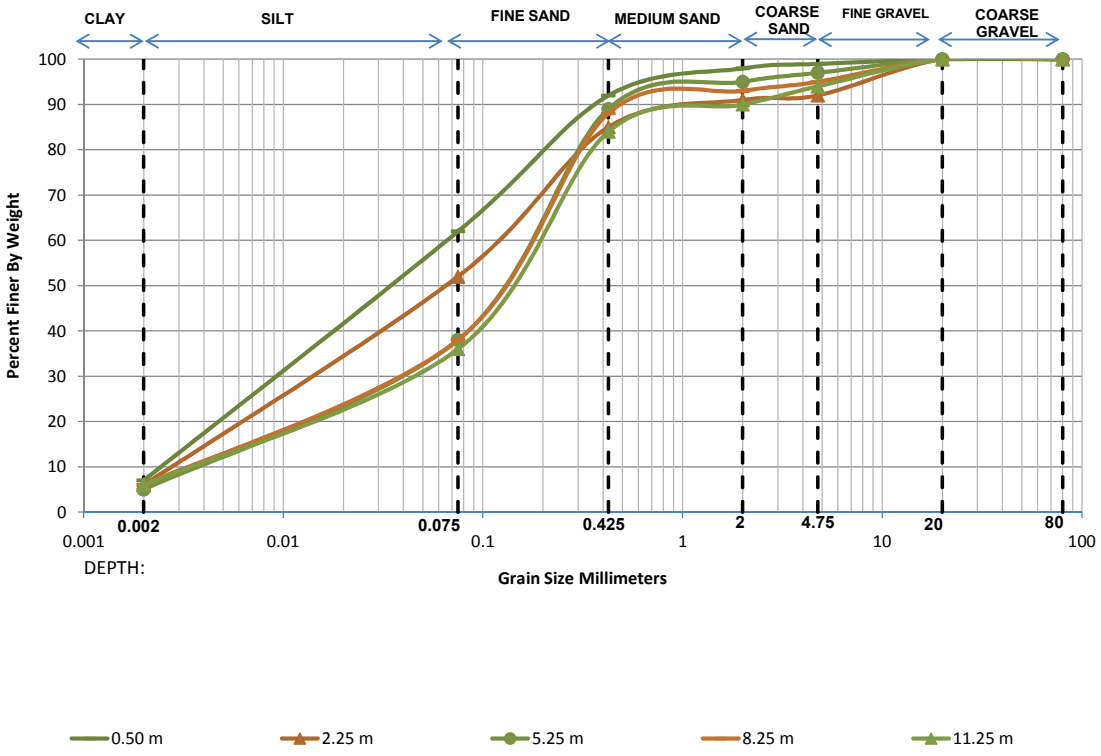
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	9+726 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.50 m	5.00	35.00	55.00	3.00	2.00	0.00	0.00	0.0066	0.0459	0.1474	22.39	2.17
2.50 m	6.00	35.00	51.00	6.00	1.00	1.00	0.00	0.0052	0.0427	0.1491	28.94	2.38
4.50 m	0.00	14.00	75.00	7.00	1.00	3.00	0.00	0.0505	0.1402	0.2426	4.81	1.61
7.00 m	0.00	20.00	67.00	6.00	3.00	4.00	0.00	0.0278	0.1142	0.2296	8.27	2.04
10.00 m	11.00	53.00	25.00	5.00	1.00	5.00	0.00	-	0.0150	0.0653	-	-
13.00 m	5.00	28.00	47.00	11.00	3.00	6.00	0.00	0.0077	0.0636	0.2142	27.97	2.47
16.00 m	5.00	30.00	51.00	7.00	1.00	5.00	1.00	0.0073	0.0576	0.1850	25.35	2.46
19.00 m	4.00	33.00	48.00	6.00	2.00	7.00	0.00	0.0086	0.0527	0.1788	20.77	1.81
22.00 m	6.00	30.00	51.00	6.00	2.00	5.00	0.00	0.0056	0.0542	0.1788	31.65	2.91
25.00 m	6.00	24.00	55.00	5.00	3.00	7.00	0.00	0.0068	0.0750	0.2065	30.42	4.01
26.50 m	10.00	44.00	26.00	9.00	2.00	9.00	0.00	0.0020	0.0210	0.1062	53.09	2.08
28.00 m	11.00	49.00	21.00	7.00	1.00	11.00	0.00	-	0.0164	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

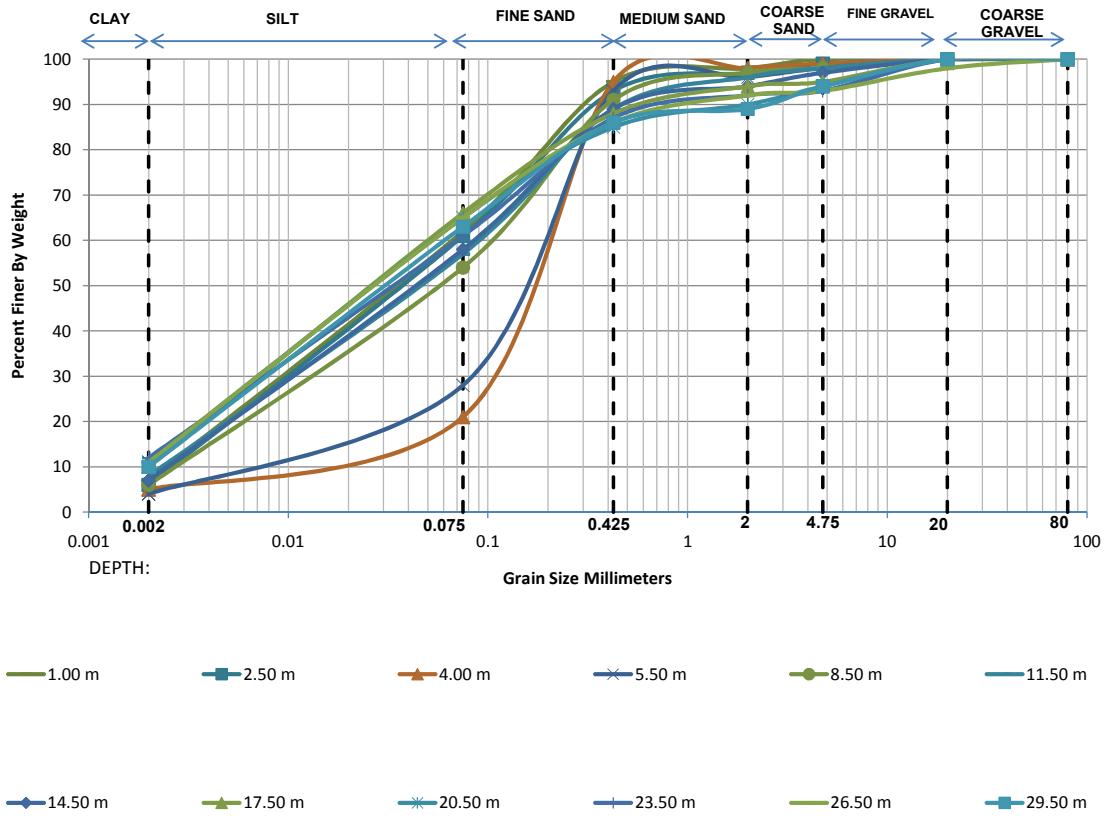
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	9+772 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	55.00	30.00	6.00	1.00	1.00	0.00	0.0035	0.0199	0.0703	19.98	1.61
2.25 m	6.00	46.00	33.00	6.00	1.00	8.00	0.00	0.0045	0.0274	0.1095	24.21	1.51
5.25 m	5.00	33.00	51.00	6.00	2.00	3.00	0.00	0.0068	0.0498	0.1658	24.36	2.20
8.25 m	6.00	32.00	50.00	5.00	2.00	5.00	0.00	0.0054	0.0490	0.1682	31.07	2.64
11.25 m	6.00	30.00	48.00	6.00	4.00	6.00	0.00	0.0056	0.0540	0.1868	33.22	2.77

GRAIN SIZE DISTRIBUTION CURVES

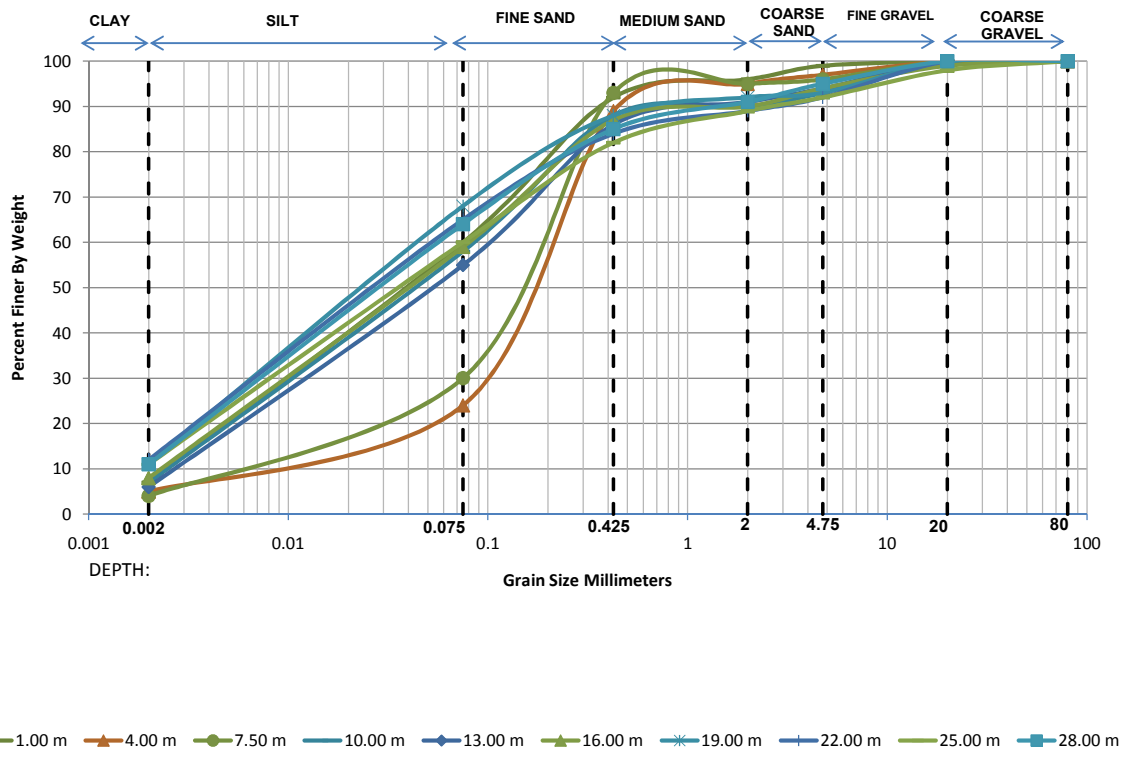
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+025 Minor Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	55.00	33.00	3.00	2.00	0.00	0.00	0.0035	0.0201	0.0704	19.97	1.63
2.50 m	6.00	55.00	32.00	4.00	2.00	1.00	0.00	0.0043	0.0217	0.0727	16.91	1.50
4.00 m	5.00	16.00	74.00	3.00	1.00	1.00	0.00	0.0157	0.1125	0.2136	13.62	3.78
5.50 m	4.00	24.00	65.00	3.00	2.00	2.00	0.00	0.0119	0.0826	0.1928	16.16	2.97
8.50 m	6.00	48.00	37.00	6.00	1.00	2.00	0.00	0.0045	0.0261	0.0958	21.41	1.58
11.50 m	8.00	49.00	32.00	7.00	2.00	2.00	0.00	0.0029	0.0215	0.0848	28.87	1.86
14.50 m	7.00	51.00	31.00	5.00	3.00	3.00	0.00	0.0036	0.0220	0.0810	22.68	1.67
17.50 m	10.00	56.00	22.00	6.00	1.00	5.00	0.00	0.0020	0.0151	0.0613	30.67	1.85
20.50 m	11.00	54.00	20.00	5.00	4.00	6.00	0.00	-	0.0144	0.0630	-	-
23.50 m	12.00	49.00	26.00	5.00	1.00	7.00	0.00	-	0.0153	0.0723	-	-
26.50 m	11.00	54.00	21.00	6.00	1.00	5.00	2.00	-	0.0145	0.0631	-	-
29.50 m	10.00	53.00	23.00	3.00	5.00	6.00	0.00	0.0020	0.0162	0.0676	33.82	1.93

GRAIN SIZE DISTRIBUTION CURVES

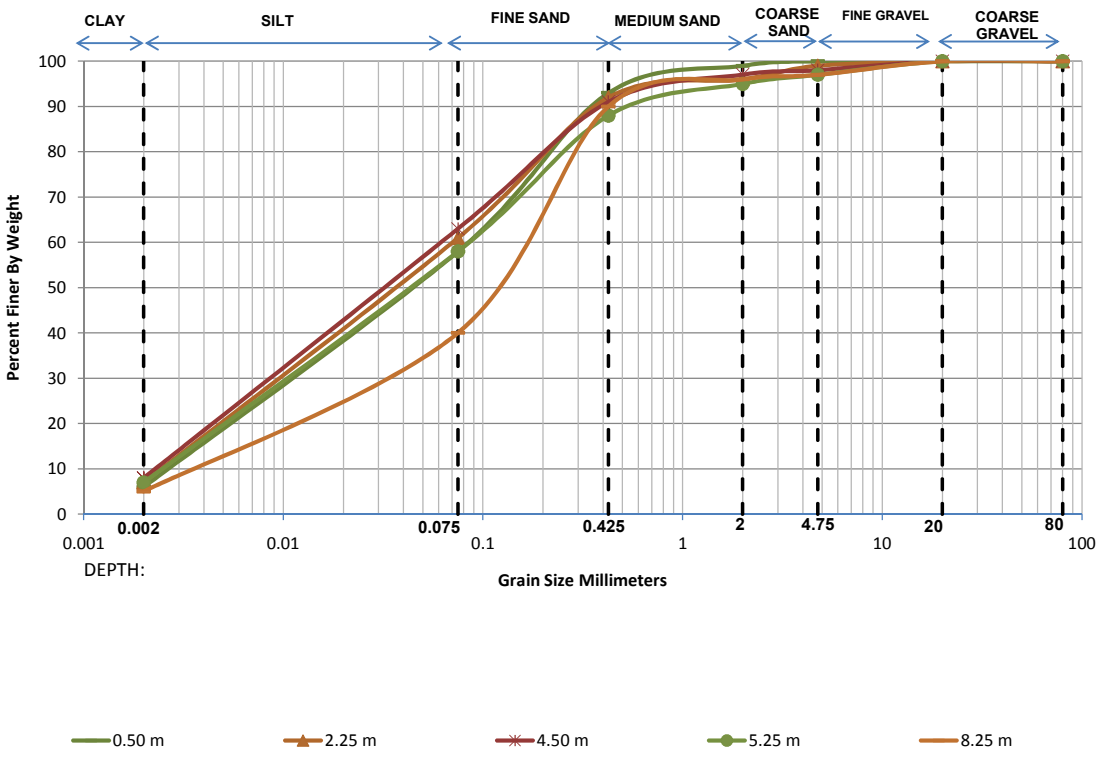
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+025 Minor Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	53.00	32.00	4.00	3.00	1.00	0.00	0.0035	0.0210	0.0750	21.15	1.65
4.00 m	5.00	19.00	65.00	6.00	2.00	3.00	0.00	0.0121	0.1003	0.2164	17.85	3.83
7.50 m	4.00	26.00	63.00	2.00	1.00	4.00	0.00	0.0109	0.0750	0.1857	17.02	2.78
10.00 m	7.00	51.00	30.00	2.00	3.00	7.00	0.00	0.0036	0.0219	0.0810	22.70	1.66
13.00 m	6.00	49.00	31.00	5.00	3.00	6.00	0.00	0.0044	0.0250	0.0939	21.20	1.50
16.00 m	8.00	51.00	28.00	3.00	4.00	5.00	1.00	0.0029	0.0202	0.0779	26.66	1.79
19.00 m	11.00	57.00	20.00	4.00	1.00	7.00	0.00	-	0.0135	0.0573	-	-
22.00 m	12.00	53.00	19.00	5.00	3.00	8.00	0.00	-	0.0135	0.0628	-	-
25.00 m	11.00	49.00	22.00	7.00	3.00	6.00	2.00	-	0.0164	0.0750	-	-
28.00 m	11.00	53.00	21.00	6.00	4.00	5.00	0.00	-	0.0148	0.0652	-	-

GRAIN SIZE DISTRIBUTION CURVES

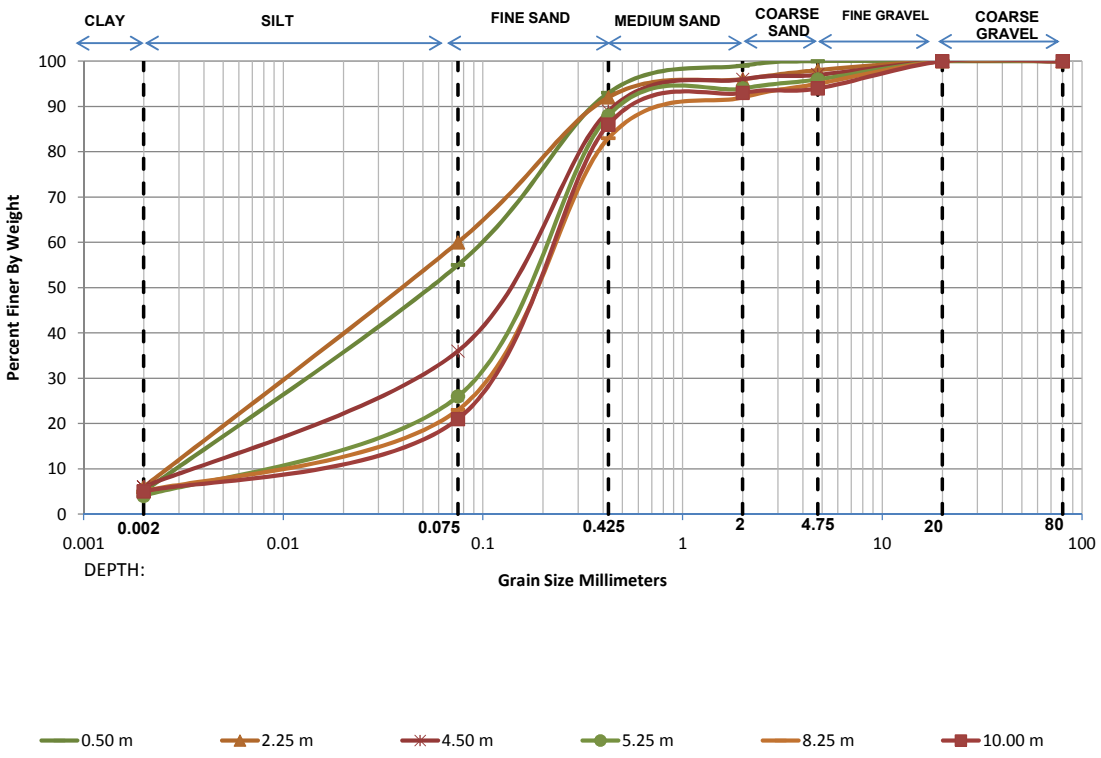
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+223 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	6.00	52.00	35.00	6.00	1.00	0.00	0.00	0.0044	0.0234	0.0806	18.46	1.55
2.25 m	7.00	54.00	31.00	4.00	3.00	1.00	0.00	0.0035	0.0204	0.0726	20.55	1.63
4.50 m	8.00	55.00	28.00	6.00	1.00	2.00	0.00	0.0029	0.0184	0.0680	23.48	1.71
5.25 m	7.00	51.00	30.00	7.00	2.00	3.00	0.00	0.0036	0.0219	0.0811	22.73	1.66
8.25 m	5.00	35.00	50.00	6.00	1.00	3.00	0.00	0.0065	0.0455	0.1559	23.83	2.03

GRAIN SIZE DISTRIBUTION CURVES

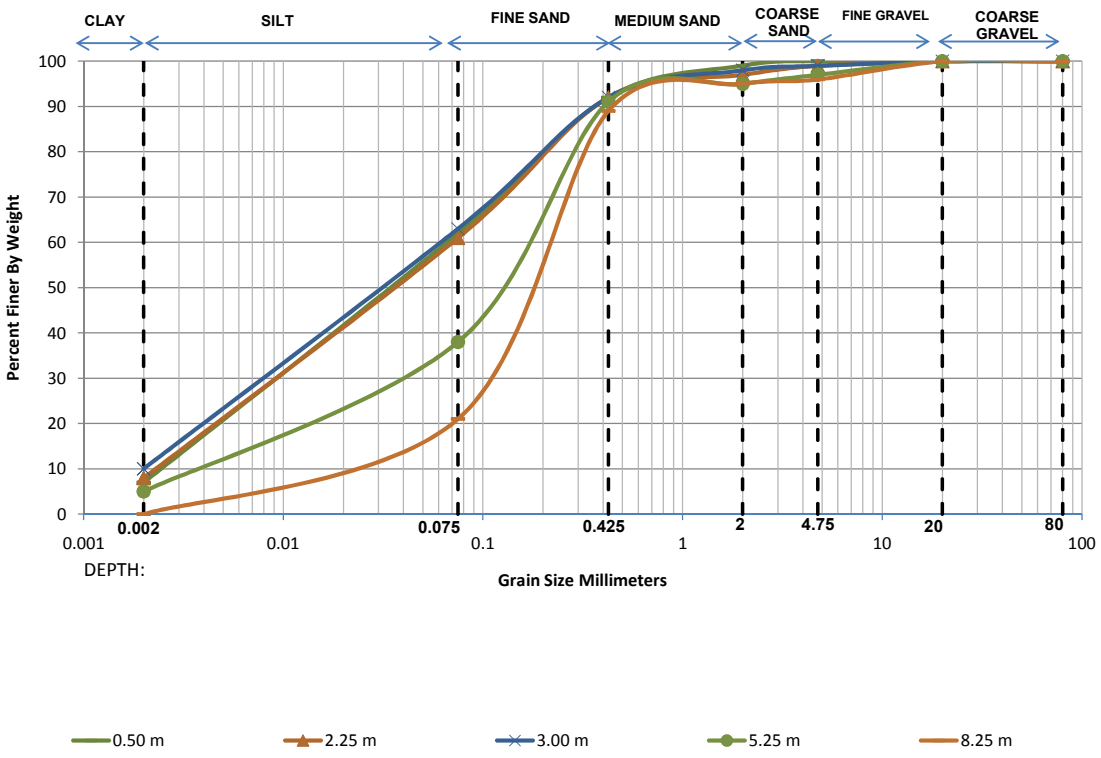
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+519 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	5.00	50.00	38.00	6.00	1.00	0.00	0.00	0.0055	0.0267	0.0909	16.67	1.43
2.25 m	6.00	54.00	32.00	4.00	2.00	2.00	0.00	0.0043	0.0221	0.0750	17.38	1.51
4.50 m	6.00	30.00	53.00	7.00	1.00	3.00	0.00	0.0057	0.0543	0.1746	30.81	2.98
5.25 m	4.00	22.00	62.00	6.00	2.00	4.00	0.00	0.0131	0.0911	0.2112	16.11	3.00
8.25 m	5.00	18.00	60.00	9.00	3.00	5.00	0.00	0.0129	0.1062	0.2374	18.45	3.69
10.00 m	5.00	16.00	65.00	7.00	1.00	6.00	0.00	0.0154	0.1150	0.2342	15.24	3.67

GRAIN SIZE DISTRIBUTION CURVES

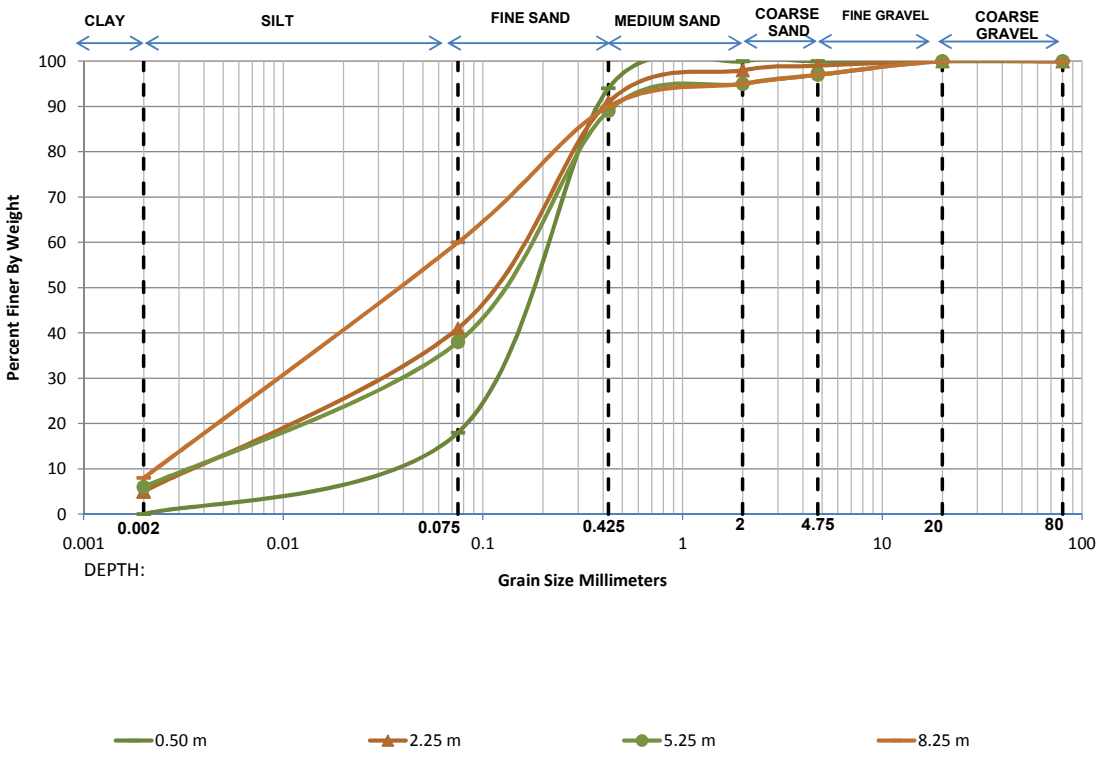
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+658 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	55.00	30.00	7.00	1.00	0.00	0.00	0.0035	0.0199	0.0703	19.98	1.61
2.25 m	8.00	53.00	31.00	5.00	2.00	1.00	0.00	0.0029	0.0194	0.0726	24.94	1.78
3.00 m	10.00	53.00	29.00	6.00	1.00	1.00	0.00	0.0020	0.0164	0.0678	33.89	1.99
5.25 m	5.00	33.00	53.00	4.00	2.00	3.00	0.00	0.0068	0.0500	0.1614	23.64	2.27
8.25 m	0.00	21.00	68.00	6.00	1.00	4.00	0.00	0.0255	0.1095	0.2215	8.67	2.12

GRAIN SIZE DISTRIBUTION CURVES

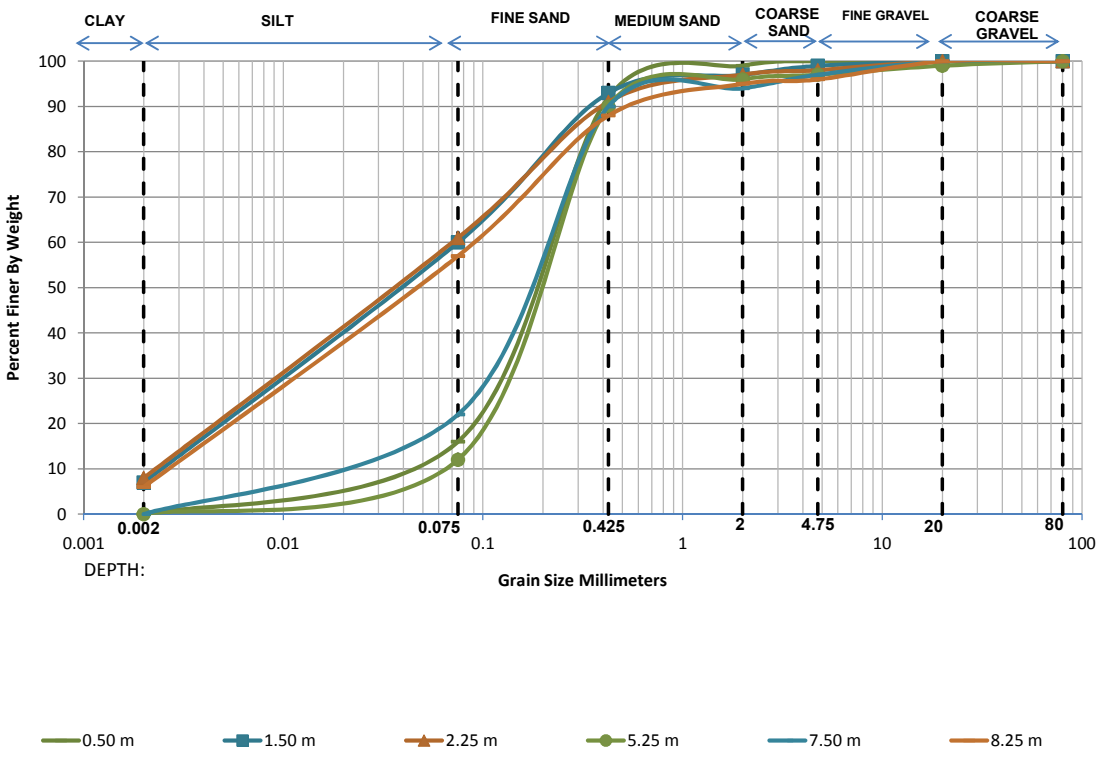
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+718 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	18.00	76.00	6.00	0.00	0.00	0.00	0.0339	0.1207	0.2198	6.48	1.95
2.25 m	5.00	36.00	50.00	7.00	1.00	1.00	0.00	0.0064	0.0436	0.1504	23.39	1.97
5.25 m	6.00	32.00	51.00	6.00	2.00	3.00	0.00	0.0054	0.0491	0.1664	30.70	2.67
8.25 m	8.00	52.00	30.00	5.00	2.00	3.00	0.00	0.0029	0.0198	0.0750	25.73	1.79

GRAIN SIZE DISTRIBUTION CURVES

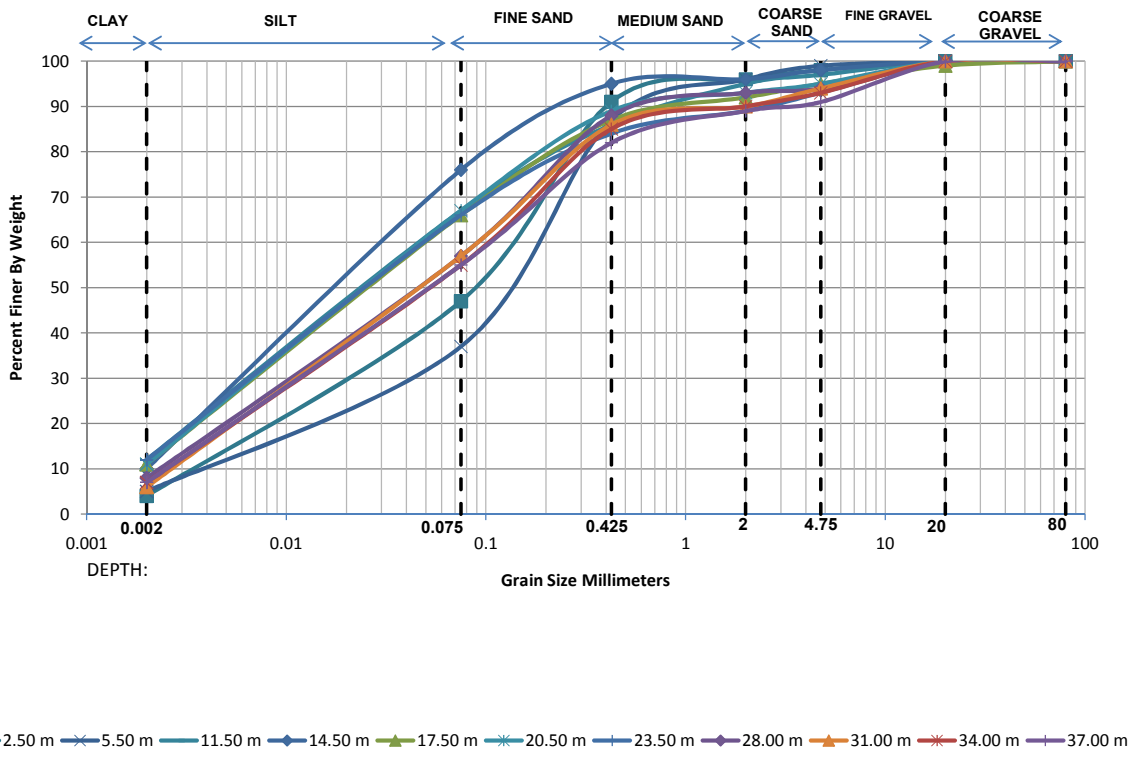
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+749 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	16.00	76.00	7.00	1.00	0.00	0.00	0.0412	0.1300	0.2301	5.59	1.78
1.50 m	7.00	53.00	33.00	4.00	2.00	1.00	0.00	0.0035	0.0210	0.0750	21.14	1.66
2.25 m	8.00	53.00	30.00	6.00	1.00	2.00	0.00	0.0029	0.0193	0.0726	24.94	1.77
5.25 m	0.00	12.00	78.00	6.00	1.00	2.00	1.00	0.0624	0.1491	0.2459	3.94	1.45
7.50 m	0.00	22.00	68.00	4.00	3.00	3.00	0.00	0.0235	0.1051	0.2154	9.15	2.18
8.25 m	6.00	51.00	31.00	7.00	1.00	4.00	0.00	0.0044	0.0237	0.0848	19.36	1.52

GRAIN SIZE DISTRIBUTION CURVES

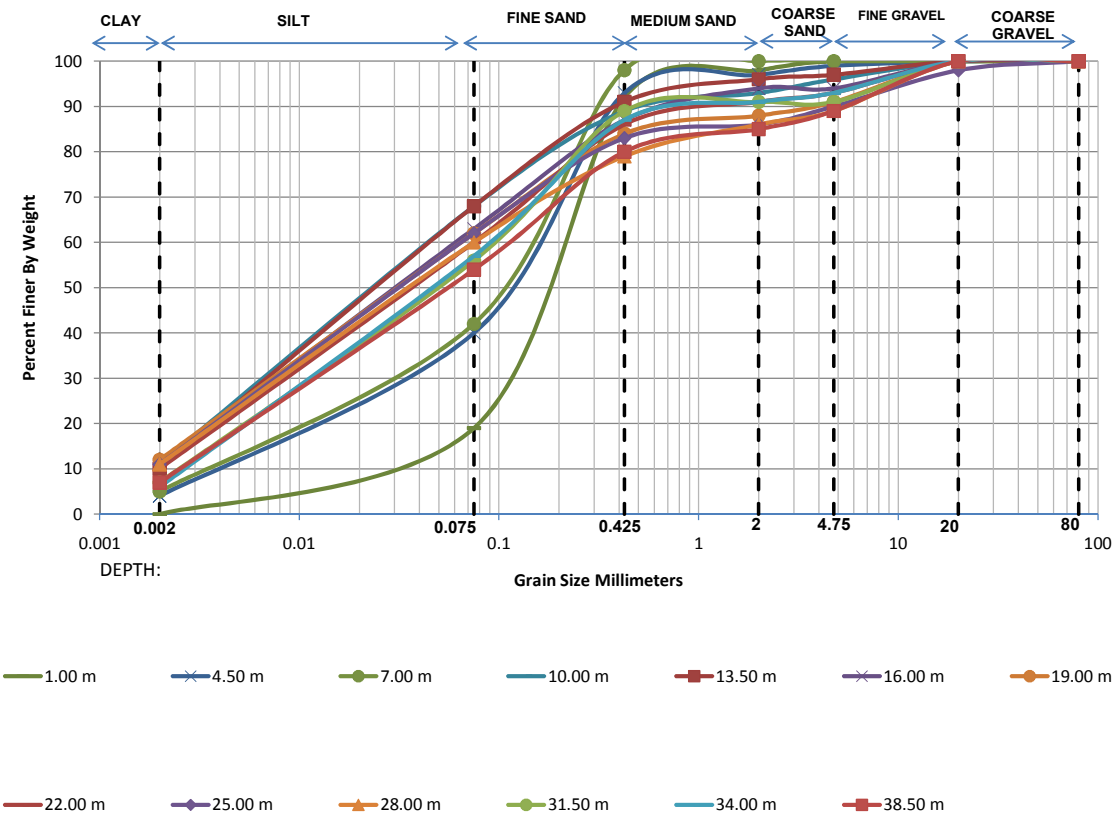
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+859 Major Bridge
B.H. No.	BH-A1_(R)



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	4.00	43.00	44.00	5.00	2.00	2.00	0.00	0.0073	0.0355	0.1247	17.12	1.39
5.50 m	5.00	32.00	50.00	9.00	3.00	1.00	0.00	0.0069	0.0522	0.1752	25.23	2.24
11.50 m	12.00	55.00	19.00	9.00	2.00	3.00	0.00	-	0.0129	0.0588	-	-
14.50 m	10.00	66.00	19.00	1.00	2.00	2.00	0.00	0.0020	0.0125	0.0460	23.02	1.70
17.50 m	11.00	55.00	21.00	5.00	3.00	4.00	1.00	-	0.0142	0.0611	-	-
20.50 m	11.00	56.00	22.00	4.00	2.00	5.00	0.00	-	0.0139	0.0592	-	-
23.50 m	12.00	54.00	18.00	5.00	4.00	7.00	0.00	-	0.0132	0.0607	-	-
28.00 m	8.00	49.00	31.00	5.00	1.00	6.00	0.00	0.0029	0.0215	0.0849	28.92	1.85
31.00 m	6.00	51.00	29.00	4.00	4.00	6.00	0.00	0.0044	0.0236	0.0851	19.46	1.50
34.00 m	7.00	48.00	30.00	5.00	3.00	7.00	0.00	0.0036	0.0238	0.0946	26.18	1.65
37.00 m	7.00	48.00	27.00	7.00	2.00	9.00	0.00	0.0036	0.0236	0.0971	26.90	1.59

GRAIN SIZE DISTRIBUTION CURVES

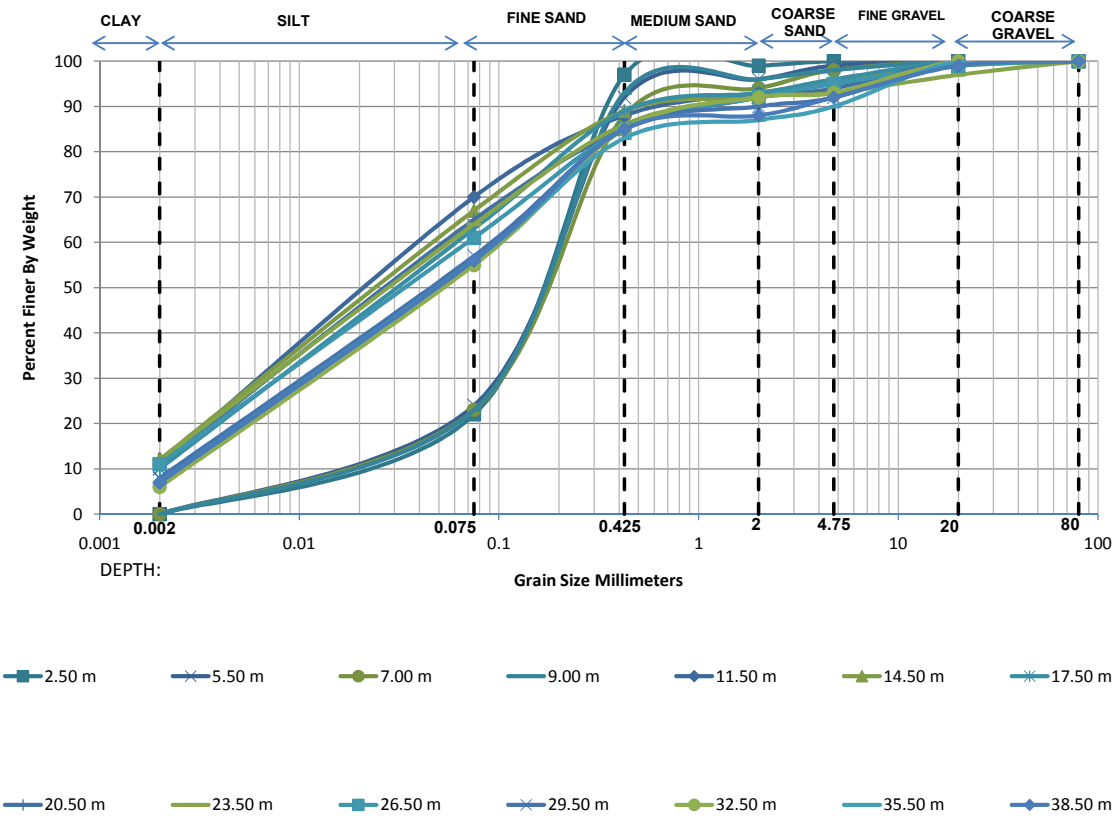
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+859 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	19.00	73.00	6.00	2.00	0.00	0.00	0.0307	0.1170	0.2207	7.18	2.02
4.50 m	4.00	36.00	53.00	4.00	2.00	1.00	0.00	0.0082	0.0467	0.1499	18.36	1.78
7.00 m	5.00	37.00	56.00	2.00	0.00	0.00	0.00	0.0064	0.0423	0.1364	21.40	2.05
10.00 m	11.00	57.00	21.00	4.00	3.00	4.00	0.00	-	0.0136	0.0573	-	-
13.50 m	10.00	58.00	23.00	5.00	1.00	3.00	0.00	0.0020	0.0145	0.0577	28.86	1.82
16.00 m	11.00	52.00	24.00	7.00	0.00	6.00	0.00	-	0.0153	0.0675	-	-
19.00 m	12.00	50.00	22.00	4.00	3.00	9.00	0.00	-	0.0147	0.0698	-	-
22.00 m	10.00	50.00	26.00	5.00	2.00	7.00	0.00	0.0020	0.0176	0.0750	37.50	2.06
25.00 m	11.00	51.00	21.00	3.00	4.00	8.00	2.00	-	0.0156	0.0698	-	-
28.00 m	11.00	49.00	19.00	7.00	3.00	11.00	0.00	-	0.0163	0.0750	-	-
31.50 m	7.00	49.00	33.00	2.00	0.00	9.00	0.00	0.0036	0.0233	0.0883	24.51	1.70
34.00 m	6.00	51.00	30.00	4.00	2.00	7.00	0.00	0.0044	0.0237	0.0849	19.39	1.51
38.50 m	7.00	47.00	26.00	5.00	4.00	11.00	0.00	0.0036	0.0242	0.1047	28.89	1.55

GRAIN SIZE DISTRIBUTION CURVES

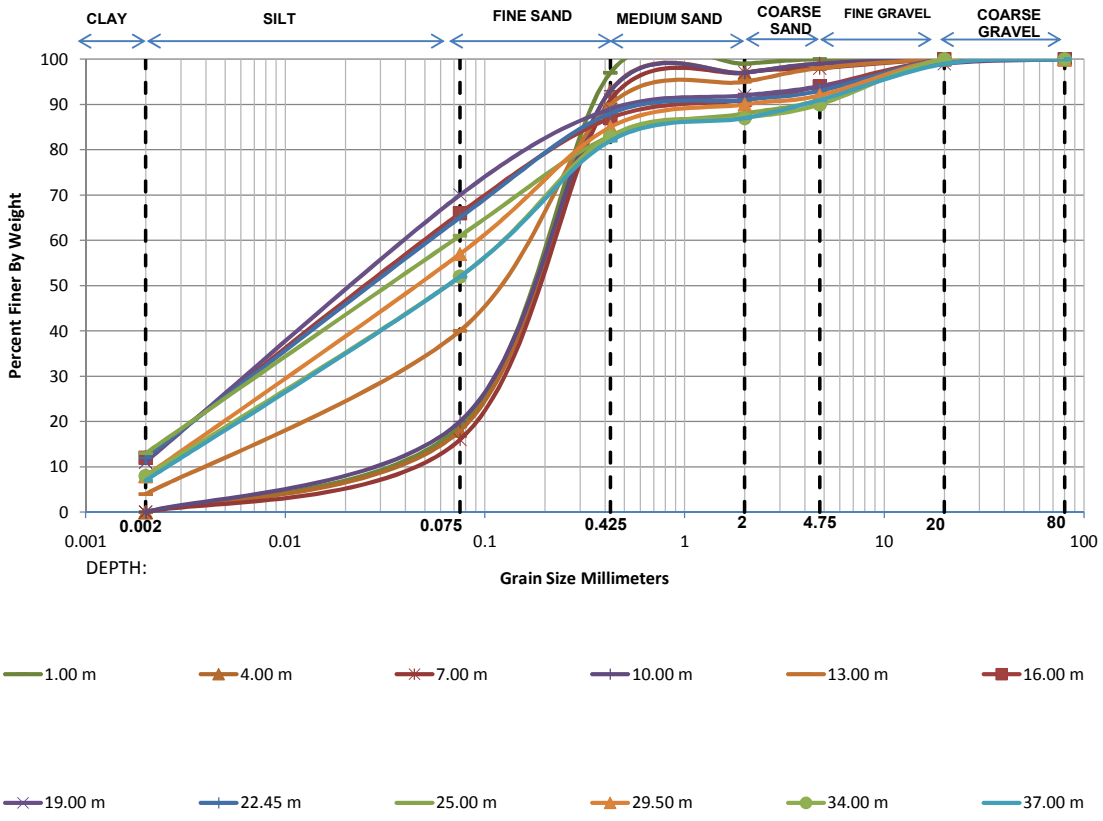
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+859 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	22.00	75.00	2.00	1.00	0.00	0.00	0.0239	0.1038	0.2012	8.41	2.24
5.50 m	0.00	24.00	68.00	4.00	3.00	1.00	0.00	0.0202	0.0969	0.2048	10.15	2.27
7.00 m	0.00	23.00	65.00	6.00	4.00	2.00	0.00	0.0216	0.1015	0.2178	10.09	2.19
9.00 m	0.00	23.00	70.00	3.00	2.00	2.00	0.00	0.0219	0.1006	0.2056	9.41	2.25
11.50 m	11.00	59.00	18.00	5.00	2.00	5.00	0.00	-	0.0130	0.0538	-	-
14.50 m	12.00	55.00	22.00	3.00	4.00	3.00	1.00	-	0.0130	0.0589	-	-
17.50 m	10.00	53.00	26.00	4.00	3.00	4.00	0.00	0.0020	0.0163	0.0677	33.85	1.96
20.50 m	11.00	54.00	20.00	7.00	2.00	6.00	0.00	-	0.0144	0.0630	-	-
23.50 m	12.00	52.00	22.00	6.00	1.00	4.00	3.00	-	0.0140	0.0651	-	-
26.50 m	11.00	50.00	24.00	7.00	3.00	4.00	1.00	-	0.0161	0.0724	-	-
29.50 m	8.00	49.00	28.00	5.00	2.00	8.00	0.00	0.0029	0.0213	0.0857	29.19	1.81
32.50 m	6.00	49.00	30.00	7.00	1.00	7.00	0.00	0.0044	0.0249	0.0947	21.40	1.48
35.50 m	7.00	49.00	27.00	4.00	3.00	10.00	0.00	0.0036	0.0229	0.0909	25.28	1.61
38.50 m	7.00	49.00	29.00	3.00	4.00	7.00	1.00	0.0036	0.0231	0.0898	24.96	1.65

GRAIN SIZE DISTRIBUTION CURVES

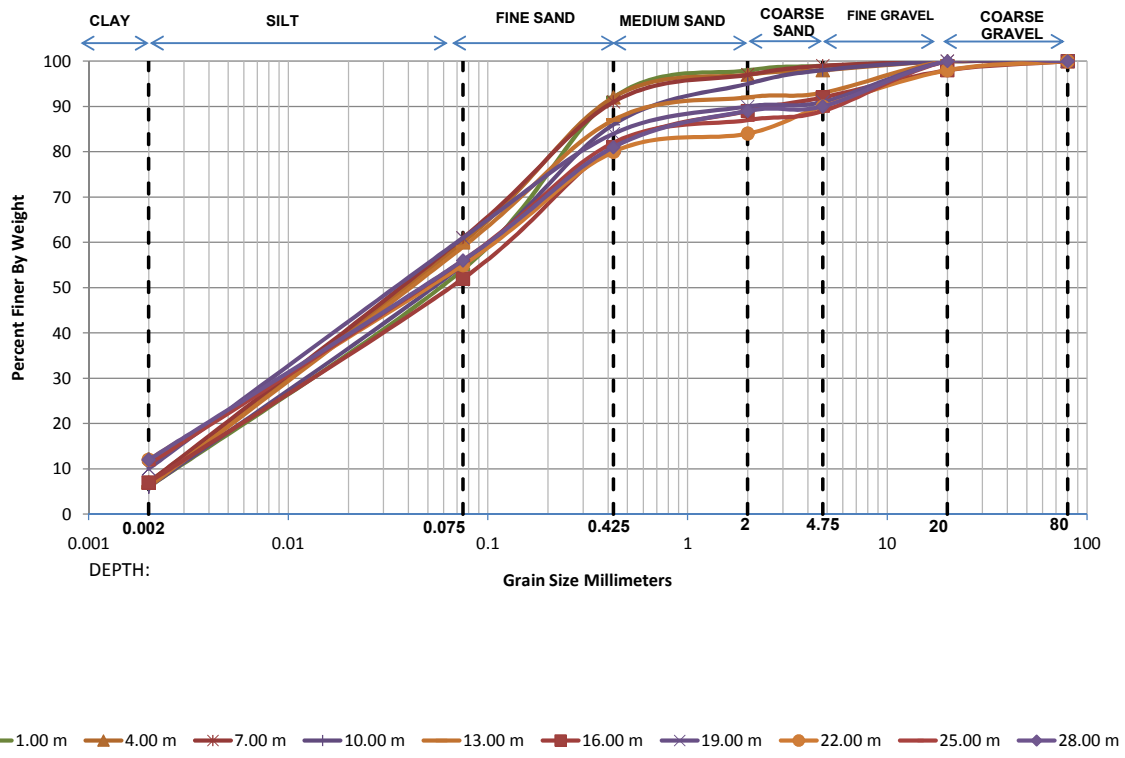
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	10+859 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	19.00	78.00	2.00	1.00	0.00	0.00	0.0311	0.1156	0.2104	6.77	2.05
4.00 m	0.00	18.00	75.00	4.00	2.00	1.00	0.00	0.0338	0.1209	0.2212	6.54	1.95
7.00 m	0.00	16.00	75.00	6.00	1.00	2.00	0.00	0.0411	0.1303	0.2319	5.64	1.78
10.00 m	0.00	20.00	73.00	4.00	2.00	1.00	0.00	0.0281	0.1126	0.2151	7.64	2.09
13.00 m	4.00	36.00	50.00	5.00	3.00	2.00	0.00	0.0081	0.0464	0.1551	19.08	1.71
16.00 m	12.00	54.00	21.00	4.00	3.00	6.00	0.00	-	0.0133	0.0608	-	-
19.00 m	11.00	59.00	19.00	3.00	2.00	5.00	1.00	-	0.0130	0.0539	-	-
22.45 m	12.00	53.00	23.00	3.00	2.00	7.00	0.00	-	0.0137	0.0629	-	-
25.00 m	13.00	48.00	22.00	5.00	3.00	9.00	0.00	-	0.0142	0.0723	-	-
29.50 m	8.00	49.00	28.00	5.00	2.00	8.00	0.00	0.0029	0.0213	0.0857	29.19	1.81
34.00 m	8.00	44.00	31.00	4.00	3.00	10.00	0.00	0.0030	0.0250	0.1120	37.59	1.87
37.00 m	7.00	45.00	30.00	5.00	4.00	8.00	1.00	0.0037	0.0260	0.1134	30.93	1.63

GRAIN SIZE DISTRIBUTION CURVES

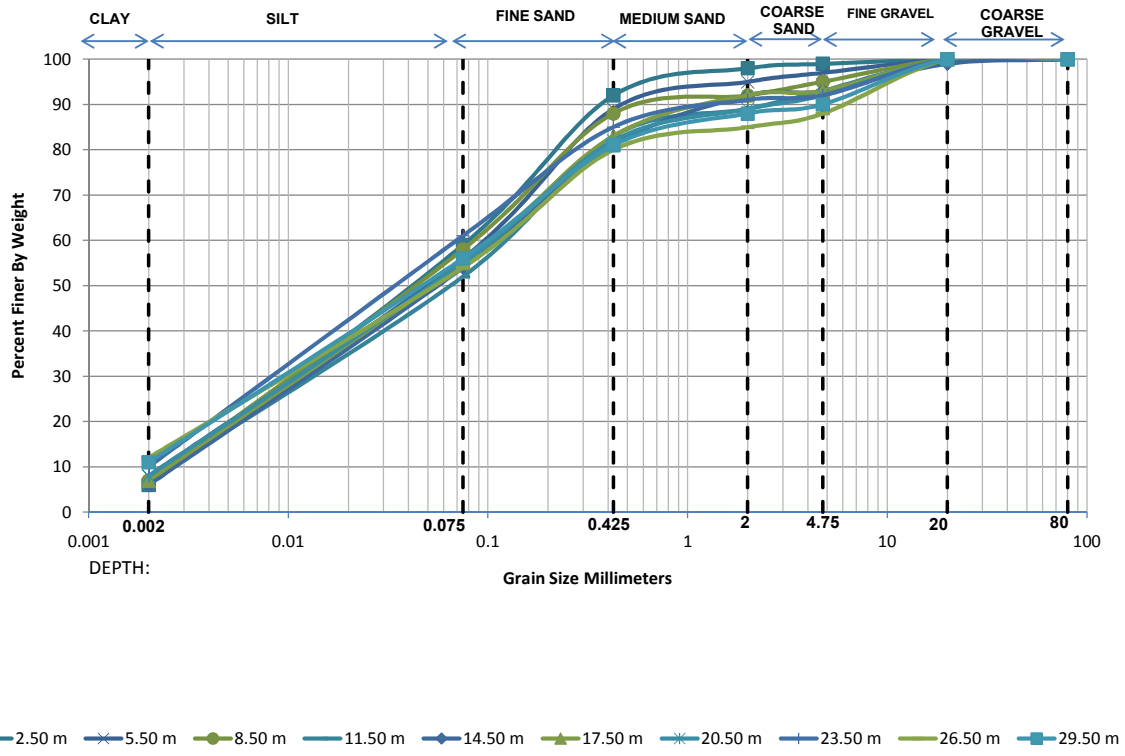
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	17+625 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	48.00	38.00	6.00	1.00	1.00	0.00	0.0045	0.0261	0.0953	21.30	1.60
4.00 m	7.00	53.00	32.00	5.00	1.00	2.00	0.00	0.0035	0.0210	0.0750	21.15	1.65
7.00 m	7.00	54.00	30.00	6.00	2.00	1.00	0.00	0.0035	0.0204	0.0726	20.56	1.62
10.00 m	6.00	49.00	31.00	9.00	3.00	2.00	0.00	0.0044	0.0250	0.0943	21.29	1.50
13.00 m	6.00	53.00	28.00	5.00	1.00	7.00	0.00	0.0043	0.0225	0.0778	17.98	1.50
16.00 m	7.00	45.00	29.00	8.00	3.00	6.00	2.00	0.0037	0.0260	0.1159	31.60	1.59
19.00 m	10.00	51.00	23.00	6.00	1.00	9.00	0.00	0.0020	0.0170	0.0724	36.20	1.99
22.00 m	12.00	43.00	25.00	4.00	6.00	8.00	2.00	-	0.0182	0.0995	-	-
25.00 m	11.00	45.00	26.00	5.00	2.00	11.00	0.00	-	0.0187	0.0922	-	-
28.00 m	12.00	44.00	25.00	8.00	1.00	10.00	0.00	-	0.0177	0.0933	-	-

GRAIN SIZE DISTRIBUTION CURVES

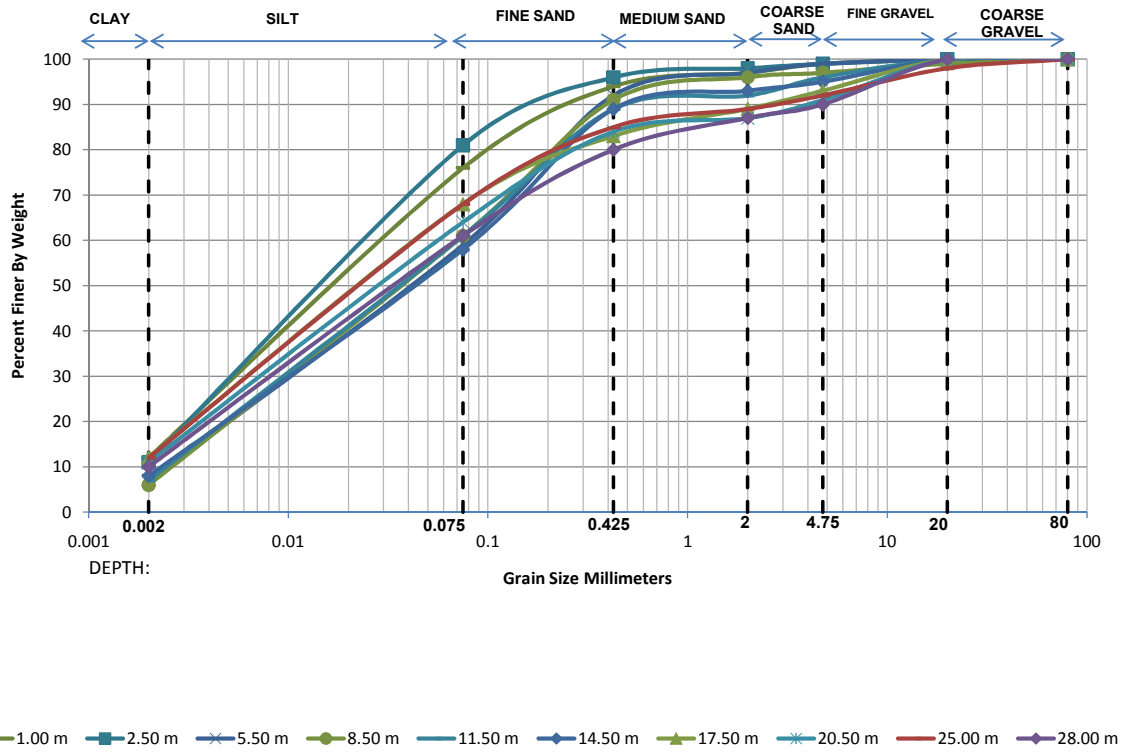
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	17+625 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	53.00	33.00	6.00	1.00	1.00	0.00	0.0043	0.0227	0.0776	17.89	1.53
5.50 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
8.50 m	7.00	51.00	30.00	4.00	3.00	5.00	0.00	0.0036	0.0219	0.0811	22.71	1.66
11.50 m	7.00	45.00	31.00	6.00	4.00	7.00	0.00	0.0037	0.0261	0.1122	30.58	1.65
14.50 m	6.00	48.00	27.00	11.00	1.00	6.00	1.00	0.0044	0.0254	0.1044	23.50	1.40
17.50 m	7.00	48.00	28.00	9.00	1.00	7.00	0.00	0.0036	0.0237	0.0965	26.73	1.61
20.50 m	8.00	47.00	27.00	7.00	3.00	8.00	0.00	0.0029	0.0225	0.0973	32.99	1.76
23.50 m	10.00	51.00	24.00	6.00	1.00	8.00	0.00	0.0020	0.0170	0.0724	36.21	2.00
26.50 m	12.00	42.00	26.00	5.00	3.00	12.00	0.00	-	0.0189	0.1057	-	-
29.50 m	11.00	45.00	25.00	7.00	2.00	10.00	0.00	-	0.0186	0.0930	-	-

GRAIN SIZE DISTRIBUTION CURVES

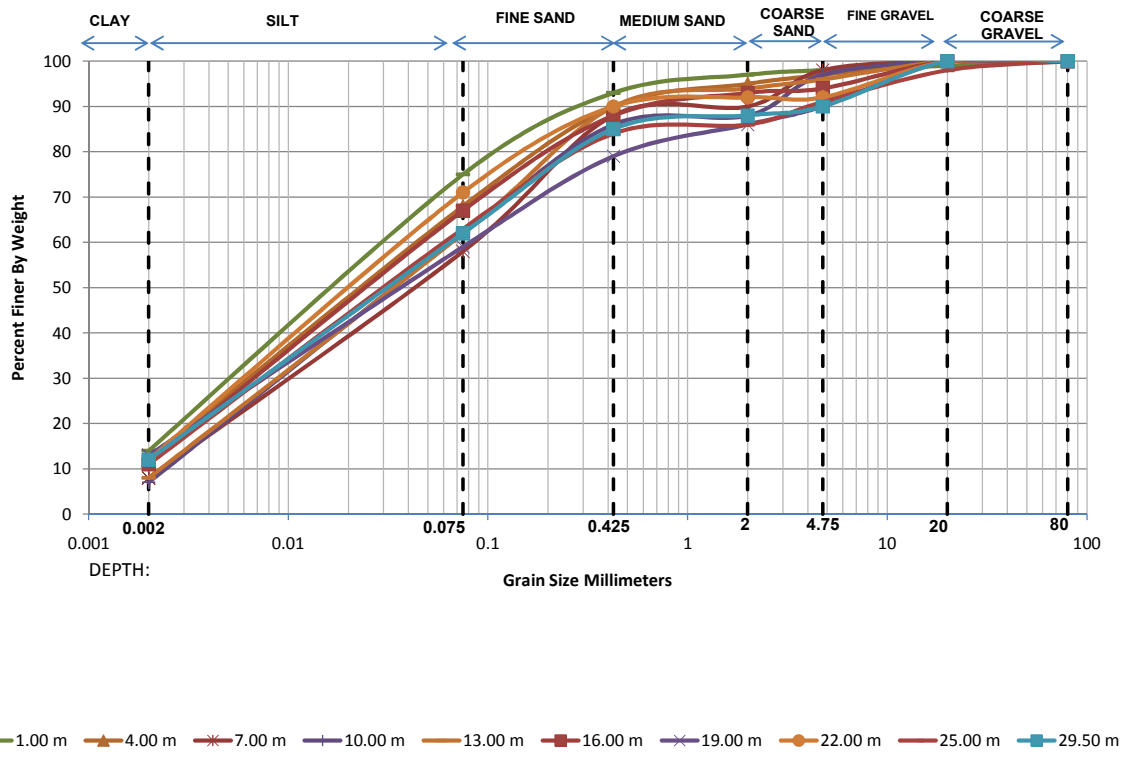
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	17+872 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	12.00	64.00	18.00	3.00	2.00	1.00	0.00	-	0.0109	0.0451	-	-
2.50 m	11.00	70.00	15.00	2.00	1.00	1.00	0.00	-	0.0108	0.0401	-	-
5.50 m	7.00	52.00	33.00	5.00	2.00	1.00	0.00	0.0036	0.0215	0.0777	21.81	1.68
8.50 m	6.00	55.00	30.00	5.00	1.00	2.00	1.00	0.0043	0.0216	0.0726	16.93	1.49
11.50 m	7.00	54.00	28.00	3.00	4.00	4.00	0.00	0.0035	0.0203	0.0726	20.57	1.61
14.50 m	8.00	50.00	31.00	4.00	2.00	5.00	0.00	0.0029	0.0209	0.0811	27.67	1.84
17.50 m	12.00	56.00	15.00	6.00	4.00	7.00	0.00	-	0.0125	0.0567	-	-
20.50 m	11.00	53.00	20.00	3.00	4.00	9.00	0.00	-	0.0148	0.0652	-	-
25.00 m	12.00	56.00	17.00	4.00	3.00	6.00	2.00	-	0.0126	0.0568	-	-
28.00 m	10.00	51.00	19.00	7.00	3.00	10.00	0.00	0.0020	0.0168	0.0724	36.19	1.95

GRAIN SIZE DISTRIBUTION CURVES

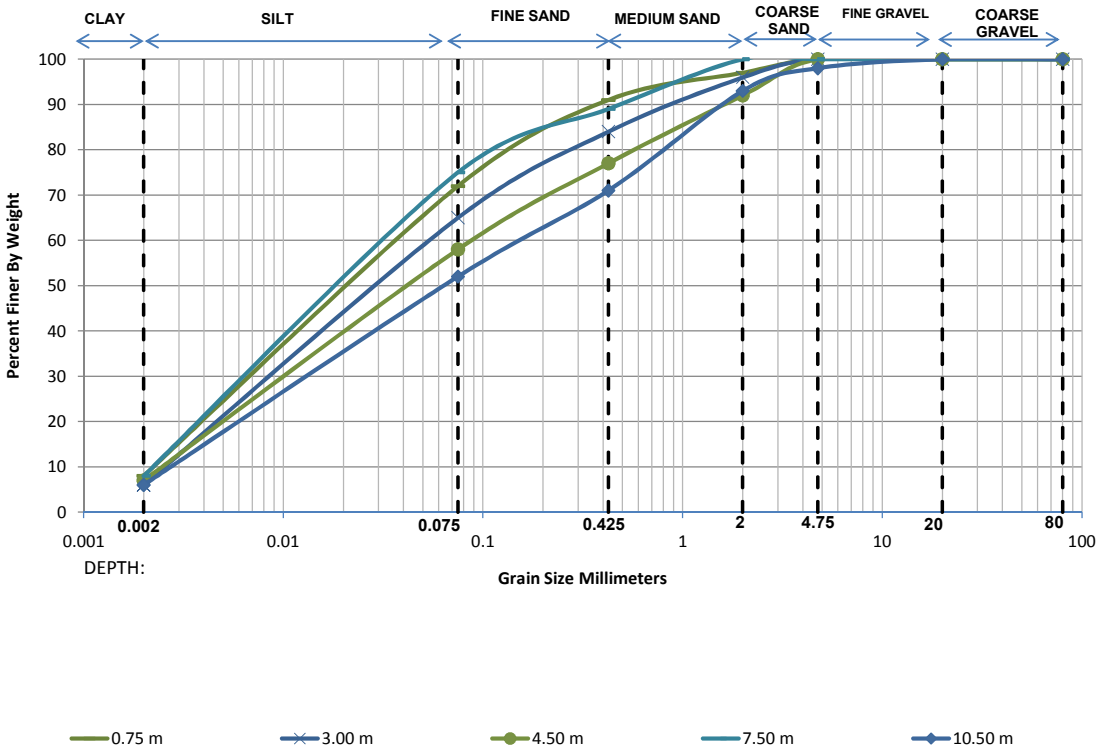
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	17+872 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	14.00	61.00	18.00	4.00	1.00	1.00	1.00	-	0.0097	0.0454	-	-
4.00 m	12.00	56.00	22.00	5.00	2.00	3.00	0.00	-	0.0128	0.0571	-	-
7.00 m	8.00	50.00	30.00	2.00	8.00	2.00	0.00	0.0029	0.0208	0.0811	27.70	1.83
10.00 m	7.00	55.00	24.00	2.00	9.00	3.00	0.00	0.0035	0.0197	0.0702	20.00	1.57
13.00 m	8.00	54.00	28.00	4.00	2.00	4.00	0.00	0.0029	0.0188	0.0702	24.20	1.73
16.00 m	11.00	56.00	21.00	5.00	1.00	6.00	0.00	-	0.0139	0.0591	-	-
19.00 m	13.00	46.00	20.00	7.00	4.00	10.00	0.00	-	0.0149	0.0786	-	-
22.00 m	12.00	59.00	19.00	2.00	0.00	8.00	0.00	-	0.0119	0.0519	-	-
25.00 m	11.00	52.00	21.00	2.00	5.00	7.00	2.00	-	0.0152	0.0675	-	-
29.50 m	12.00	50.00	23.00	3.00	2.00	10.00	0.00	-	0.0147	0.0698	-	-

GRAIN SIZE DISTRIBUTION CURVES

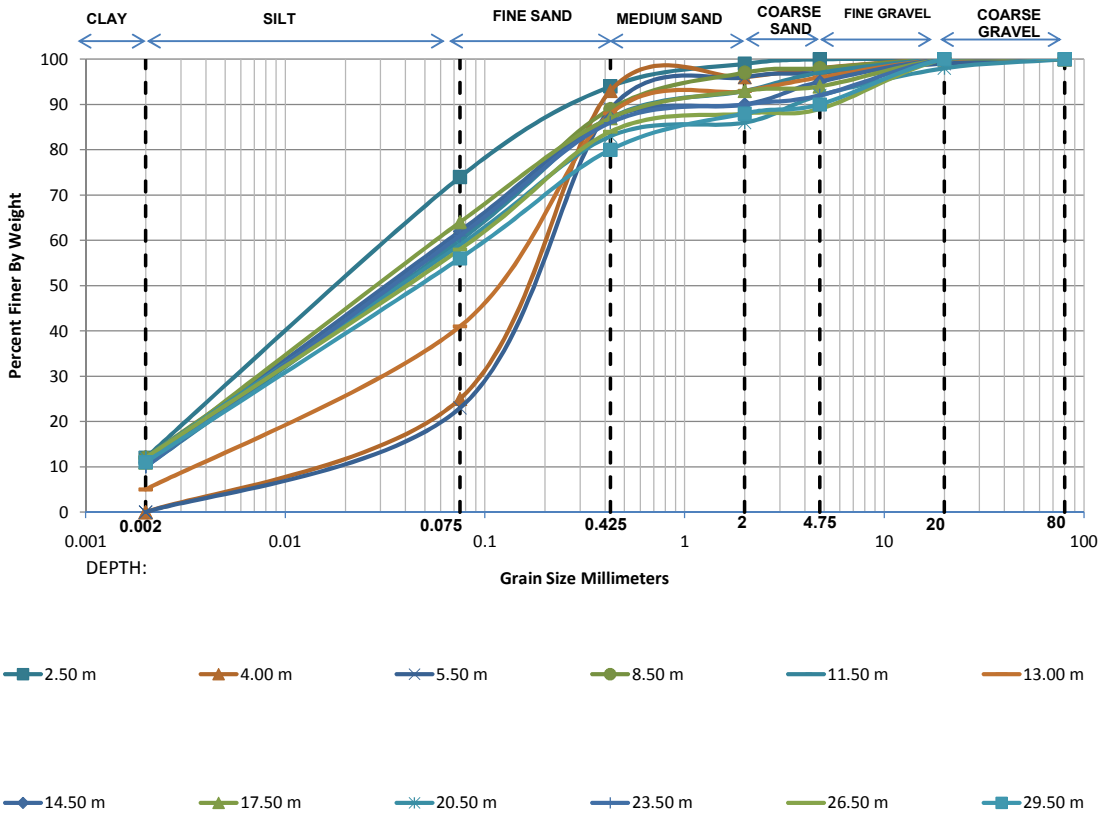
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	New Ch. 19+010 IMT Sohna Station
B.H. No.	BH-PLT-07



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.75 m	8.00	64.00	19.00	6.00	3.00	0.00	0.00	0.0028	0.0152	0.0520	18.25	1.55
3.00 m	6.00	59.00	19.00	12.00	4.00	0.00	0.00	0.0042	0.0194	0.0640	15.24	1.40
4.50 m	7.00	51.00	19.00	15.00	8.00	0.00	0.00	0.0036	0.0213	0.0842	23.69	1.52
7.50 m	8.00	67.00	14.00	11.00	0.00	0.00	0.00	0.0028	0.0143	0.0479	16.87	1.52
10.50 m	6.00	46.00	19.00	22.00	5.00	2.00	0.00	0.0045	0.0264	0.1596	35.71	0.98

GRAIN SIZE DISTRIBUTION CURVES

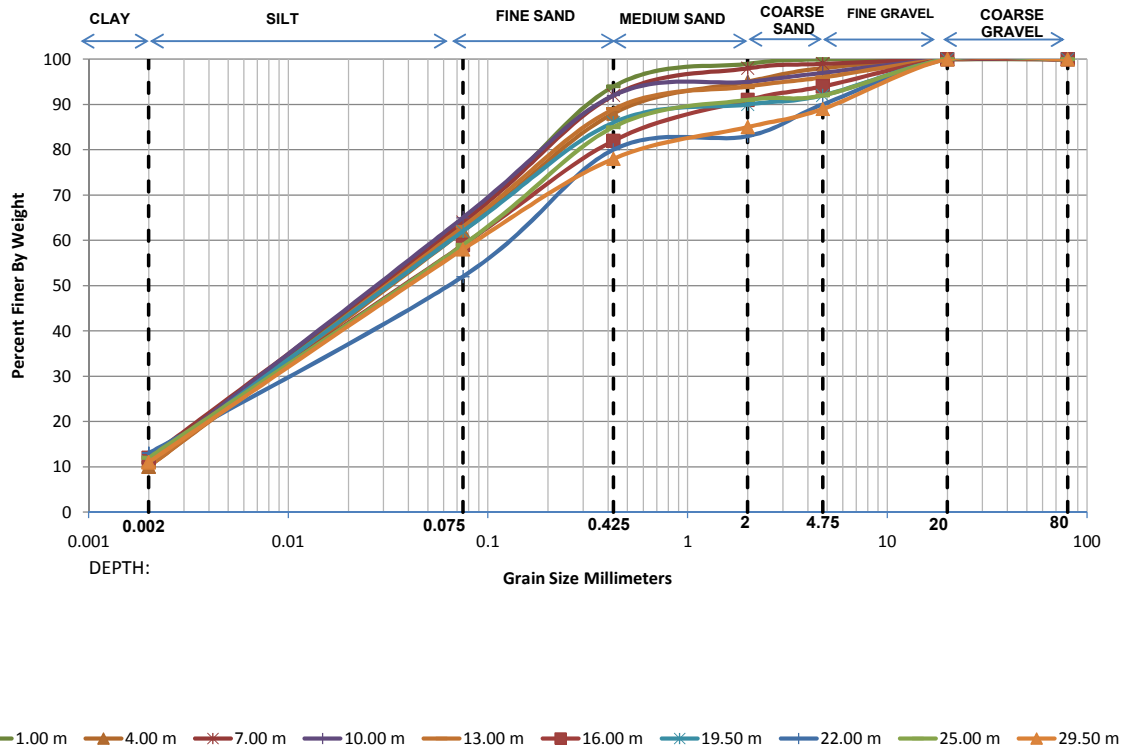
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	18+750 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	12.00	62.00	20.00	5.00	1.00	0.00	0.00	-	0.0114	0.0477	-	-
4.00 m	0.00	25.00	68.00	3.00	2.00	2.00	0.00	0.0188	0.0929	0.1993	10.63	2.31
5.50 m	0.00	23.00	66.00	7.00	1.00	2.00	1.00	0.0216	0.1013	0.2156	9.96	2.20
8.50 m	12.00	49.00	28.00	8.00	1.00	2.00	0.00	-	0.0153	0.0724	-	-
11.50 m	10.00	50.00	27.00	6.00	4.00	3.00	0.00	0.0020	0.0176	0.0750	37.50	2.07
13.00 m	5.00	36.00	47.00	5.00	3.00	4.00	0.00	0.0064	0.0434	0.1553	24.24	1.89
14.50 m	11.00	51.00	25.00	3.00	5.00	5.00	0.00	-	0.0157	0.0699	-	-
17.50 m	11.00	53.00	23.00	6.00	1.00	6.00	0.00	-	0.0149	0.0653	-	-
20.50 m	12.00	47.00	24.00	3.00	6.00	6.00	2.00	-	0.0160	0.0782	-	-
23.50 m	10.00	51.00	25.00	4.00	2.00	8.00	0.00	0.0020	0.0171	0.0724	36.21	2.02
26.50 m	12.00	46.00	26.00	4.00	1.00	11.00	0.00	-	0.0166	0.0820	-	-
29.50 m	11.00	45.00	24.00	8.00	2.00	10.00	0.00	-	0.0186	0.0939	-	-

GRAIN SIZE DISTRIBUTION CURVES

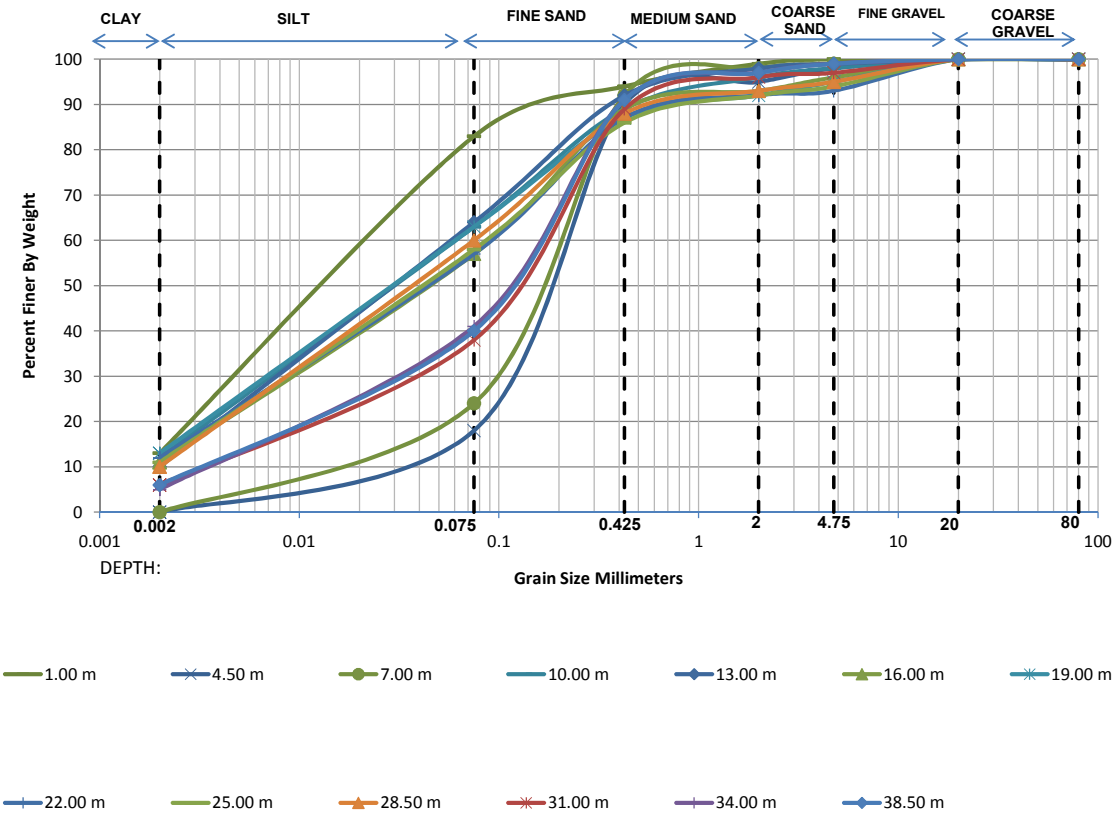
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	18+750 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	11.00	53.00	30.00	5.00	1.00	0.00	0.00	-	0.0152	0.0655	-	-
4.00 m	10.00	52.00	26.00	7.00	3.00	2.00	0.00	0.0020	0.0167	0.0700	35.00	1.99
7.00 m	12.00	52.00	28.00	6.00	1.00	1.00	0.00	-	0.0142	0.0653	-	-
10.00 m	11.00	54.00	27.00	3.00	2.00	3.00	0.00	-	0.0147	0.0633	-	-
13.00 m	10.00	53.00	26.00	5.00	2.00	4.00	0.00	0.0020	0.0163	0.0677	33.85	1.96
16.00 m	12.00	47.00	23.00	9.00	3.00	6.00	0.00	-	0.0160	0.0783	-	-
19.50 m	11.00	51.00	24.00	4.00	2.00	8.00	0.00	-	0.0157	0.0699	-	-
22.00 m	13.00	39.00	28.00	3.00	7.00	10.00	0.00	-	0.0194	0.1178	-	-
25.00 m	12.00	47.00	26.00	6.00	1.00	8.00	0.00	-	0.0161	0.0781	-	-
29.50 m	11.00	47.00	20.00	7.00	4.00	11.00	0.00	-	0.0173	0.0836	-	-

GRAIN SIZE DISTRIBUTION CURVES

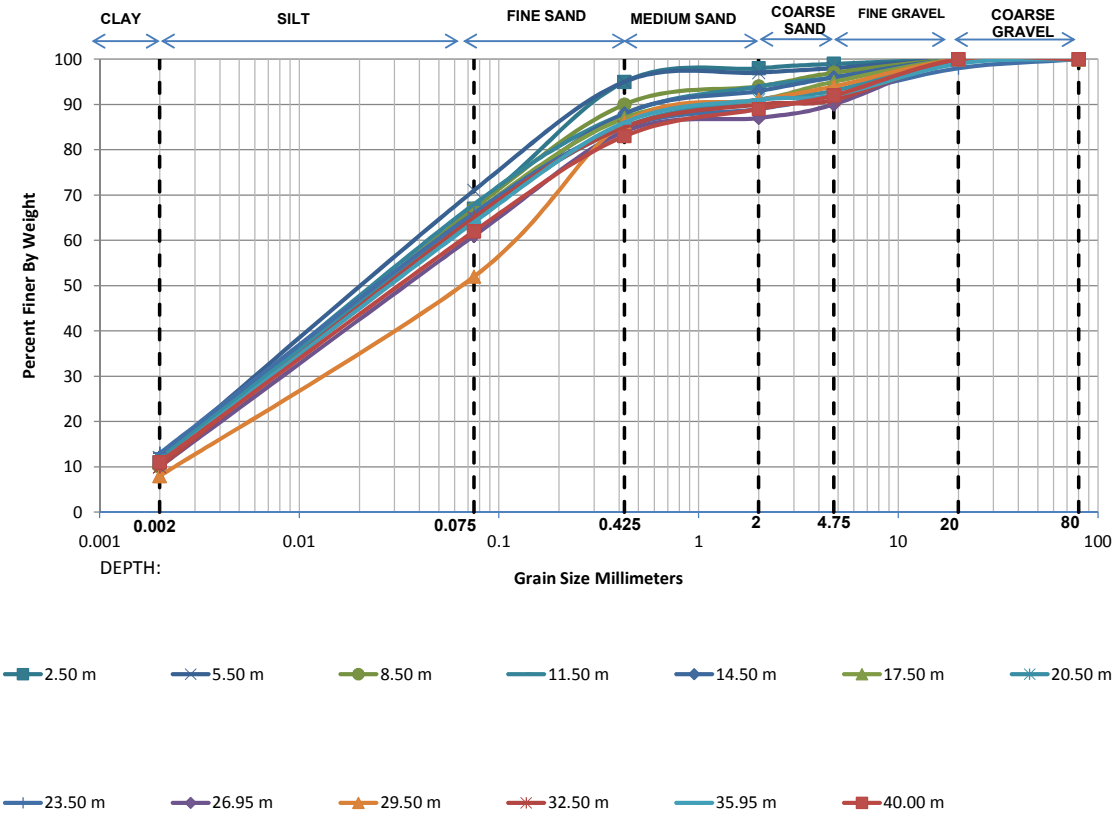
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	19+500 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	13.00	70.00	11.00	5.00	1.00	0.00	0.00	-	0.0091	0.0370	-	-
4.50 m	0.00	18.00	72.00	5.00	3.00	2.00	0.00	0.0336	0.1218	0.2278	6.77	1.94
7.00 m	0.00	24.00	68.00	6.00	1.00	1.00	0.00	0.0202	0.0969	0.2054	10.18	2.27
10.00 m	12.00	51.00	26.00	7.00	2.00	2.00	0.00	-	0.0145	0.0674	-	-
13.00 m	10.00	54.00	28.00	6.00	1.00	1.00	0.00	0.0020	0.0160	0.0656	32.79	1.95
16.00 m	11.00	46.00	32.00	4.00	3.00	4.00	0.00	-	0.0184	0.0851	-	-
19.00 m	13.00	50.00	24.00	5.00	3.00	5.00	0.00	-	0.0135	0.0673	-	-
22.00 m	12.00	45.00	30.00	5.00	1.00	7.00	0.00	-	0.0173	0.0856	-	-
25.00 m	11.00	47.00	28.00	6.00	2.00	6.00	0.00	-	0.0177	0.0817	-	-
28.50 m	10.00	50.00	28.00	5.00	2.00	5.00	0.00	0.0020	0.0177	0.0750	37.50	2.08
31.00 m	6.00	32.00	51.00	7.00	1.00	3.00	0.00	0.0054	0.0491	0.1667	30.75	2.66
34.00 m	5.00	36.00	50.00	6.00	2.00	1.00	0.00	0.0064	0.0436	0.1501	23.35	1.97
38.50 m	6.00	34.00	51.00	6.00	2.00	1.00	0.00	0.0052	0.0447	0.1547	29.56	2.47

GRAIN SIZE DISTRIBUTION CURVES

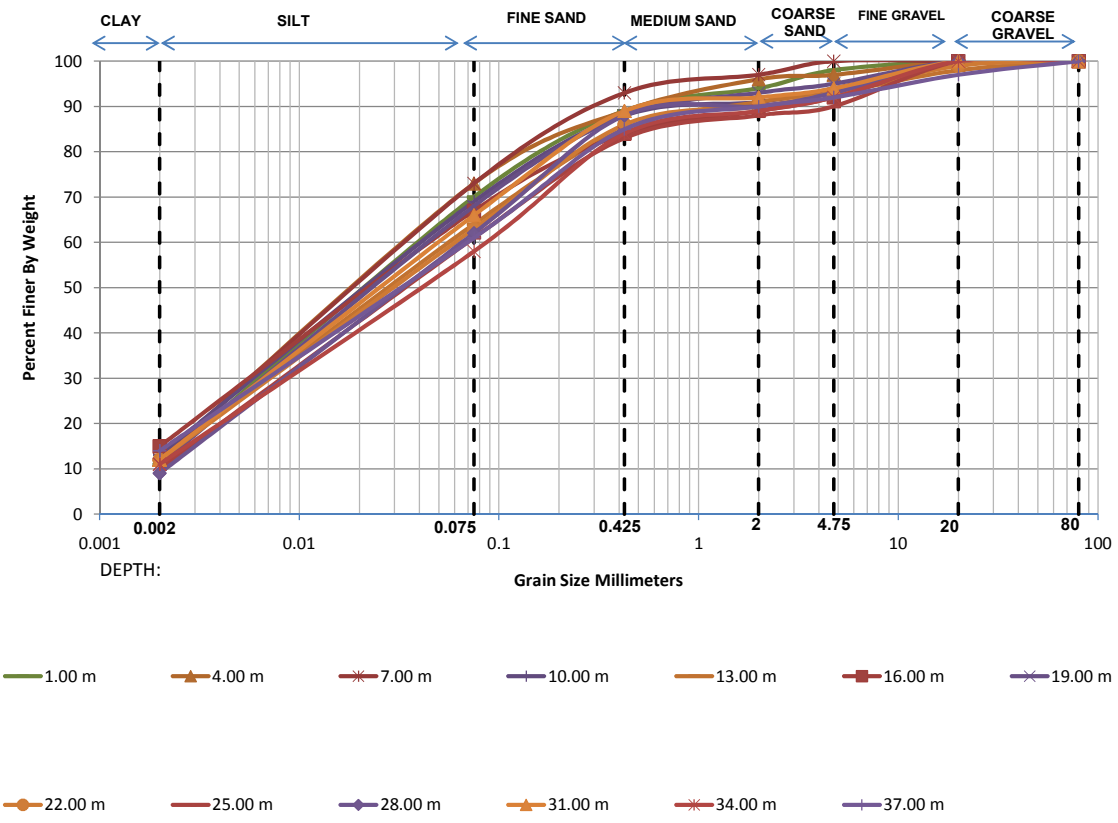
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	19+500 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	11.00	56.00	28.00	3.00	1.00	1.00	0.00	-	0.0141	0.0595	-	-
5.50 m	12.00	59.00	24.00	2.00	1.00	2.00	0.00	-	0.0121	0.0522	-	-
8.50 m	10.00	57.00	23.00	4.00	3.00	3.00	0.00	0.0020	0.0148	0.0595	29.75	1.84
11.50 m	11.00	57.00	20.00	6.00	2.00	4.00	0.00	-	0.0135	0.0573	-	-
14.50 m	12.00	53.00	23.00	5.00	3.00	4.00	0.00	-	0.0137	0.0629	-	-
17.50 m	11.00	55.00	21.00	4.00	4.00	5.00	0.00	-	0.0142	0.0611	-	-
20.50 m	12.00	53.00	20.00	6.00	2.00	7.00	0.00	-	0.0136	0.0628	-	-
23.50 m	13.00	53.00	19.00	4.00	3.00	6.00	2.00	-	0.0124	0.0605	-	-
26.95 m	10.00	51.00	23.00	3.00	3.00	10.00	0.00	0.0020	0.0170	0.0724	36.20	1.99
29.50 m	8.00	44.00	34.00	5.00	3.00	6.00	0.00	0.0030	0.0252	0.1087	36.44	1.95
32.50 m	10.00	55.00	20.00	5.00	1.00	9.00	0.00	0.0020	0.0153	0.0632	31.62	1.86
35.95 m	11.00	53.00	22.00	5.00	1.00	7.00	1.00	-	0.0149	0.0652	-	-
40.00 m	11.00	51.00	21.00	6.00	3.00	8.00	0.00	-	0.0156	0.0698	-	-

GRAIN SIZE DISTRIBUTION CURVES

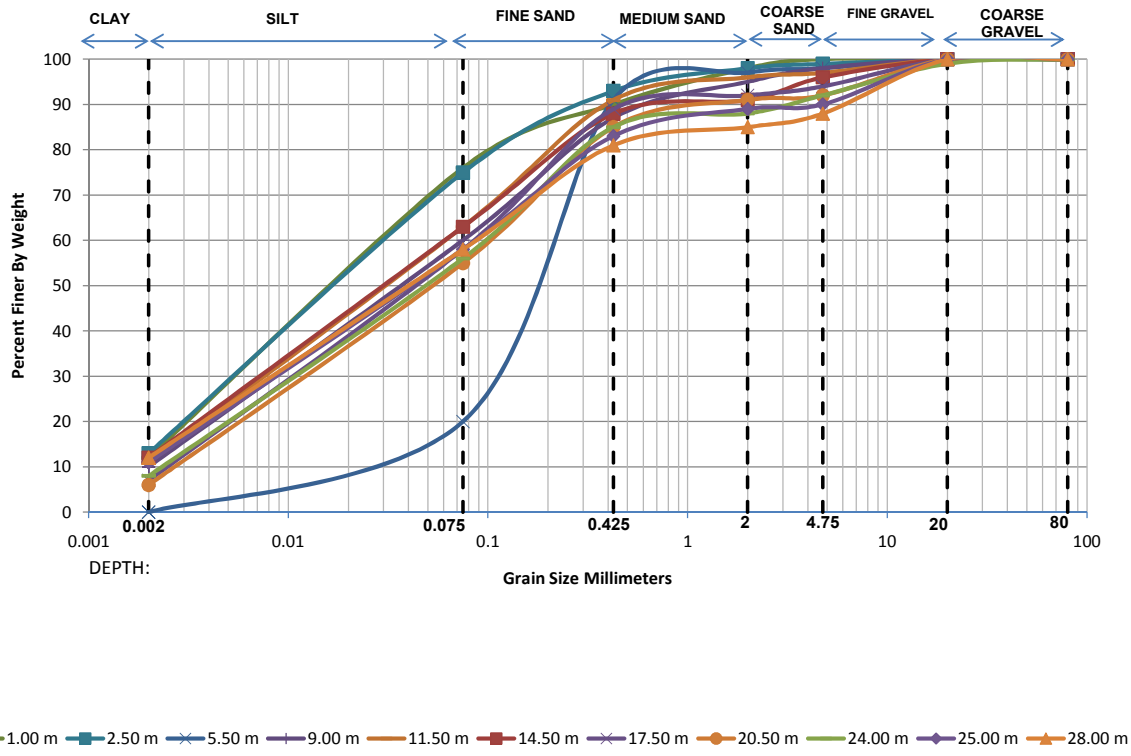
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	19+500 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	11.00	59.00	19.00	5.00	4.00	2.00	0.00	-	0.0130	0.0539	-	-
4.00 m	12.00	61.00	16.00	7.00	1.00	3.00	0.00	-	0.0114	0.0488	-	-
7.00 m	12.00	61.00	20.00	4.00	3.00	0.00	0.00	-	0.0115	0.0491	-	-
10.00 m	13.00	56.00	19.00	3.00	3.00	6.00	0.00	-	0.0116	0.0548	-	-
13.00 m	12.00	52.00	21.00	6.00	2.00	5.00	2.00	-	0.0139	0.0650	-	-
16.00 m	15.00	52.00	17.00	5.00	3.00	8.00	0.00	-	0.0105	0.0578	-	-
19.00 m	11.00	57.00	20.00	5.00	2.00	5.00	0.00	-	0.0135	0.0573	-	-
22.00 m	12.00	51.00	23.00	4.00	3.00	6.00	1.00	-	0.0144	0.0674	-	-
25.00 m	10.00	51.00	22.00	5.00	2.00	10.00	0.00	0.0020	0.0169	0.0724	36.20	1.98
28.00 m	9.00	53.00	26.00	2.00	3.00	7.00	0.00	0.0024	0.0177	0.0701	29.22	1.86
31.00 m	12.00	54.00	23.00	3.00	2.00	6.00	0.00	-	0.0134	0.0609	-	-
34.00 m	11.00	47.00	26.00	5.00	3.00	8.00	0.00	-	0.0176	0.0820	-	-
37.00 m	14.00	47.00	24.00	5.00	2.00	5.00	3.00	-	0.0134	0.0722	-	-

GRAIN SIZE DISTRIBUTION CURVES

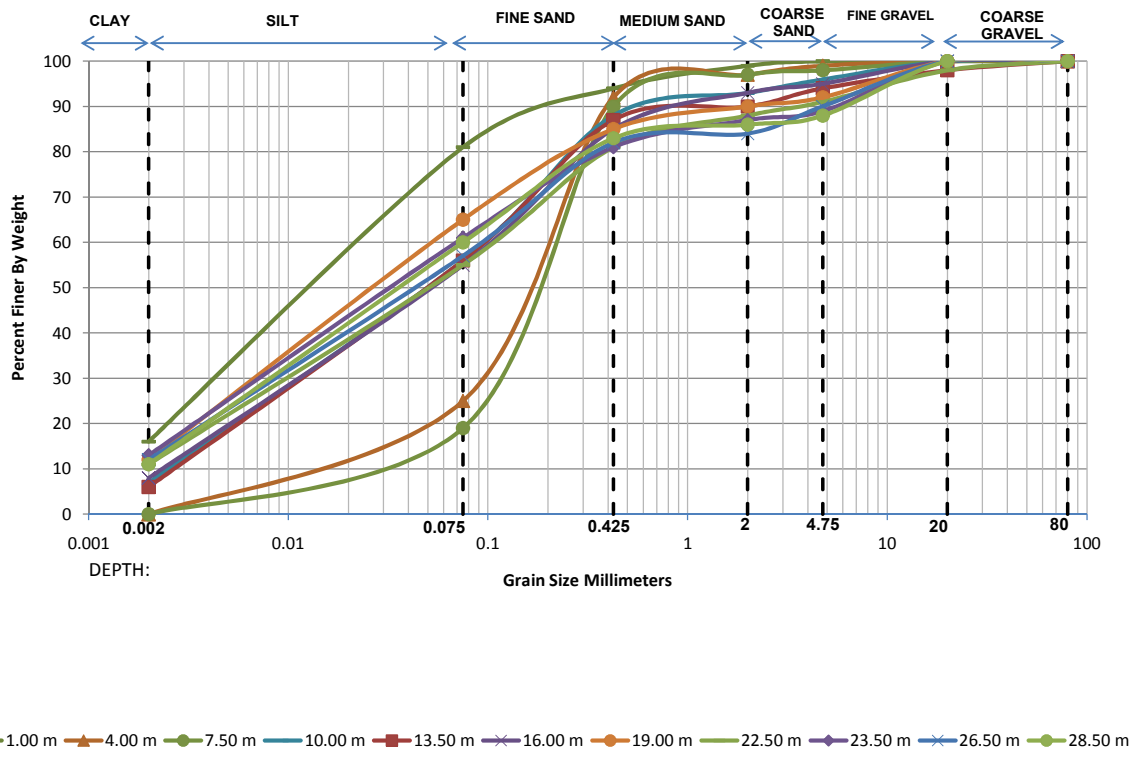
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	19+715 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	12.00	64.00	14.00	8.00	2.00	0.00	0.00	-	0.0108	0.0448	-	-
2.50 m	13.00	62.00	18.00	5.00	1.00	1.00	0.00	-	0.0104	0.0459	-	-
5.50 m	0.00	20.00	71.00	6.00	1.00	2.00	0.00	0.0280	0.1131	0.2199	7.85	2.08
9.00 m	10.00	50.00	27.00	8.00	3.00	2.00	0.00	0.0020	0.0176	0.0750	37.50	2.07
11.50 m	11.00	52.00	28.00	5.00	1.00	3.00	0.00	-	0.0155	0.0676	-	-
14.50 m	12.00	51.00	25.00	3.00	5.00	4.00	0.00	-	0.0144	0.0674	-	-
17.50 m	7.00	51.00	31.00	3.00	2.00	6.00	0.00	0.0036	0.0220	0.0810	22.67	1.67
20.50 m	6.00	49.00	30.00	6.00	1.00	8.00	0.00	0.0044	0.0249	0.0946	21.37	1.49
24.00 m	8.00	48.00	29.00	3.00	4.00	7.00	1.00	0.0029	0.0220	0.0899	30.57	1.82
25.00 m	11.00	47.00	25.00	6.00	1.00	10.00	0.00	-	0.0175	0.0822	-	-
28.00 m	12.00	46.00	23.00	4.00	3.00	12.00	0.00	-	0.0165	0.0826	-	-

GRAIN SIZE DISTRIBUTION CURVES

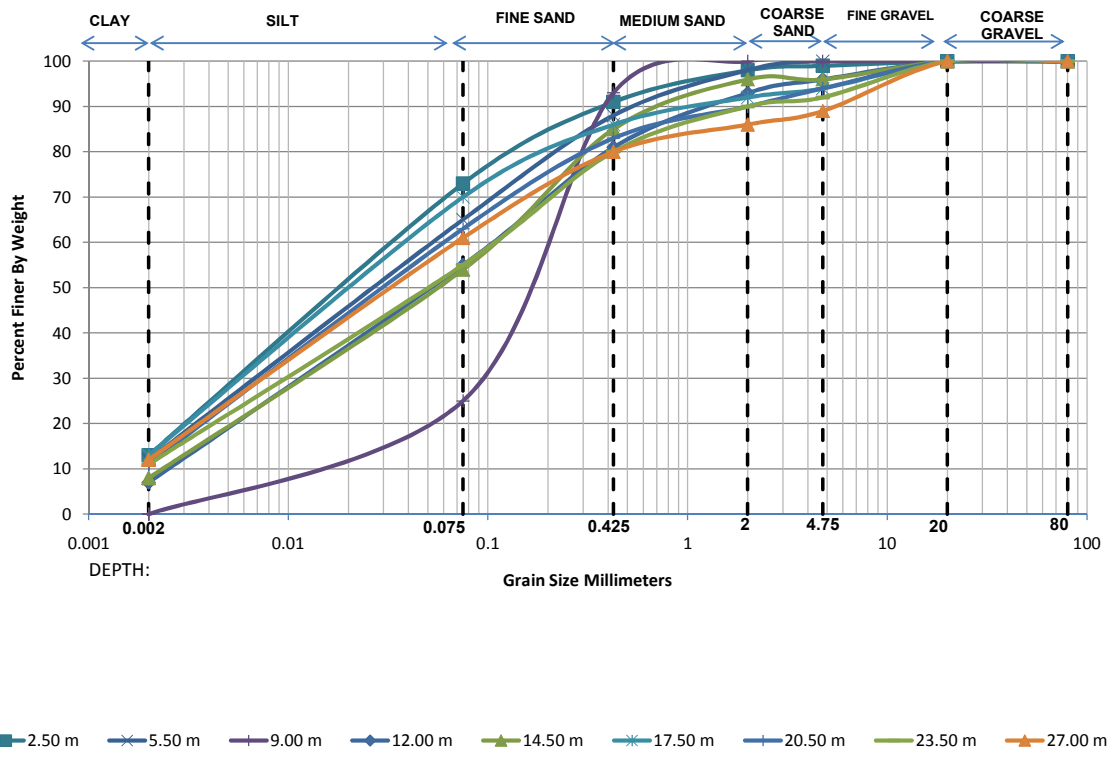
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	19+715 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	16.00	65.00	13.00	5.00	1.00	0.00	0.00	-	0.0075	0.0373	-	-
4.00 m	0.00	25.00	67.00	5.00	2.00	1.00	0.00	0.0187	0.0930	0.2019	10.79	2.29
7.50 m	0.00	19.00	71.00	7.00	1.00	2.00	0.00	0.0306	0.1176	0.2254	7.36	2.00
10.00 m	7.00	49.00	32.00	5.00	3.00	4.00	0.00	0.0036	0.0232	0.0888	24.65	1.69
13.50 m	6.00	50.00	31.00	3.00	4.00	4.00	2.00	0.0044	0.0243	0.0889	20.19	1.51
16.00 m	8.00	47.00	30.00	8.00	2.00	5.00	0.00	0.0030	0.0227	0.0951	32.24	1.83
19.00 m	12.00	53.00	20.00	5.00	2.00	8.00	0.00	-	0.0136	0.0628	-	-
22.50 m	11.00	44.00	26.00	7.00	3.00	7.00	2.00	-	0.0193	0.0988	-	-
23.50 m	13.00	48.00	20.00	6.00	2.00	11.00	0.00	-	0.0141	0.0722	-	-
26.50 m	12.00	45.00	25.00	2.00	6.00	10.00	0.00	-	0.0171	0.0869	-	-
28.50 m	11.00	49.00	23.00	3.00	2.00	12.00	0.00	-	0.0165	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

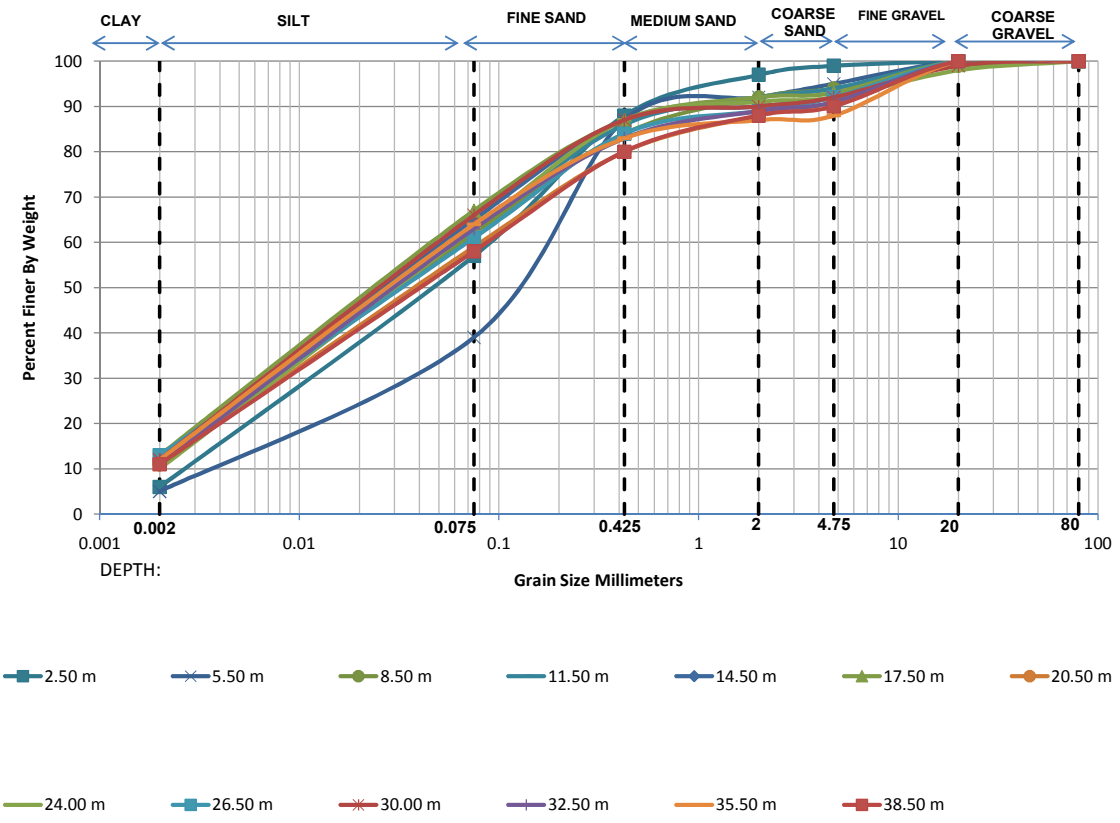
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	19+715 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	13.00	60.00	18.00	7.00	1.00	1.00	0.00	-	0.0107	0.0485	-	-
5.50 m	12.00	53.00	23.00	10.00	2.00	0.00	0.00	-	0.0137	0.0629	-	-
9.00 m	0.00	25.00	68.00	7.00	0.00	0.00	0.00	0.0188	0.0930	0.2004	10.69	2.30
12.00 m	7.00	48.00	26.00	12.00	3.00	4.00	0.00	0.0036	0.0235	0.0988	27.39	1.55
14.50 m	8.00	46.00	31.00	11.00	0.00	4.00	0.00	0.0030	0.0234	0.1005	33.95	1.84
17.50 m	13.00	57.00	16.00	6.00	2.00	6.00	0.00	-	0.0113	0.0530	-	-
20.50 m	11.00	52.00	20.00	7.00	4.00	6.00	0.00	-	0.0151	0.0674	-	-
23.50 m	11.00	44.00	25.00	10.00	2.00	8.00	0.00	-	0.0193	0.1003	-	-
27.00 m	12.00	49.00	19.00	6.00	3.00	11.00	0.00	-	0.0149	0.0723	-	-

GRAIN SIZE DISTRIBUTION CURVES

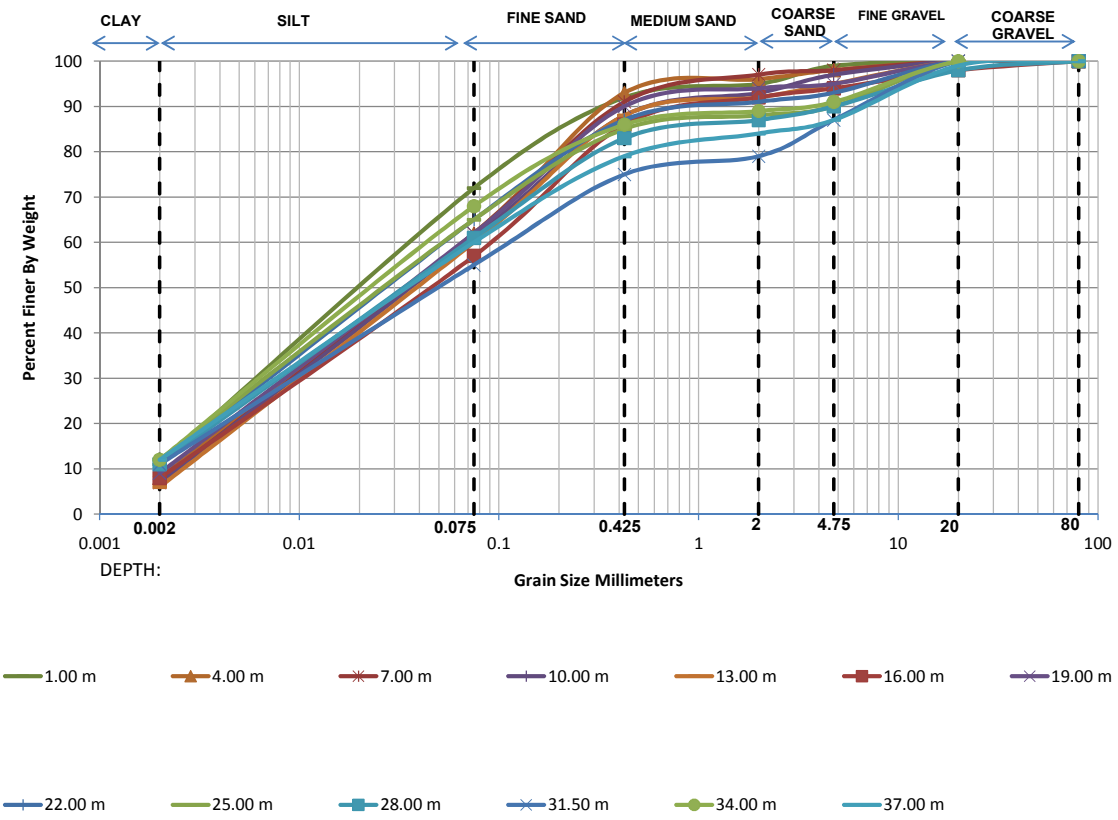
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	20+300 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	51.00	31.00	9.00	2.00	1.00	0.00	0.0044	0.0237	0.0849	19.38	1.52
5.50 m	5.00	34.00	48.00	5.00	3.00	5.00	0.00	0.0066	0.0474	0.1657	24.94	2.04
8.50 m	11.00	51.00	22.00	8.00	2.00	5.00	1.00	-	0.0156	0.0698	-	-
11.50 m	12.00	51.00	23.00	6.00	2.00	6.00	0.00	-	0.0144	0.0674	-	-
14.50 m	12.00	53.00	22.00	3.00	2.00	8.00	0.00	-	0.0136	0.0629	-	-
17.50 m	13.00	54.00	20.00	5.00	1.00	7.00	0.00	-	0.0122	0.0585	-	-
20.50 m	11.00	48.00	21.00	8.00	3.00	9.00	0.00	-	0.0168	0.0784	-	-
24.00 m	10.00	53.00	24.00	4.00	1.00	6.00	2.00	0.0020	0.0162	0.0677	33.83	1.94
26.50 m	13.00	48.00	23.00	5.00	3.00	8.00	0.00	-	0.0142	0.0723	-	-
30.00 m	12.00	54.00	21.00	3.00	2.00	7.00	1.00	-	0.0133	0.0608	-	-
32.50 m	11.00	52.00	20.00	6.00	2.00	9.00	0.00	-	0.0151	0.0674	-	-
35.50 m	12.00	52.00	19.00	4.00	1.00	12.00	0.00	-	0.0138	0.0650	-	-
38.50 m	11.00	47.00	22.00	8.00	2.00	10.00	0.00	-	0.0174	0.0830	-	-

GRAIN SIZE DISTRIBUTION CURVES

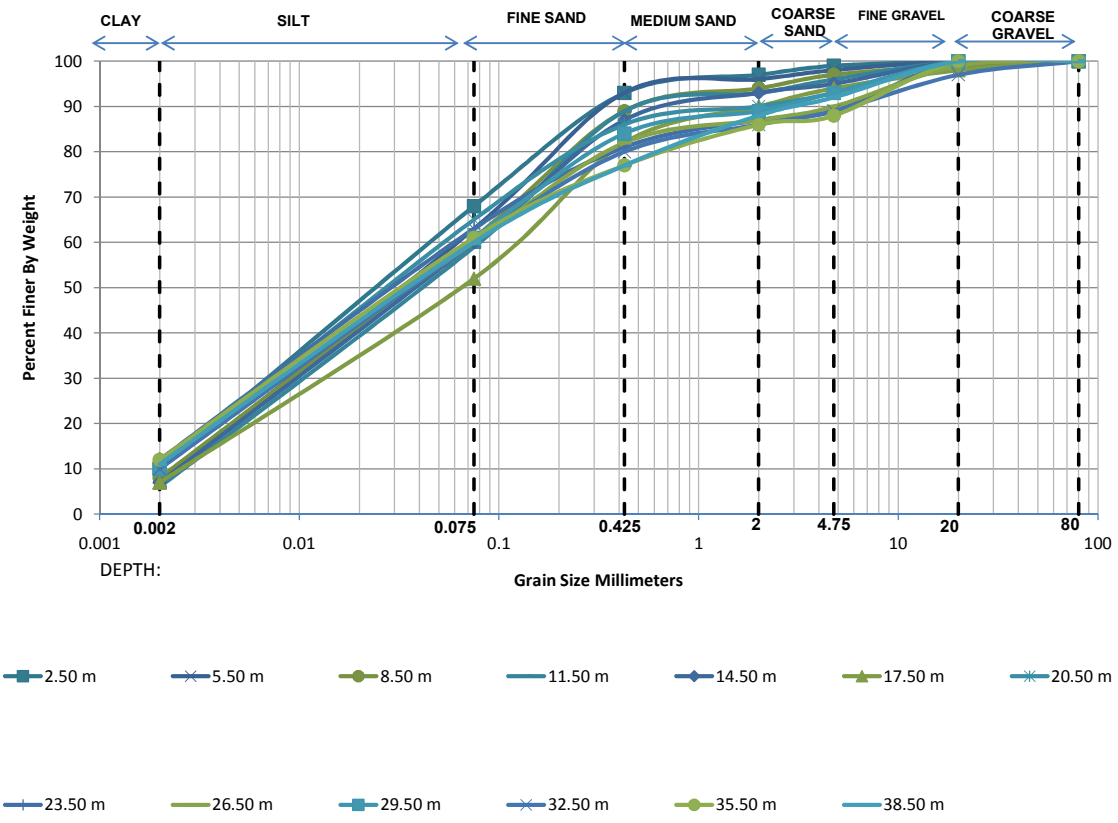
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	20+300 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	11.00	61.00	20.00	3.00	4.00	1.00	0.00	-	0.0125	0.0509	-	-
4.00 m	8.00	54.00	31.00	3.00	2.00	2.00	0.00	0.0029	0.0189	0.0703	24.20	1.75
7.00 m	7.00	55.00	29.00	6.00	1.00	2.00	0.00	0.0035	0.0199	0.0703	19.98	1.60
10.00 m	7.00	54.00	27.00	5.00	4.00	3.00	0.00	0.0035	0.0203	0.0726	20.57	1.60
13.00 m	6.00	54.00	28.00	4.00	3.00	5.00	0.00	0.0043	0.0219	0.0750	17.41	1.49
16.00 m	8.00	49.00	29.00	6.00	2.00	4.00	2.00	0.0029	0.0214	0.0854	29.11	1.82
19.00 m	9.00	53.00	28.00	4.00	1.00	5.00	0.00	0.0024	0.0178	0.0701	29.23	1.88
22.00 m	11.00	54.00	22.00	4.00	2.00	7.00	0.00	-	0.0145	0.0631	-	-
25.00 m	12.00	53.00	20.00	3.00	2.00	10.00	0.00	-	0.0136	0.0628	-	-
28.00 m	11.00	50.00	22.00	4.00	3.00	8.00	2.00	-	0.0160	0.0724	-	-
31.50 m	11.00	44.00	20.00	4.00	8.00	13.00	0.00	-	0.0190	0.1068	-	-
34.00 m	12.00	56.00	18.00	3.00	2.00	9.00	0.00	-	0.0126	0.0569	-	-
37.00 m	12.00	48.00	19.00	5.00	3.00	12.00	1.00	-	0.0154	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

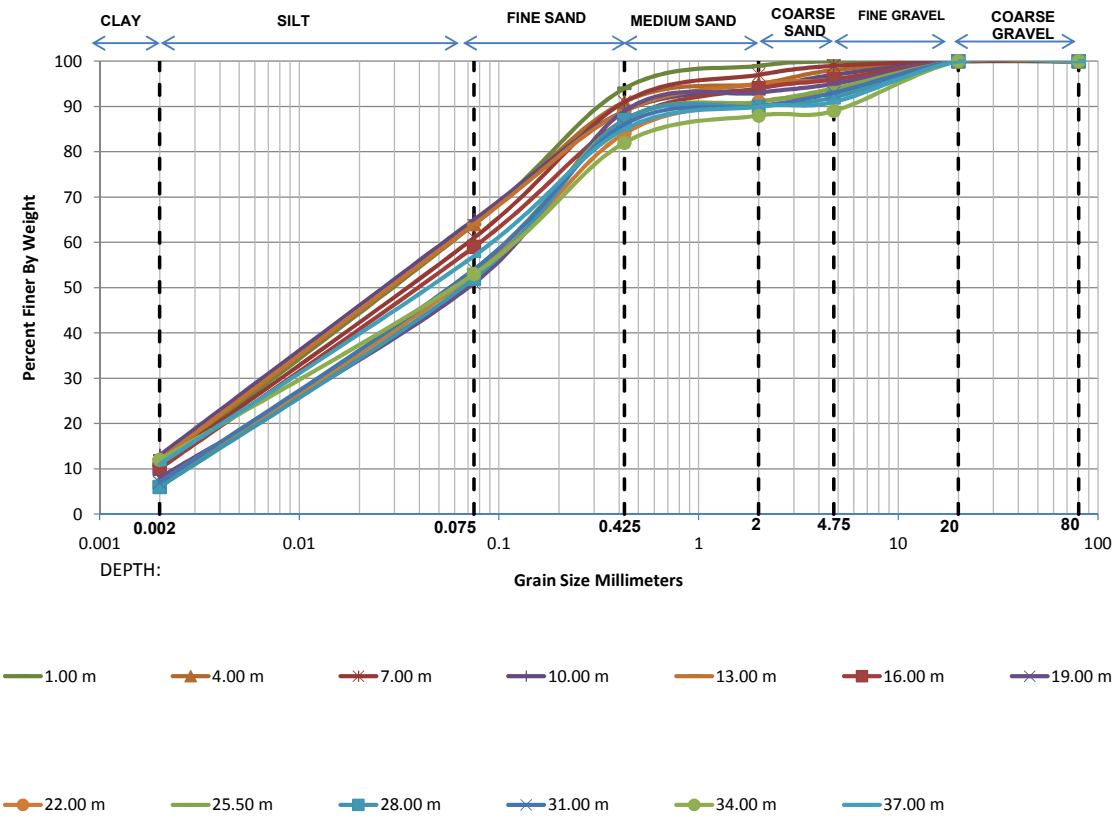
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	20+300 Major Bridge
B.H. No.	BH-P2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	10.00	58.00	25.00	4.00	2.00	1.00	0.00	0.0020	0.0146	0.0578	28.91	1.84
5.50 m	7.00	56.00	30.00	3.00	2.00	2.00	0.00	0.0035	0.0195	0.0682	19.43	1.59
8.50 m	8.00	53.00	28.00	5.00	3.00	2.00	1.00	0.0029	0.0192	0.0725	24.95	1.75
11.50 m	6.00	53.00	30.00	4.00	3.00	4.00	0.00	0.0043	0.0226	0.0777	17.94	1.51
14.50 m	7.00	53.00	27.00	6.00	2.00	5.00	0.00	0.0035	0.0207	0.0750	21.19	1.62
17.50 m	7.00	45.00	30.00	8.00	4.00	4.00	2.00	0.0037	0.0260	0.1142	31.13	1.62
20.50 m	10.00	55.00	21.00	4.00	3.00	7.00	0.00	0.0020	0.0154	0.0633	31.64	1.87
23.50 m	12.00	51.00	18.00	6.00	2.00	11.00	0.00	-	0.0142	0.0672	-	-
26.50 m	11.00	49.00	22.00	5.00	3.00	9.00	1.00	-	0.0164	0.0750	-	-
29.50 m	10.00	51.00	23.00	5.00	4.00	7.00	0.00	0.0020	0.0170	0.0724	36.20	1.99
32.50 m	10.00	50.00	20.00	6.00	3.00	8.00	3.00	0.0020	0.0173	0.0750	37.50	1.99
35.50 m	12.00	49.00	16.00	9.00	2.00	12.00	0.00	-	0.0148	0.0722	-	-
38.50 m	11.00	49.00	17.00	11.00	4.00	8.00	0.00	-	0.0162	0.0750	-	-

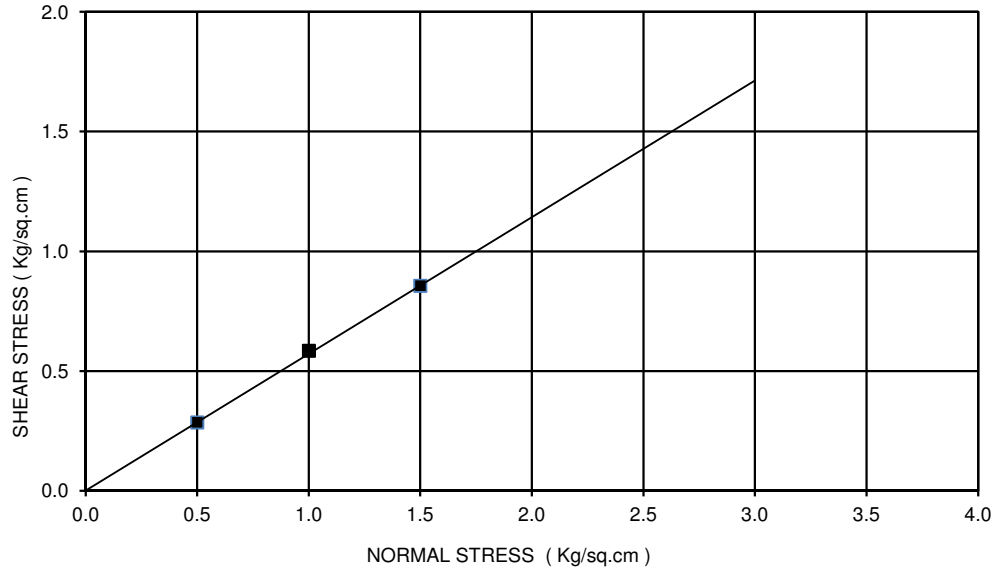
GRAIN SIZE DISTRIBUTION CURVES

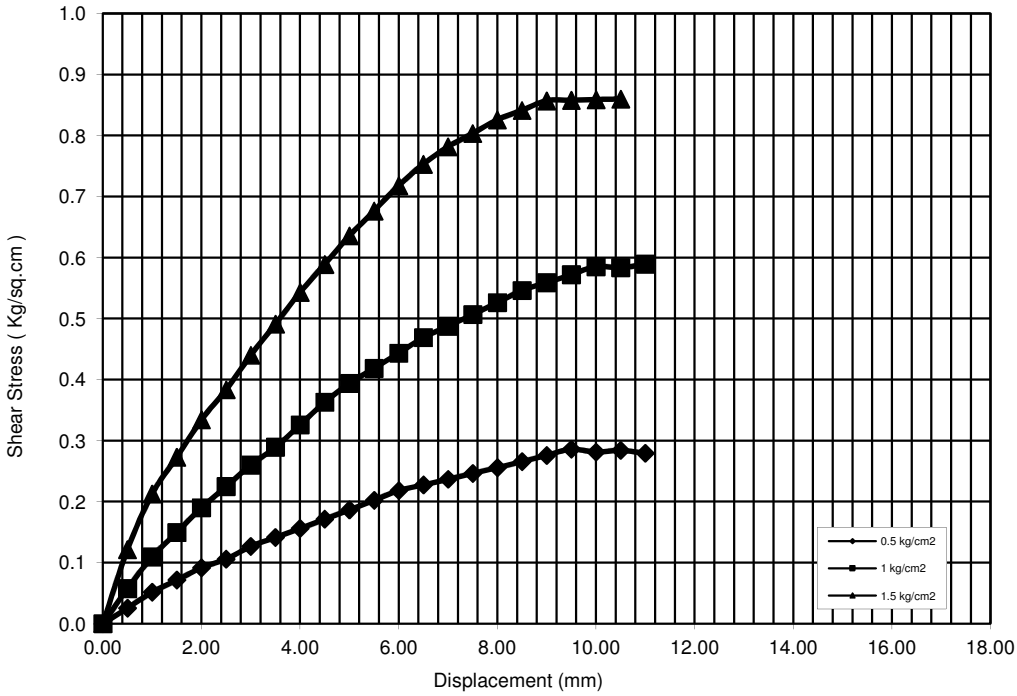
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	20+300 Major Bridge
B.H. No.	BH-A2



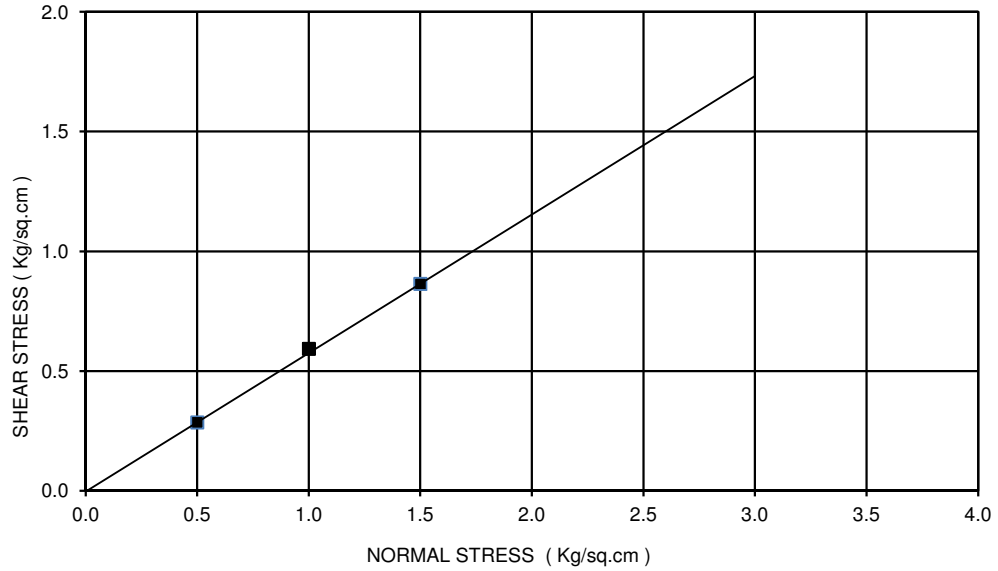
Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	11.00	53.00	30.00	5.00	1.00	0.00	0.00	-	0.0152	0.0655	-	-
4.00 m	12.00	52.00	27.00	4.00	3.00	2.00	0.00	-	0.0142	0.0652	-	-
7.00 m	11.00	50.00	30.00	6.00	2.00	1.00	0.00	-	0.0164	0.0724	-	-
10.00 m	13.00	52.00	24.00	5.00	3.00	3.00	0.00	-	0.0129	0.0628	-	-
13.00 m	12.00	52.00	25.00	6.00	1.00	4.00	0.00	-	0.0141	0.0652	-	-
16.00 m	10.00	49.00	28.00	7.00	2.00	4.00	0.00	0.0020	0.0182	0.0780	38.98	2.12
19.00 m	8.00	43.00	38.00	4.00	2.00	5.00	0.00	0.0030	0.0263	0.1103	36.82	2.09
22.00 m	6.00	47.00	31.00	7.00	2.00	7.00	0.00	0.0045	0.0264	0.1056	23.56	1.48
25.50 m	7.00	47.00	33.00	4.00	3.00	6.00	0.00	0.0036	0.0247	0.0979	26.93	1.71
28.00 m	6.00	46.00	35.00	3.00	2.00	8.00	0.00	0.0045	0.0275	0.1069	23.60	1.56
31.00 m	7.00	47.00	32.00	4.00	3.00	7.00	0.00	0.0036	0.0246	0.0986	27.13	1.69
34.00 m	12.00	41.00	29.00	6.00	1.00	11.00	0.00	-	0.0198	0.1093	-	-
37.00 m	11.00	46.00	28.00	5.00	1.00	9.00	0.00	-	0.0182	0.0860	-	-

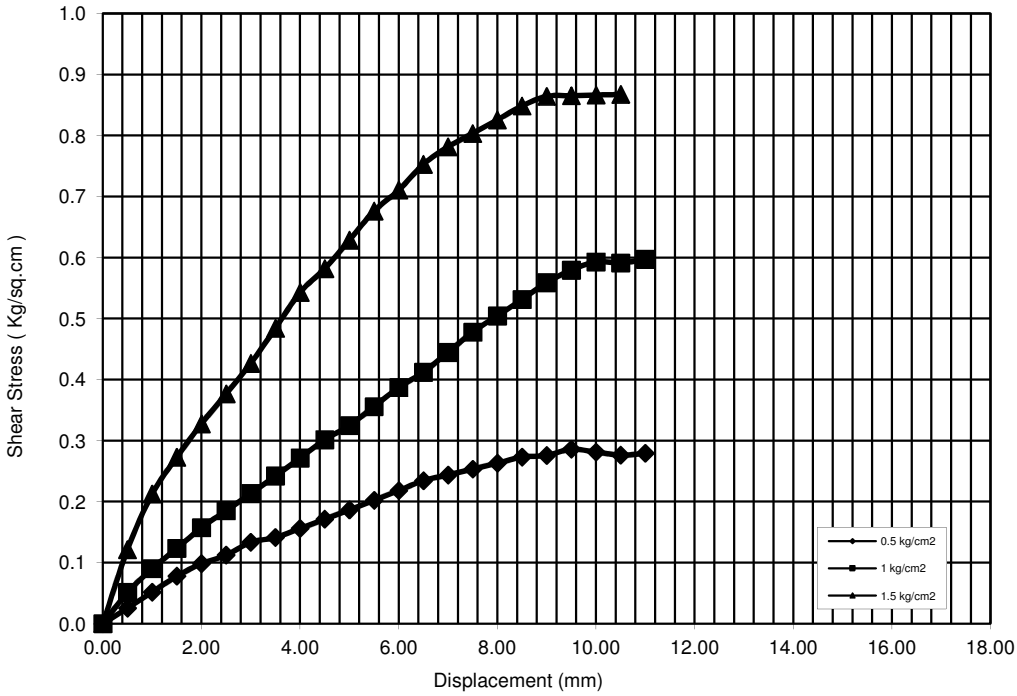
BORE HOLE NO: BH-CL
CHAINAGE : 0+627
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



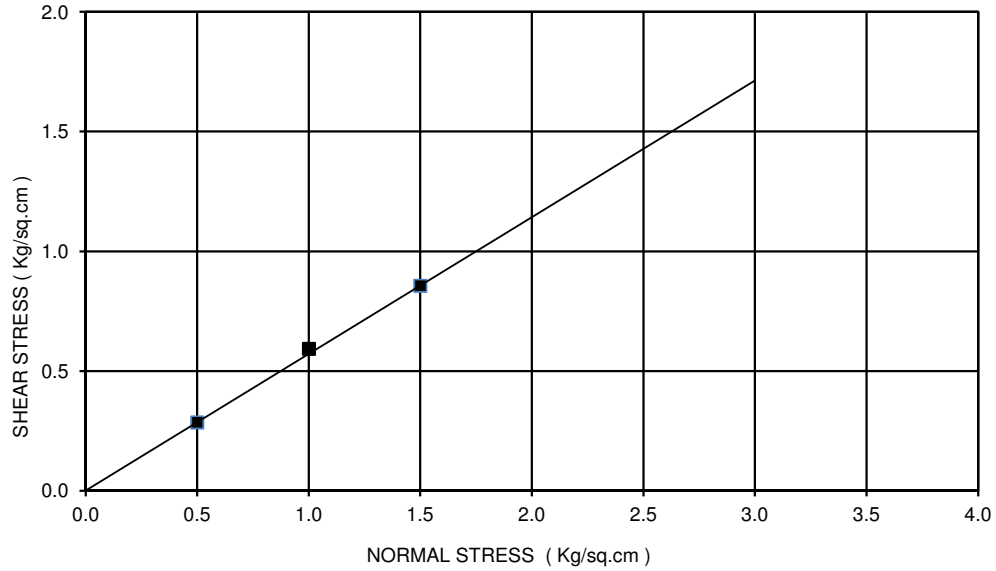


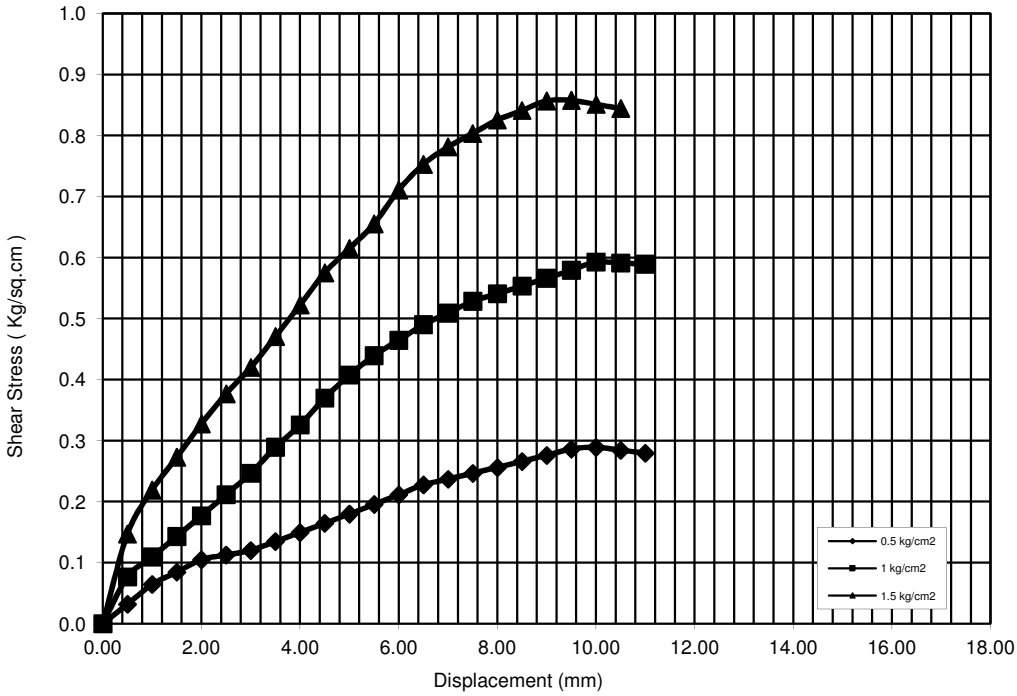
BORE HOLE NO: BH-CL
CHAINAGE : 0+529
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST





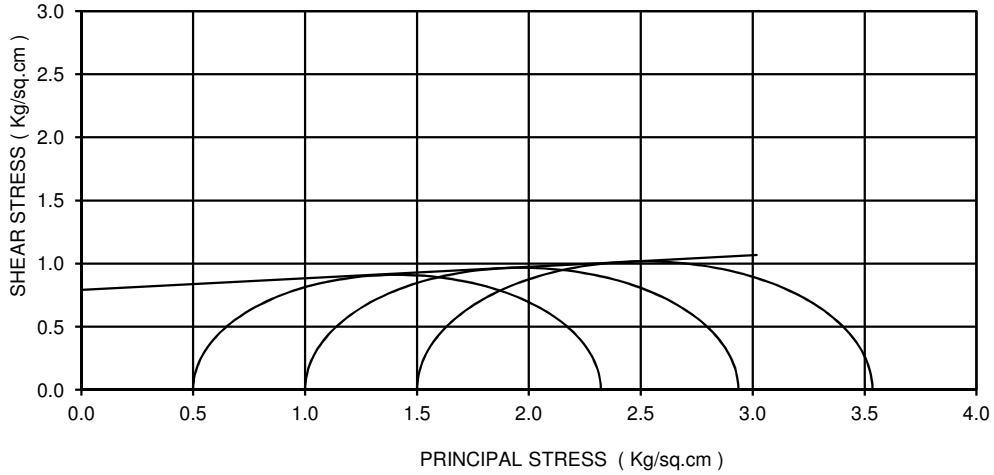
BOREHOLE NO.:- CL
SAMPLE NO.: UDS-1
DEPTH: 1.00m
COHESION (c): 0.00 kg/ sq. cm.
ANGLE OF FRICTION (phi): 30 deg.
TYPE OF TEST : DST

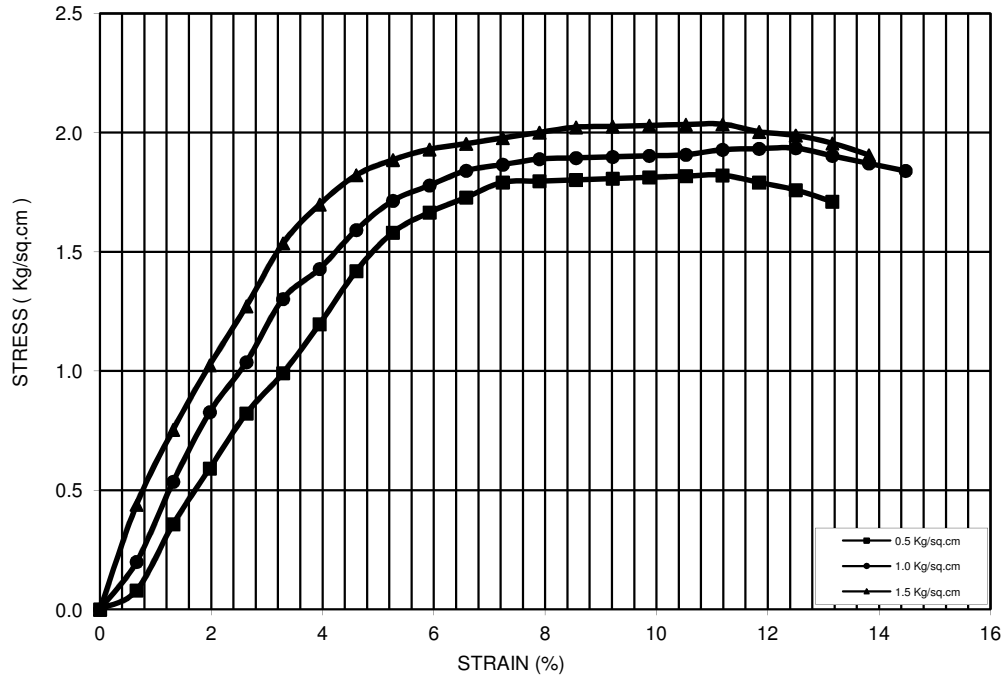




BORE HOLE NO: CL

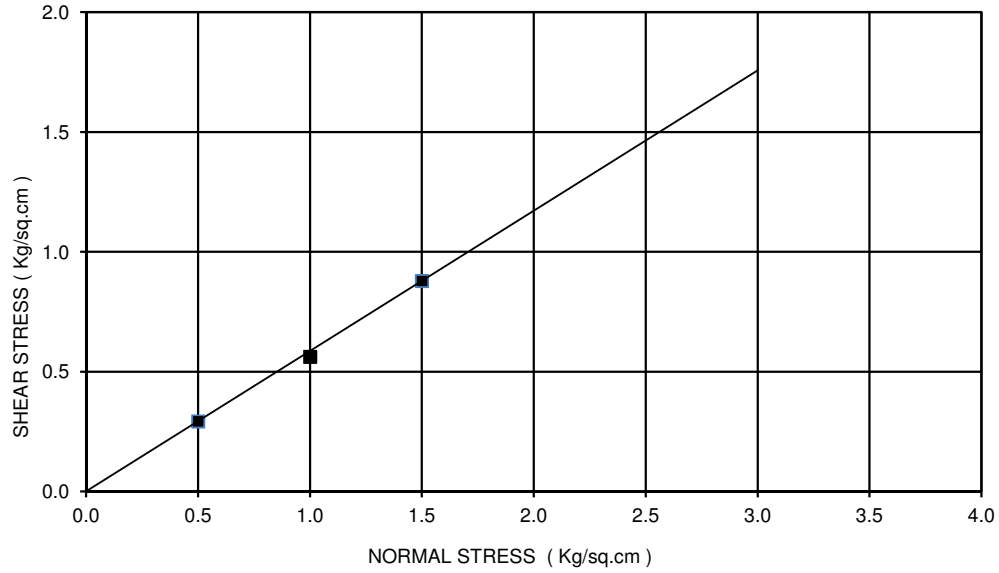
SAMPLE NO.: UDS-3
DEPTH:7.00 m
COHESION(C)= 0.79 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT

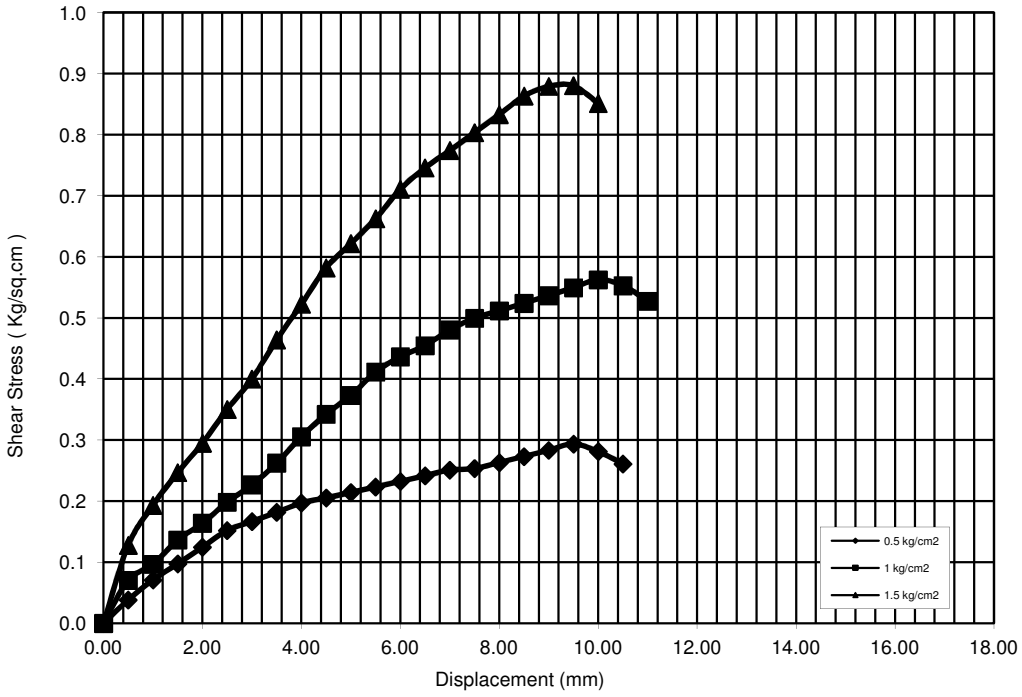




BORE HOLE NO: CL

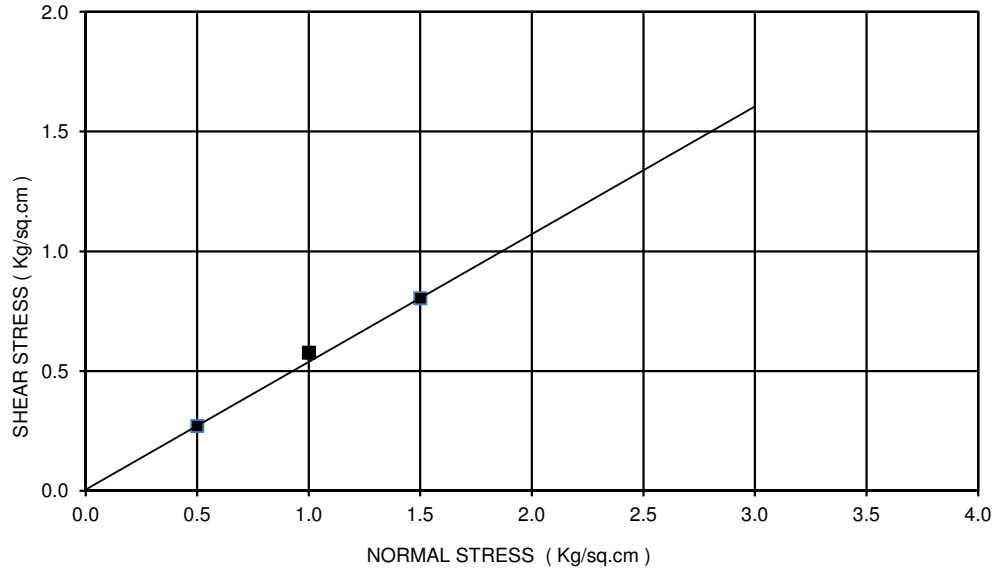
SAMPLE NO.: UDS-4
DEPTH: 10.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST

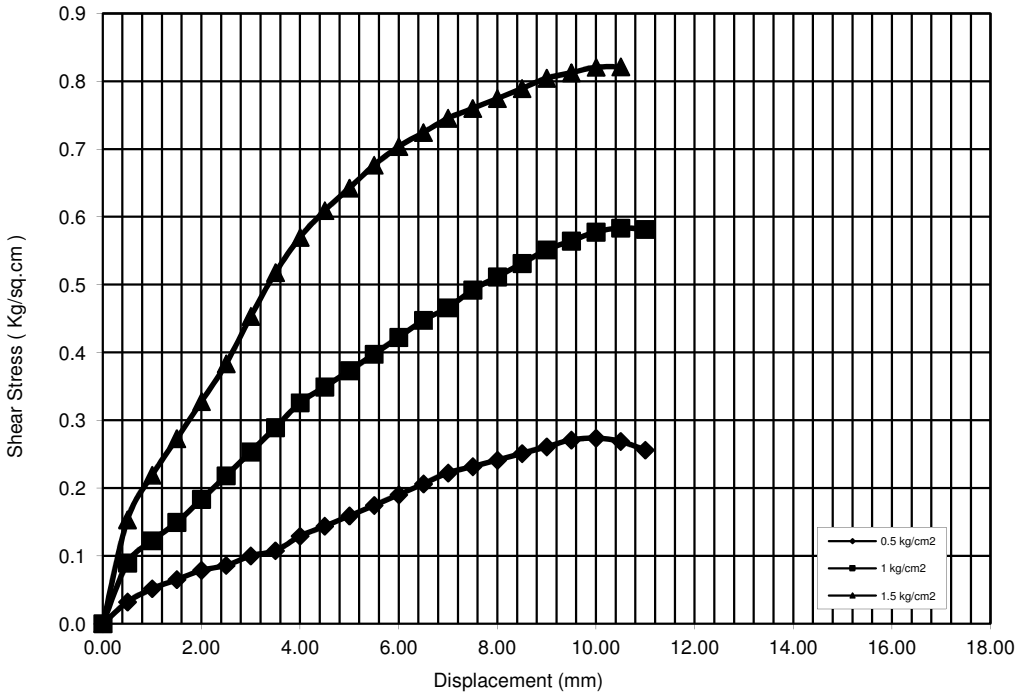




BORE HOLE NO: BH-R-61

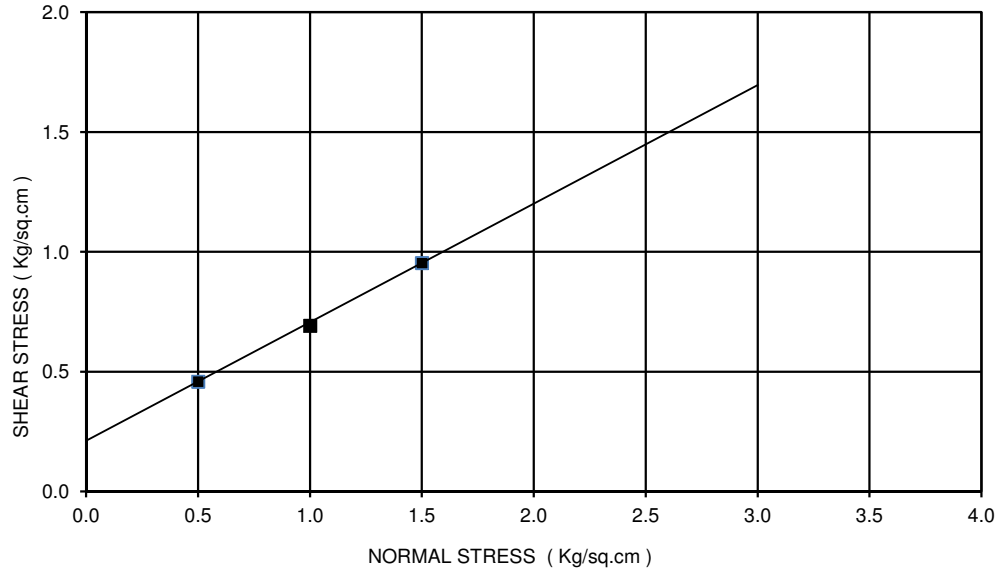
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST

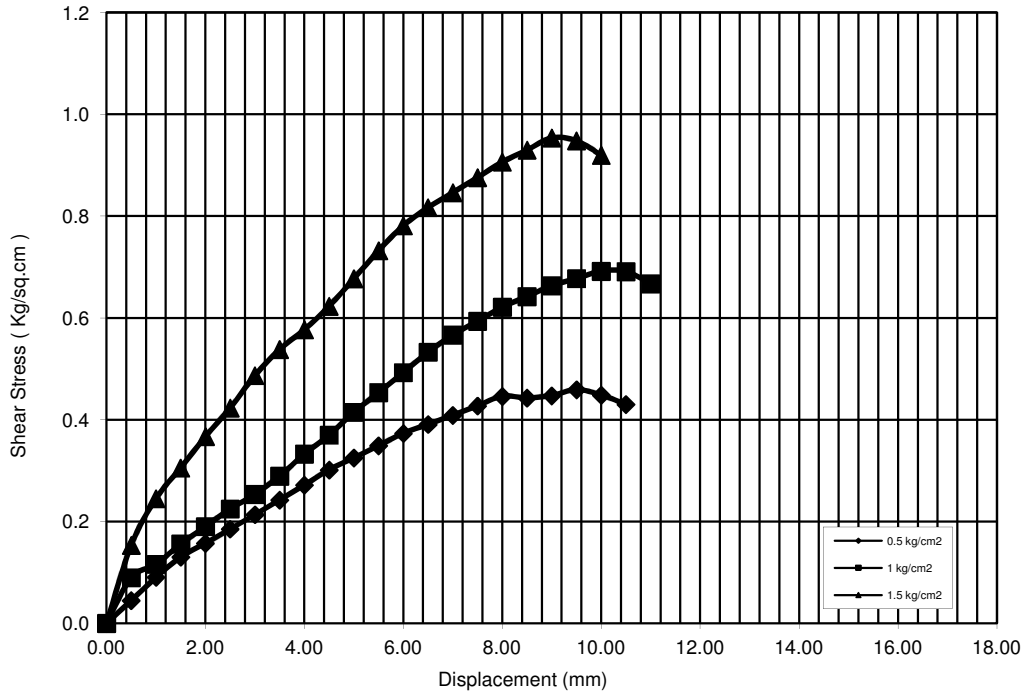




BORE HOLE NO: CL

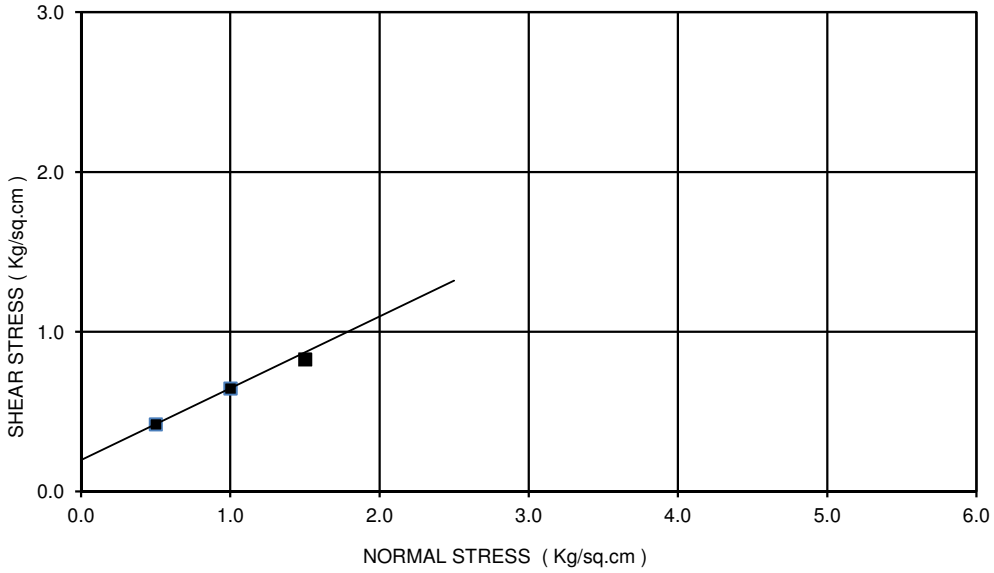
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST

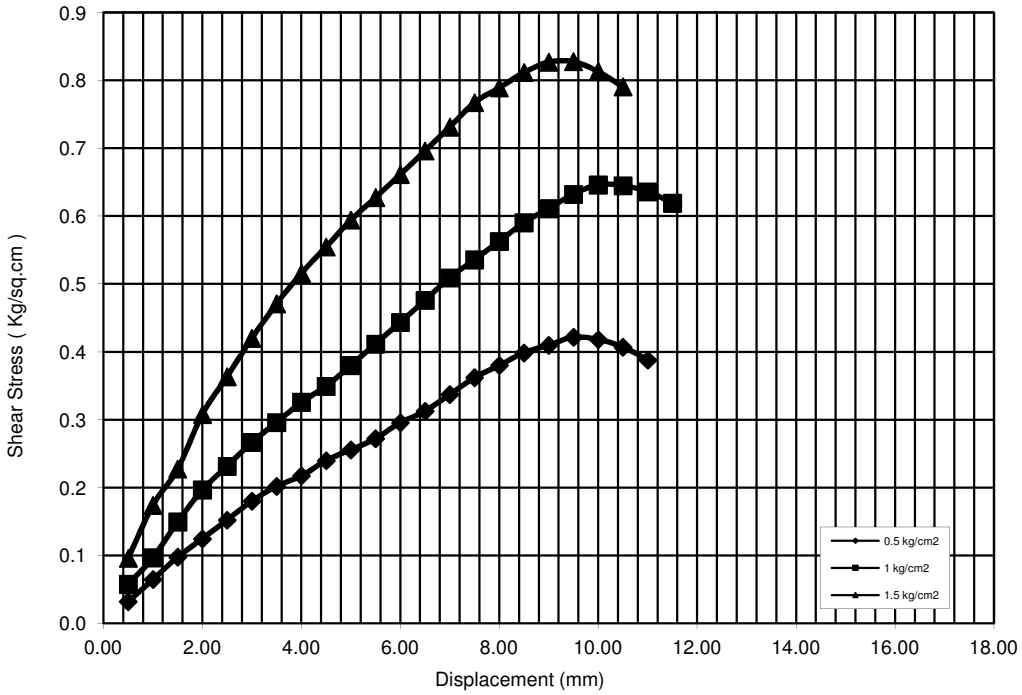




BORE HOLE NO: CL

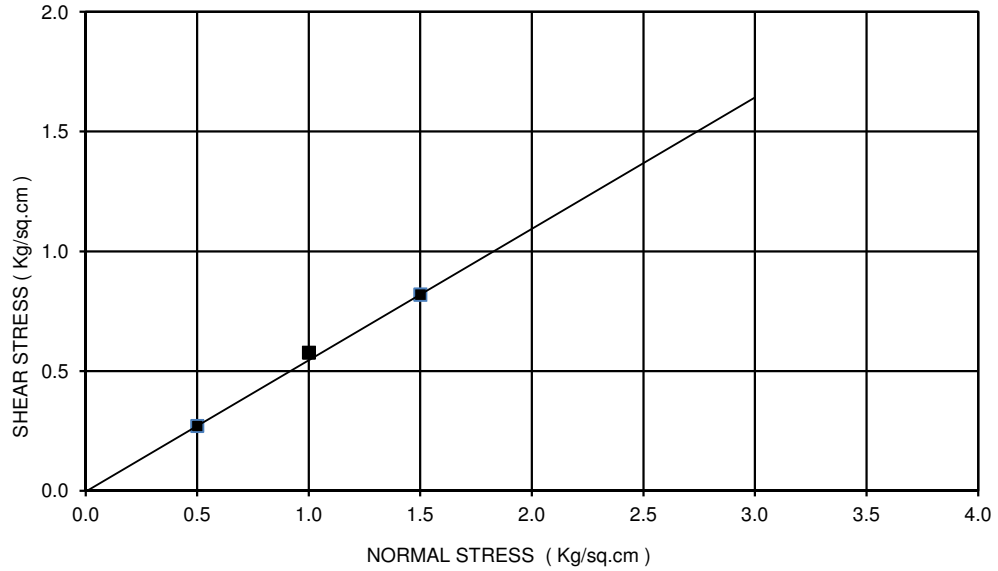
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST

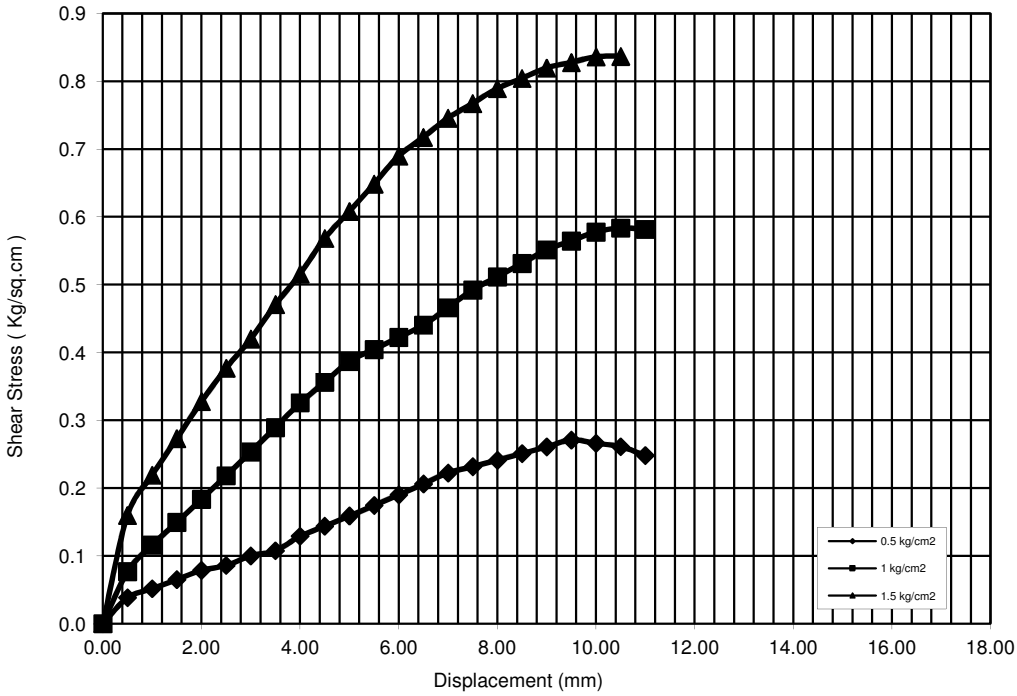




BORE HOLE NO: CL

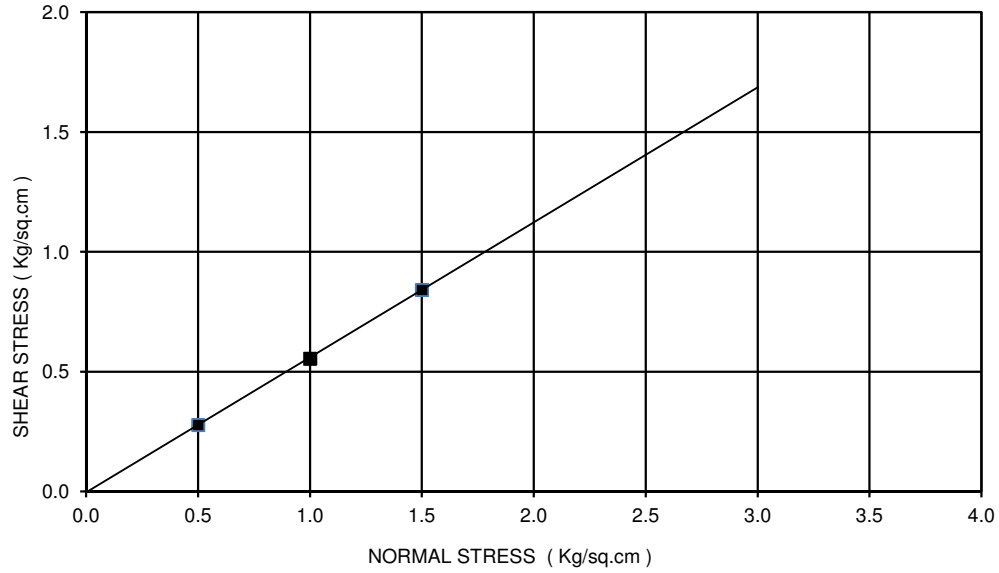
SAMPLE NO.: UDS-3
DEPTH: 8.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST

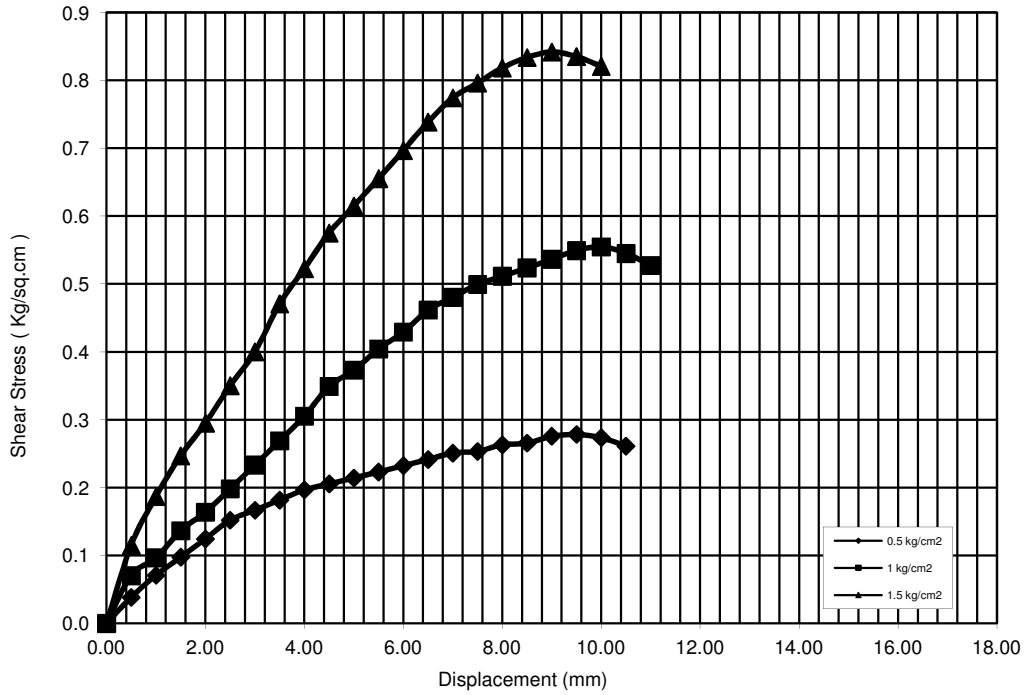




BORE HOLE NO: BH-CL

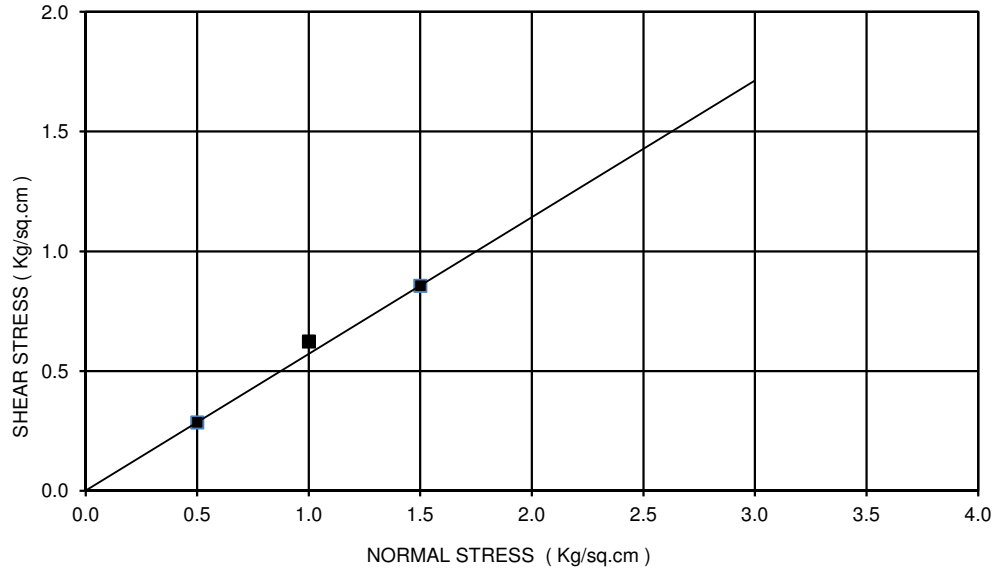
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST

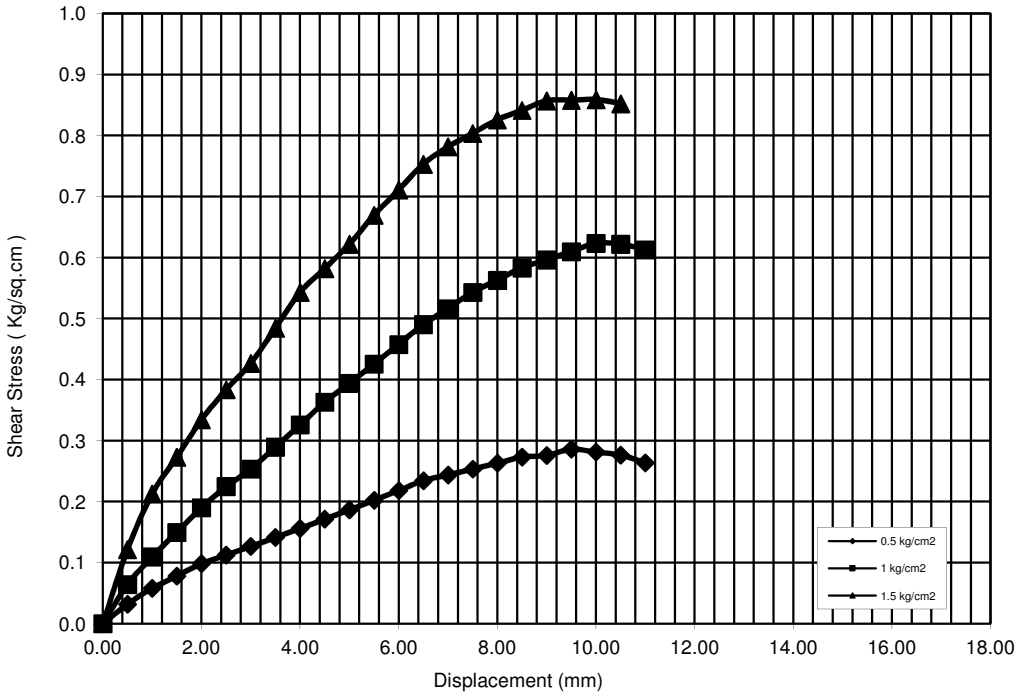




BORE HOLE NO: BH-CL

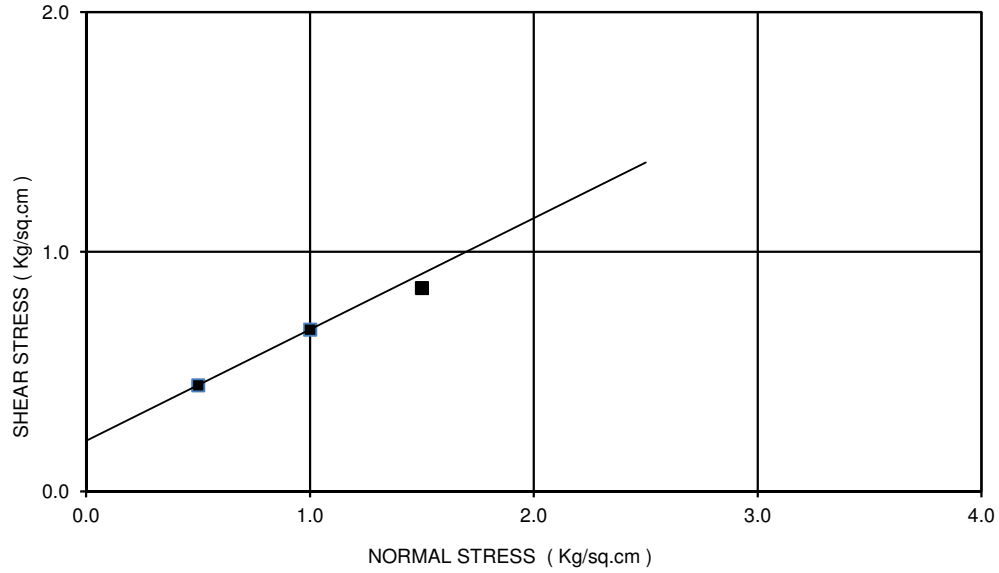
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi):30deg
TYPE OF THE TEST: DST

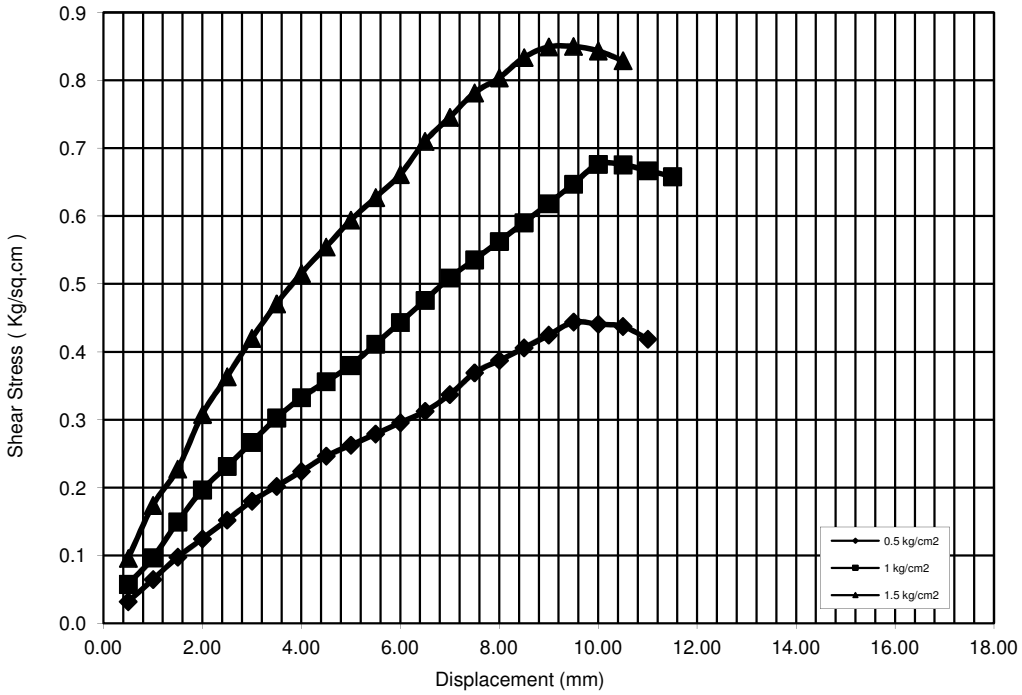




BORE HOLE NO: BH-CL

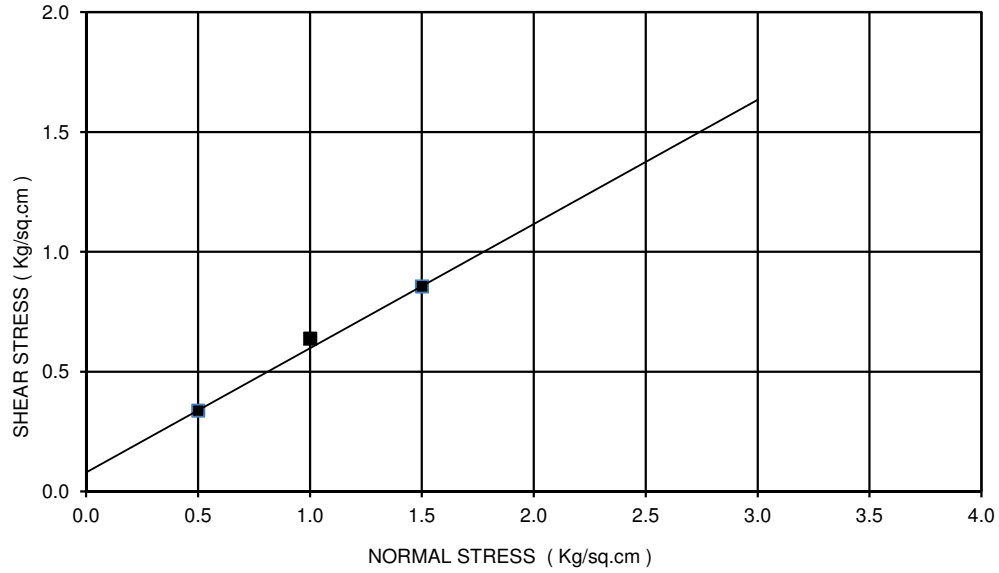
SAMPLE NO.: UDS-3
DEPTH: 8.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST

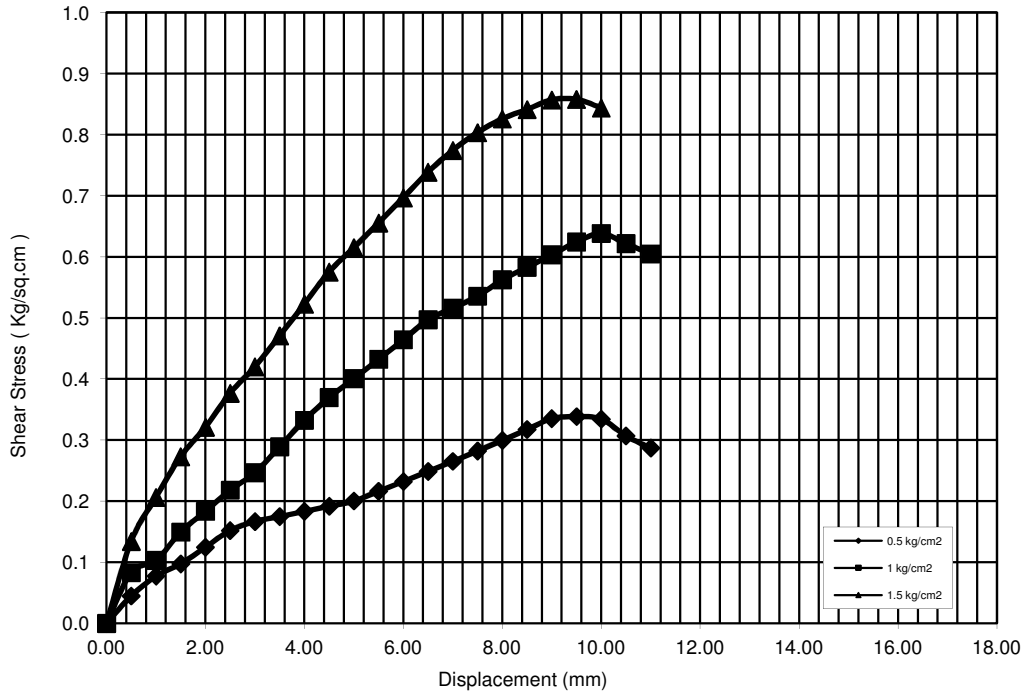




BORE HOLE NO: BH-CL

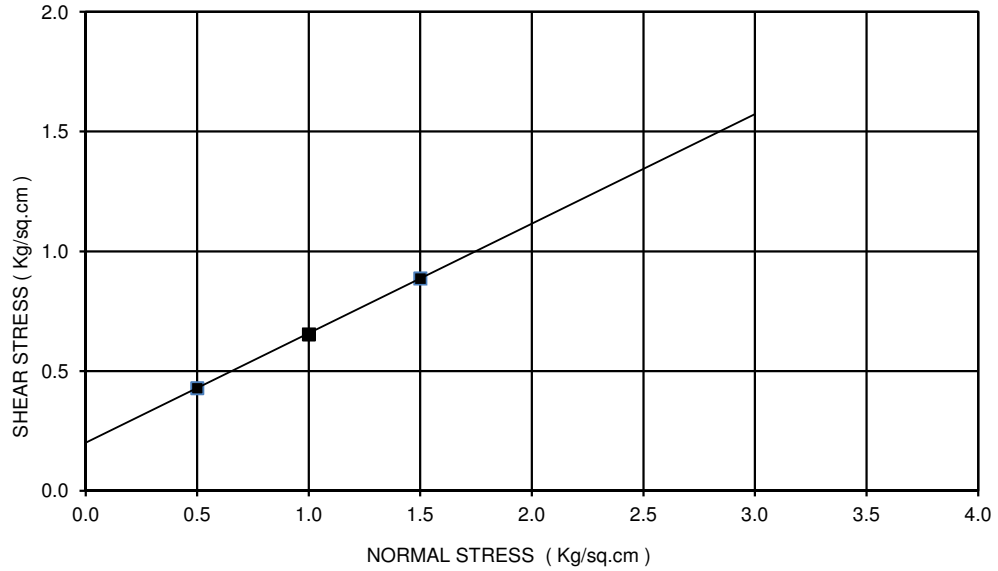
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST

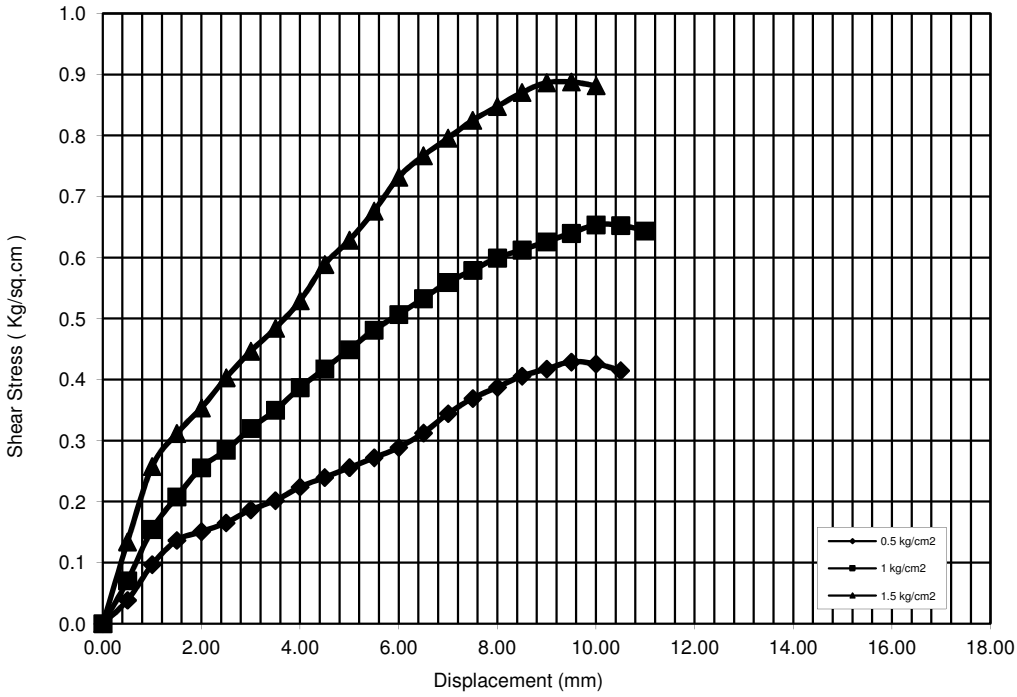




BORE HOLE NO: BH-CL

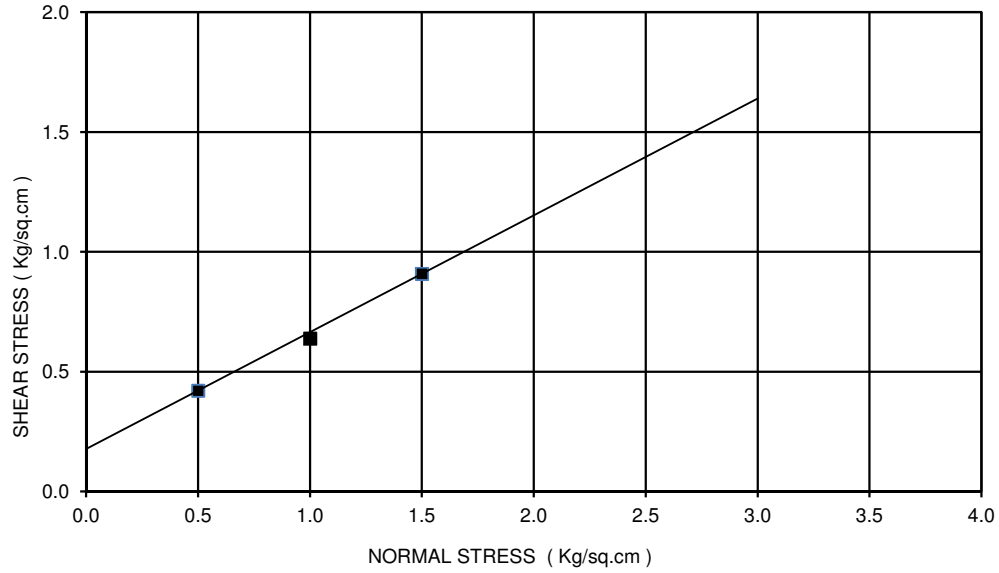
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST

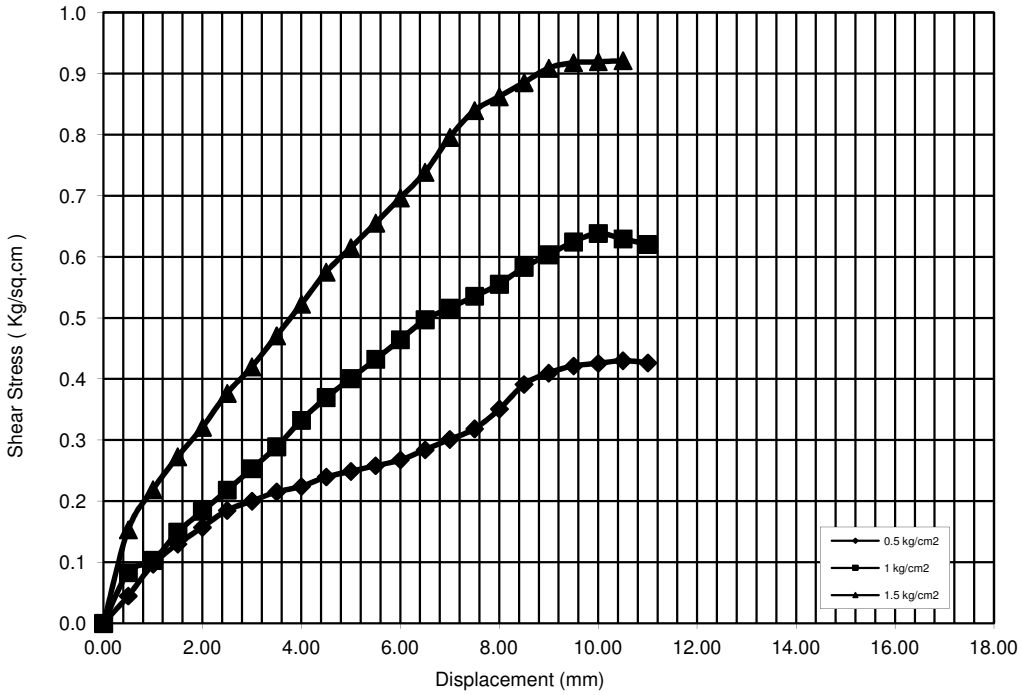




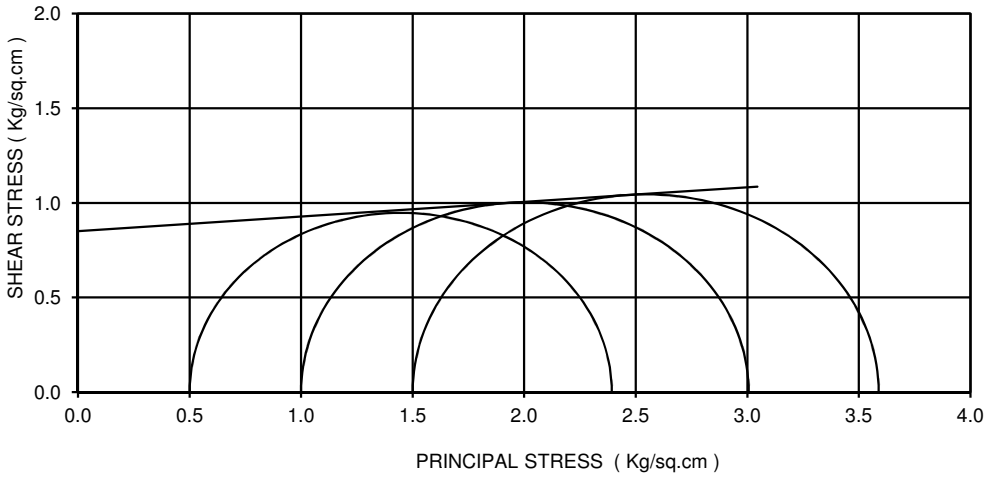
BORE HOLE NO: BH-CL

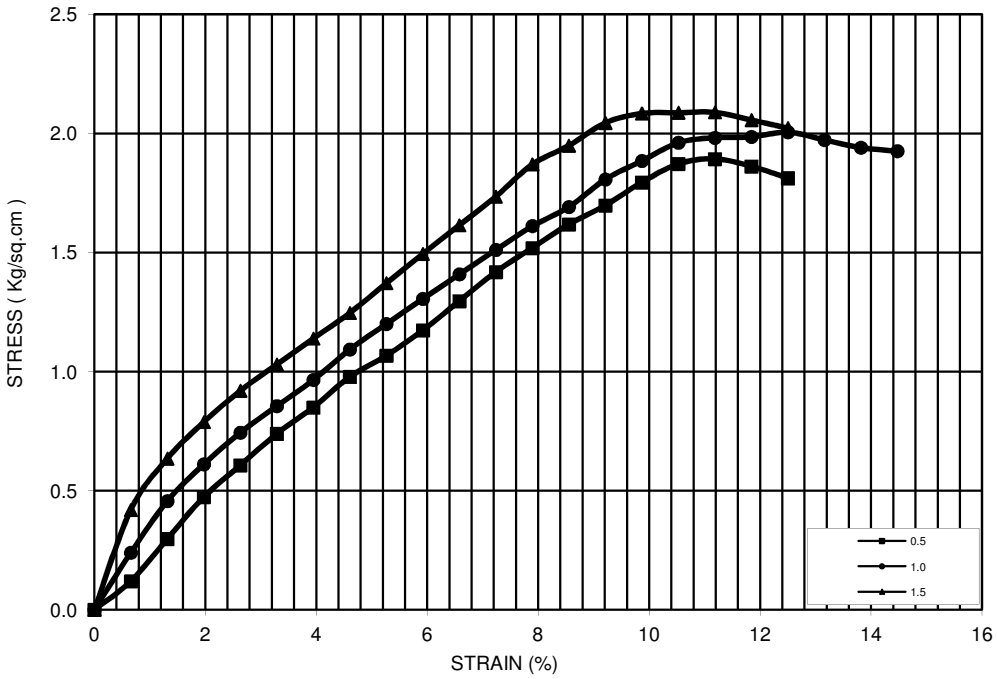
SAMPLE NO.: UDS-3
DEPTH: 8.50 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



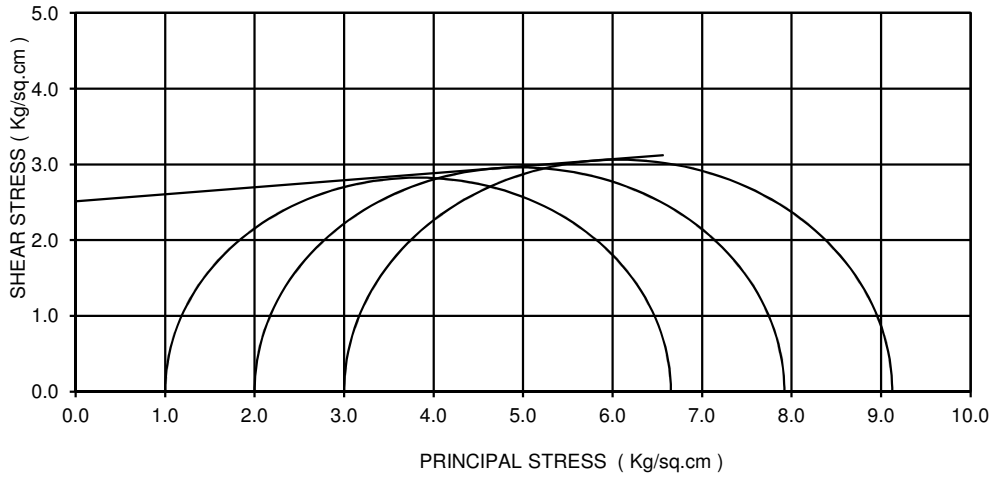


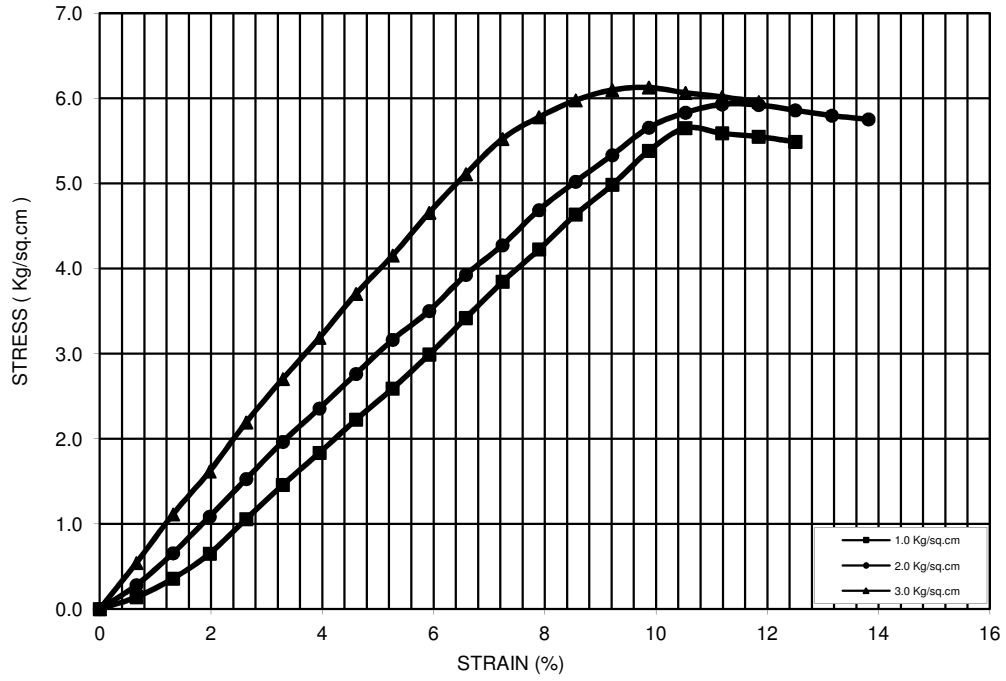
BORE HOLE NO: BH-A-1
CHAINAGE :3+497.7
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.85 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



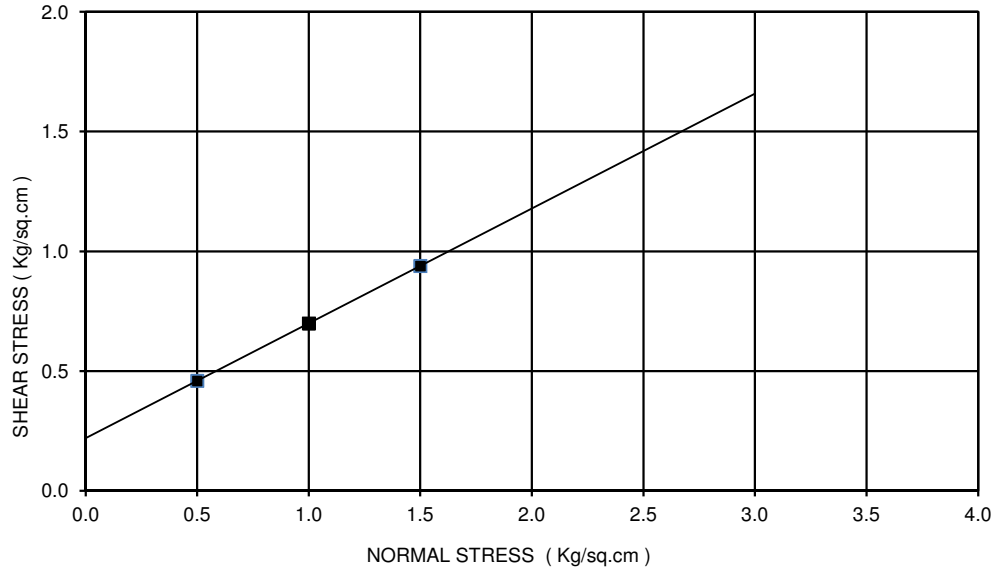


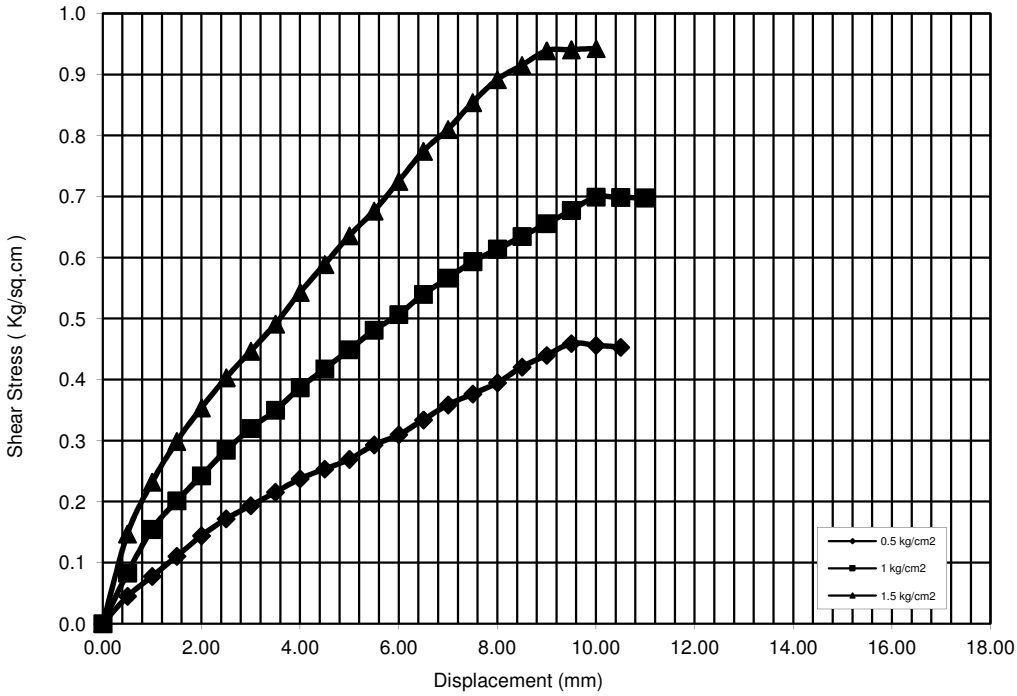
BORE HOLE NO: BH-A-1
CHAINAGE :3+497.7
SAMPLE NO.: UDS-10
DEPTH: 29.50 m
COHESION(C)= 2.51 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



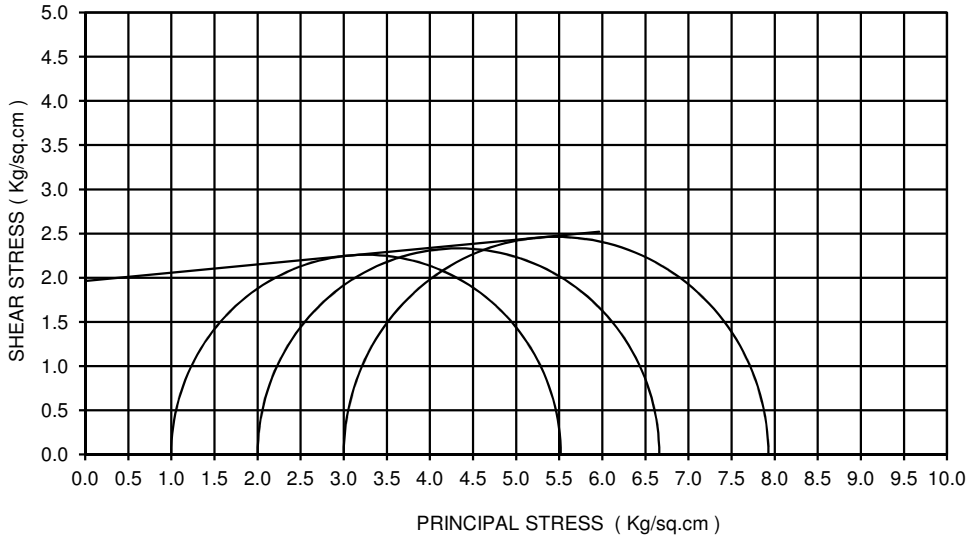


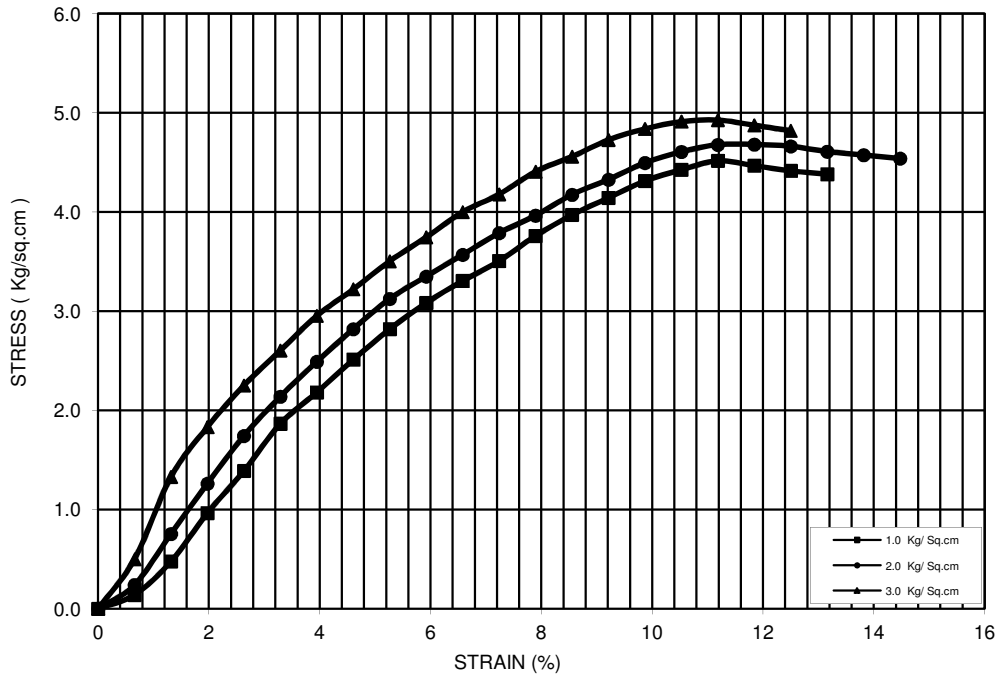
BORE HOLE NO: BH-P-1
CHAINAGE :3+497.7
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



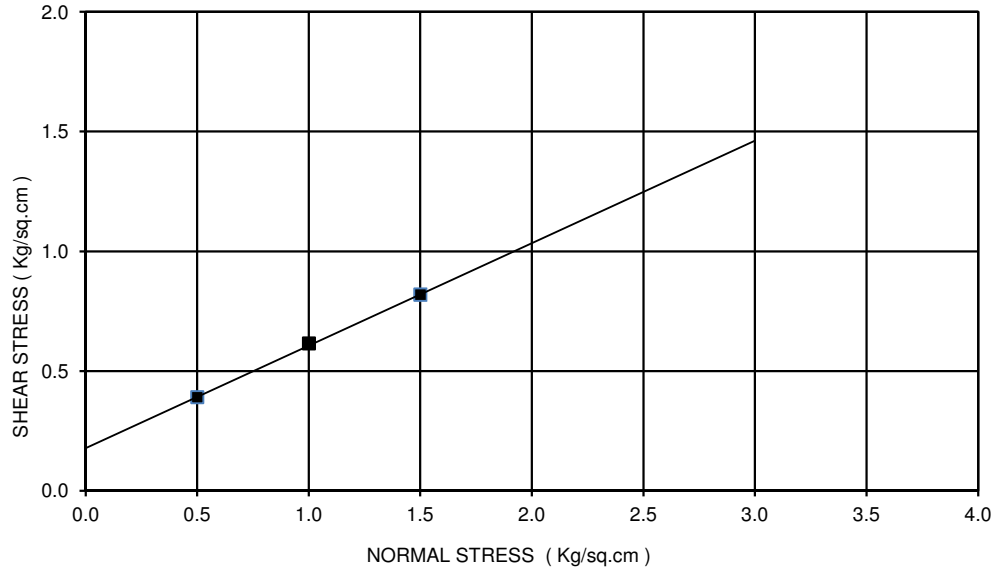


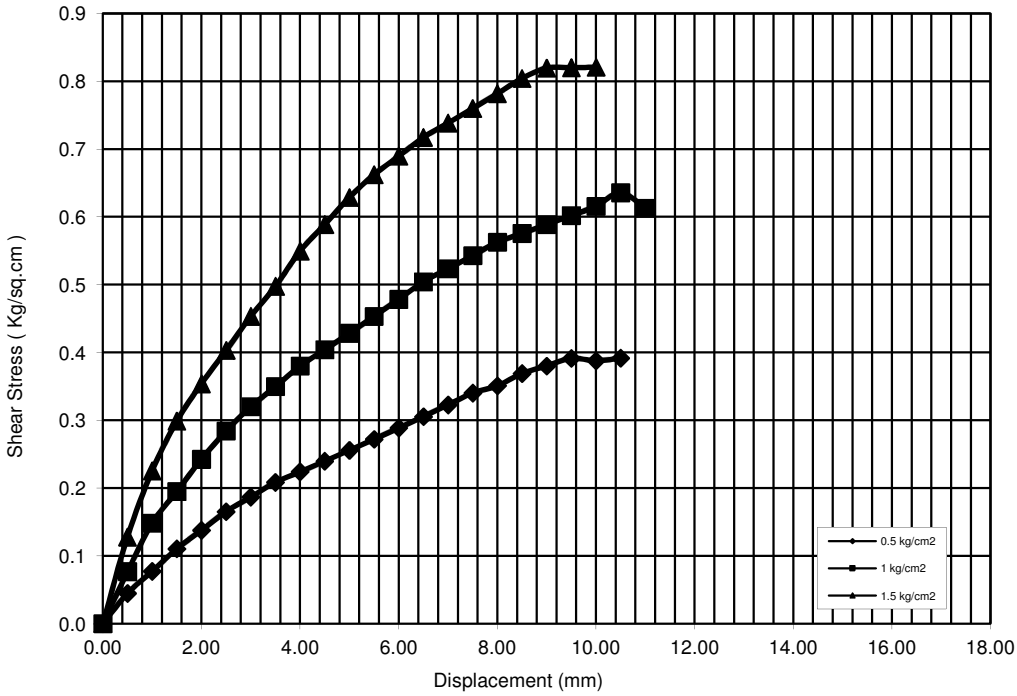
BORE HOLE NO: BH-P-1
CHAINAGE :3+497.7
SAMPLE NO.: UDS-7
DEPTH: 22.00 m
COHESION(C)= 1.96 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



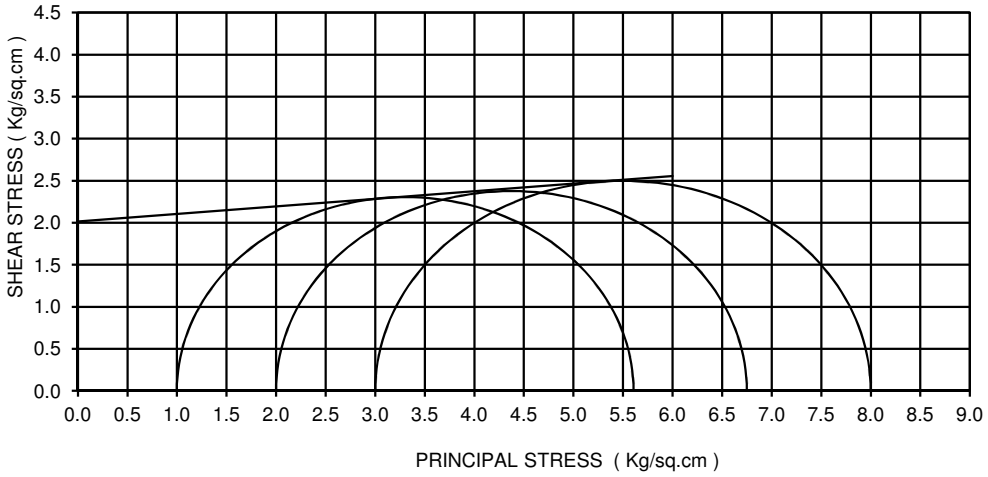


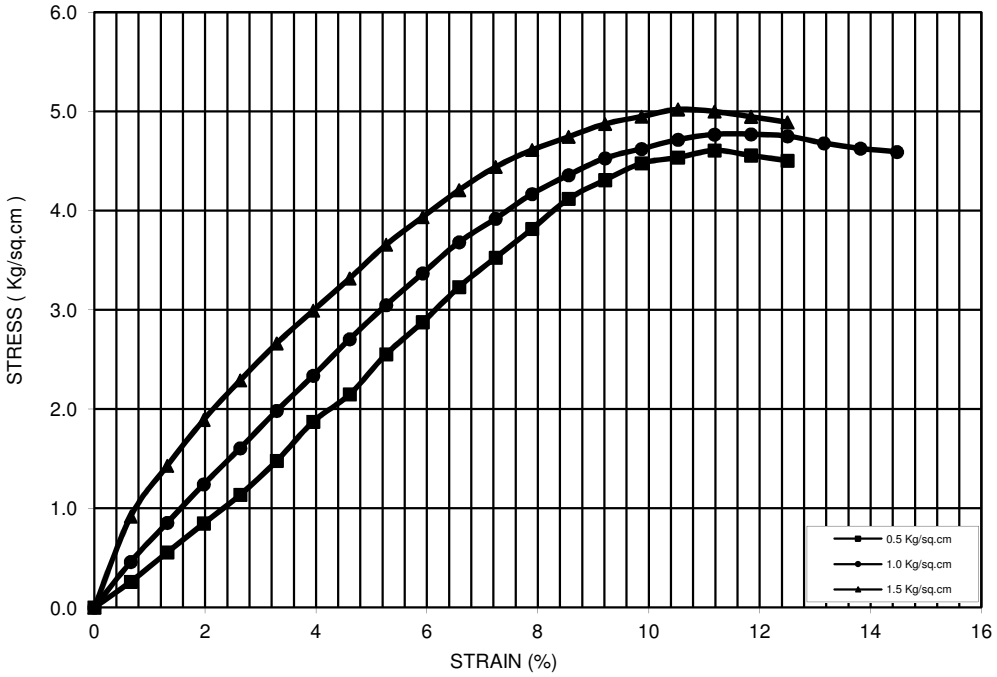
BORE HOLE NO: BH-P-2
CHAINAGE :3+497.7
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



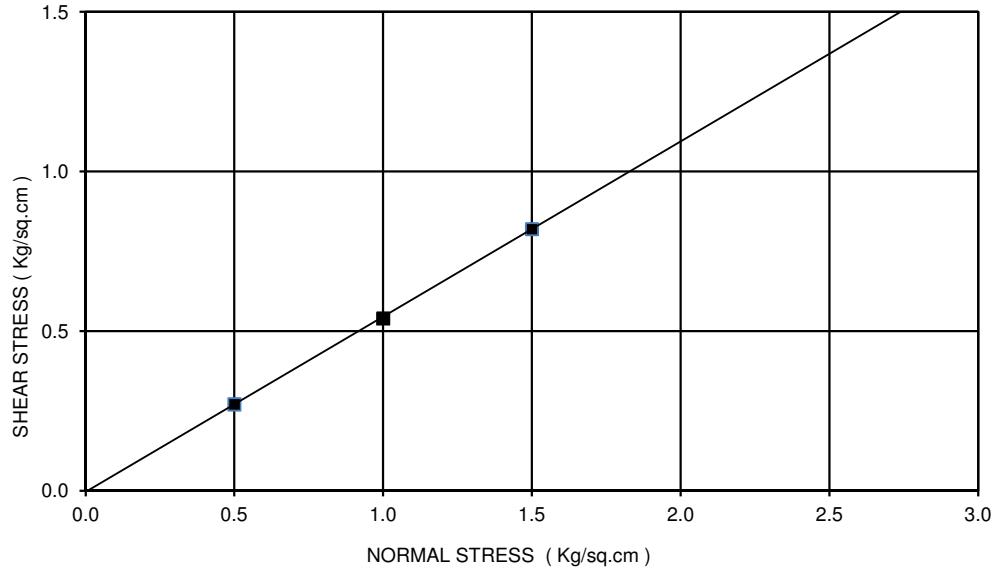


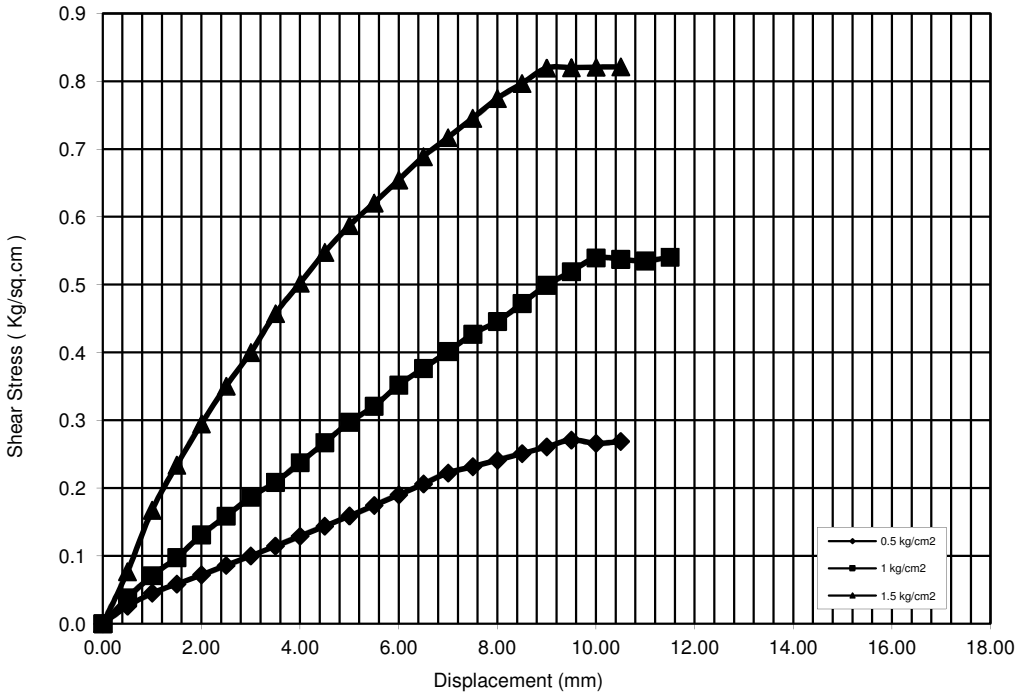
BORE HOLE NO: BH-P-2
CHAINAGE :3+497.7
SAMPLE NO.: UDS-10
DEPTH: 29.50 m
COHESION(C)= 2.02 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



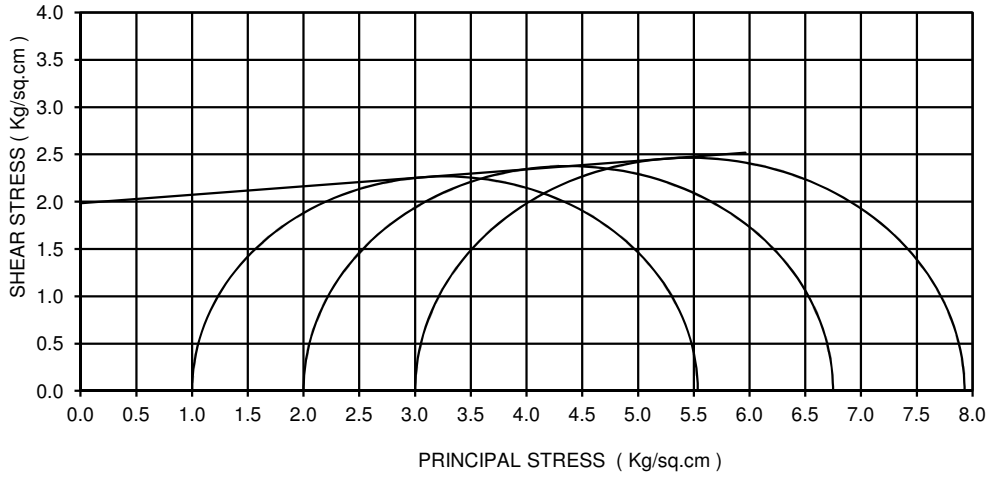


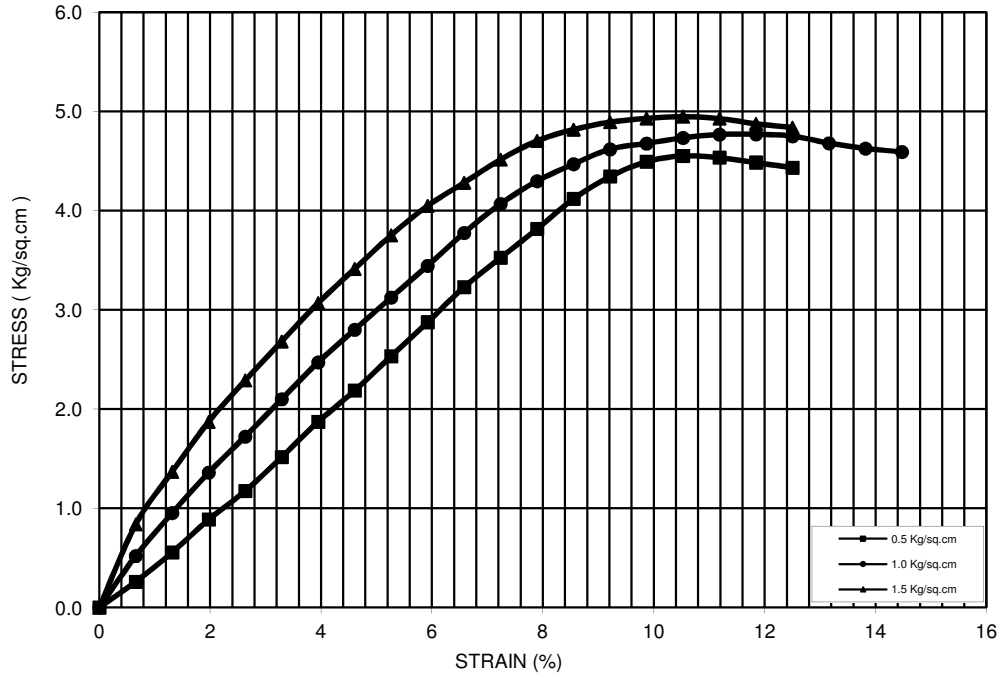
BORE HOLE NO: BH-P-3
CHAINAGE :3+497.7
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST



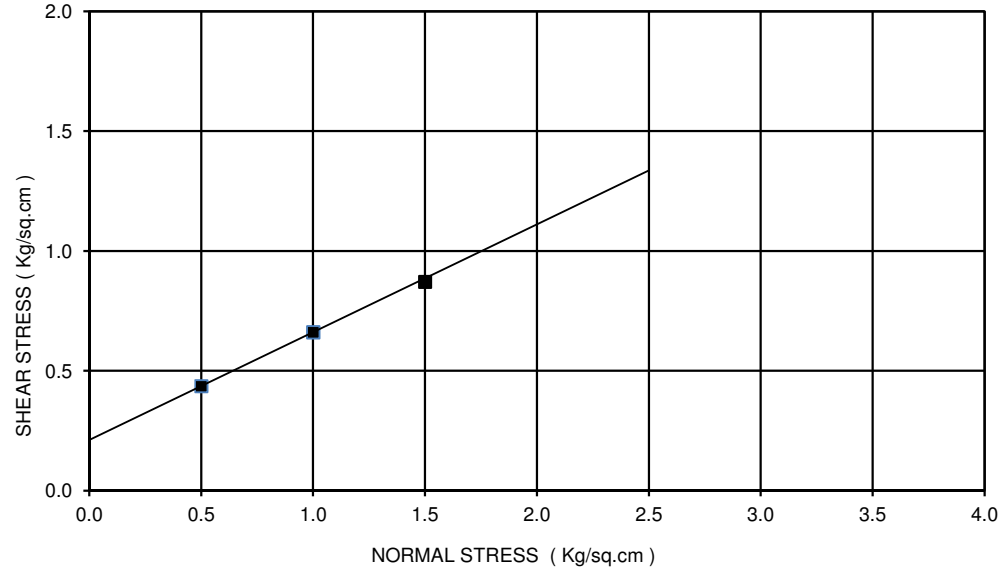


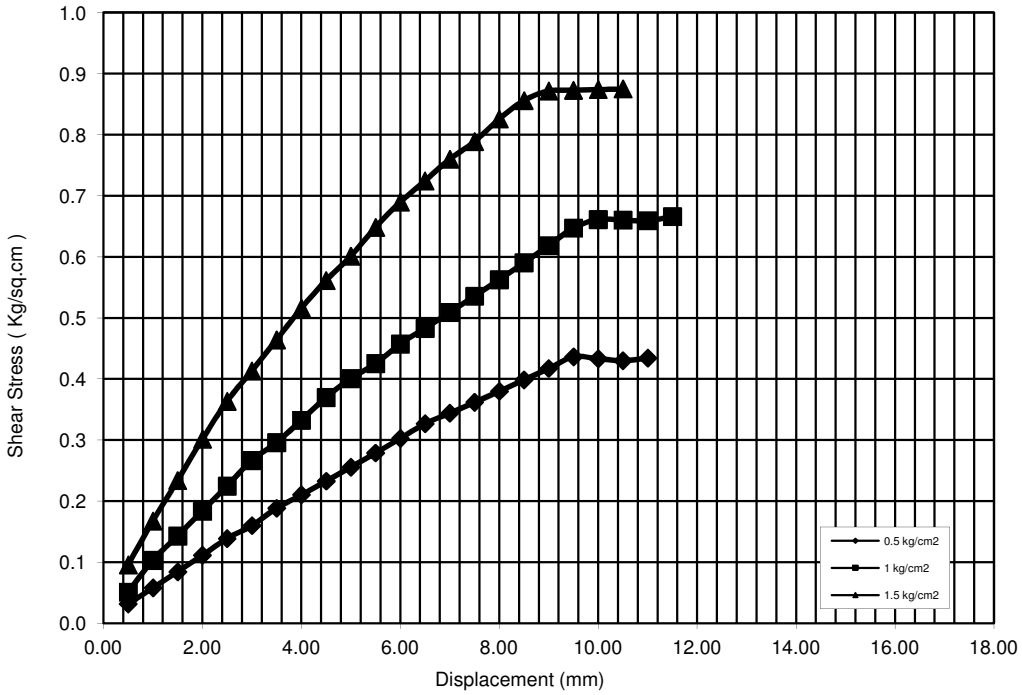
BORE HOLE NO: BH-P-3
CHAINAGE :3+497.7
SAMPLE NO.: UDS-9
DEPTH: 25.00 m
COHESION(C)= 1.98 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



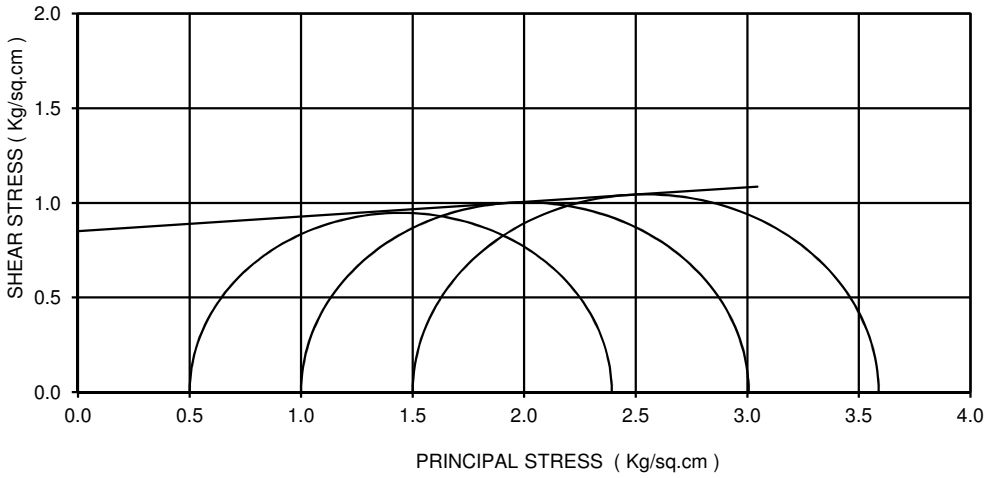


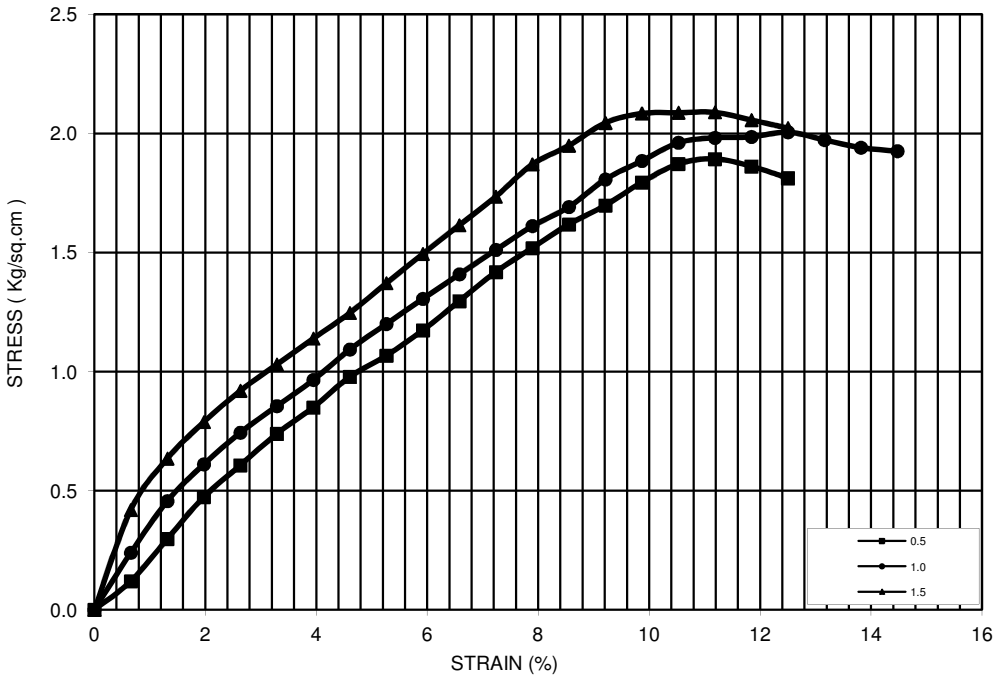
BORE HOLE NO: BH-A-2
CHAINAGE :3+497.7
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



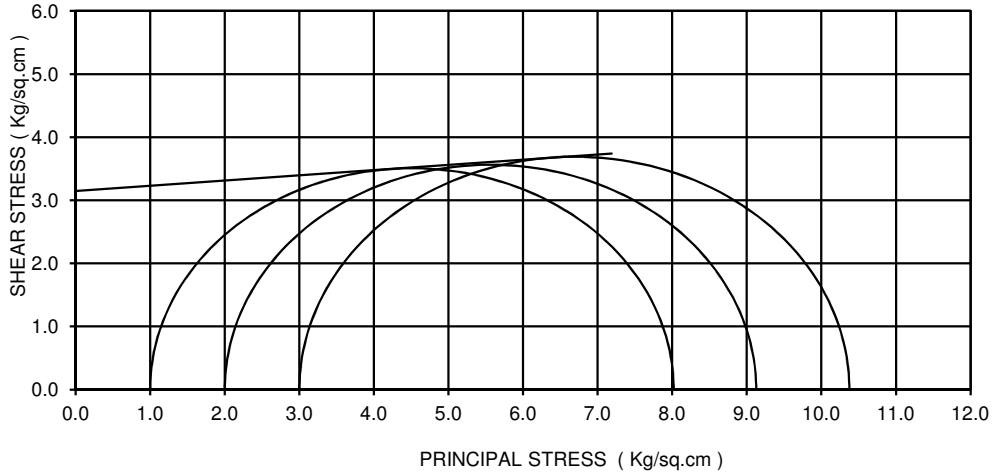


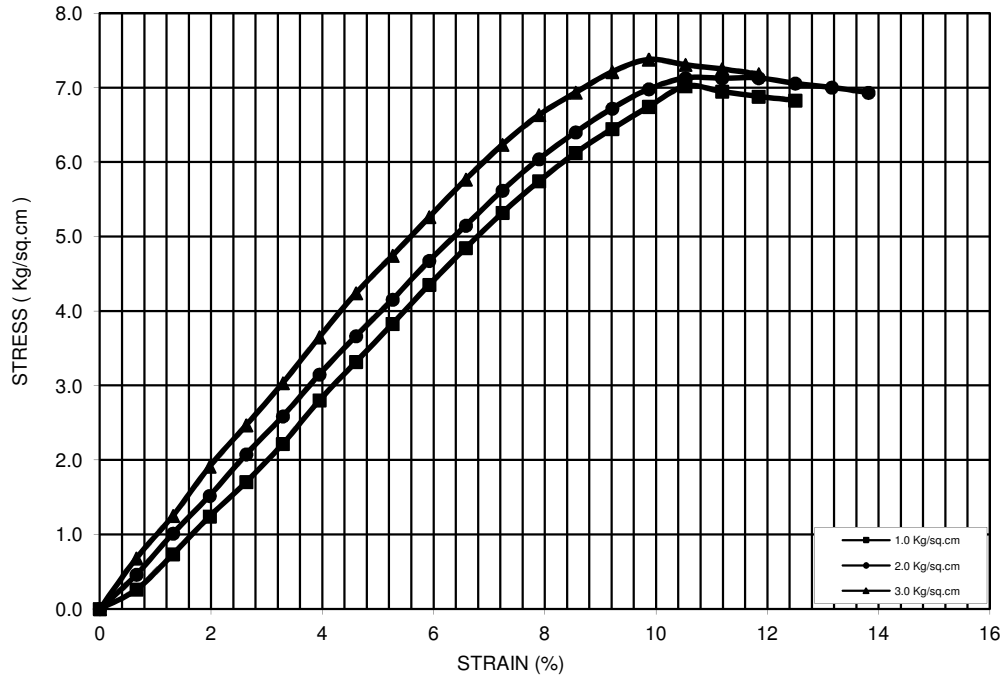
BORE HOLE NO: BH-A-1
CHAINAGE :3+497.7
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.85 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



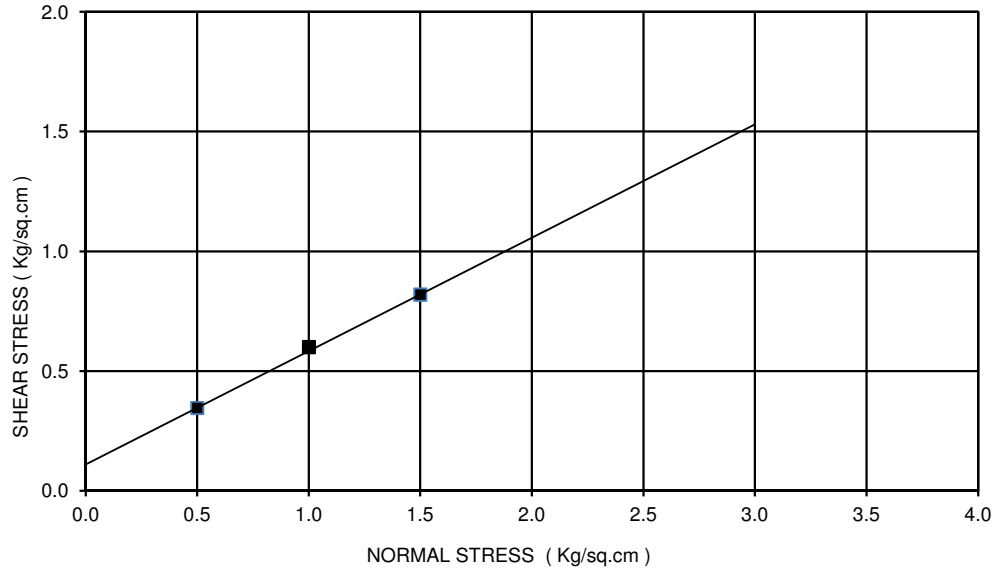


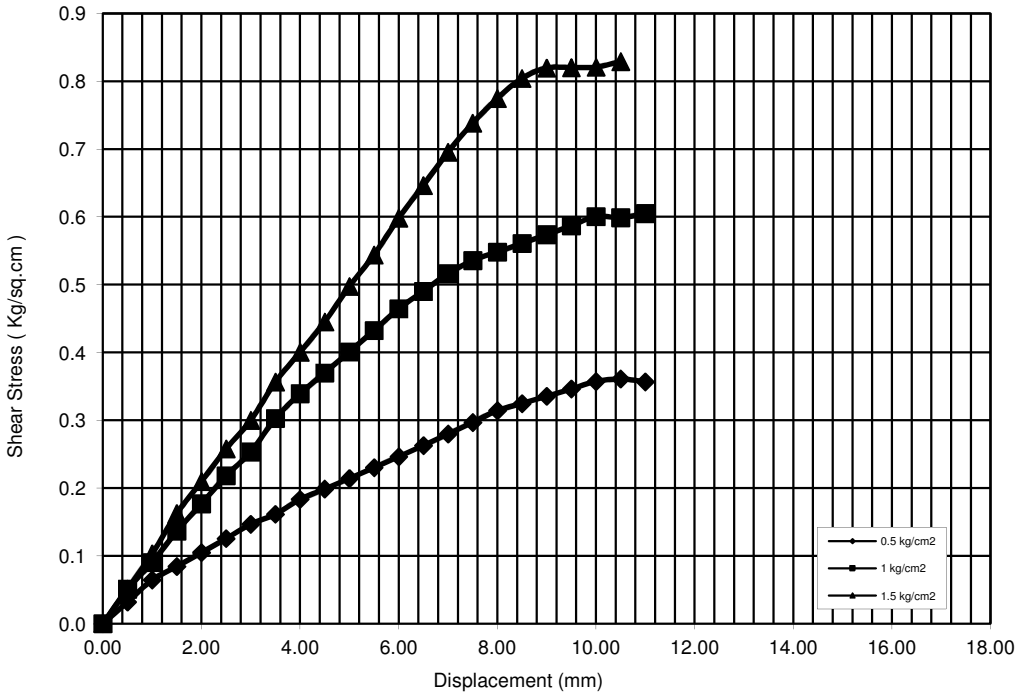
BORE HOLE NO: BH-A-2
CHAINAGE :3+497.7
SAMPLE NO.: UDS-8
DEPTH: 29.50 m
COHESION(C)= 3.15 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



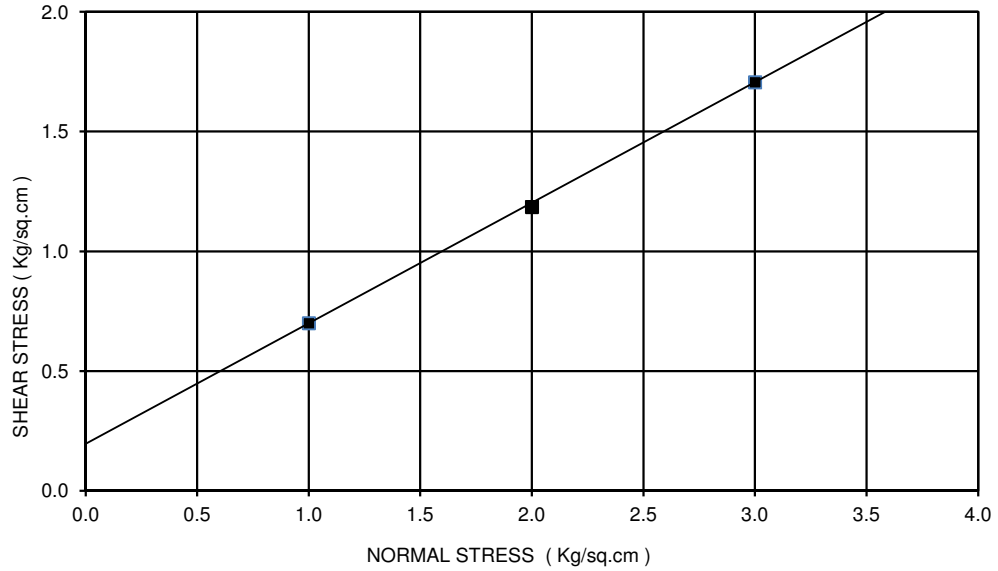


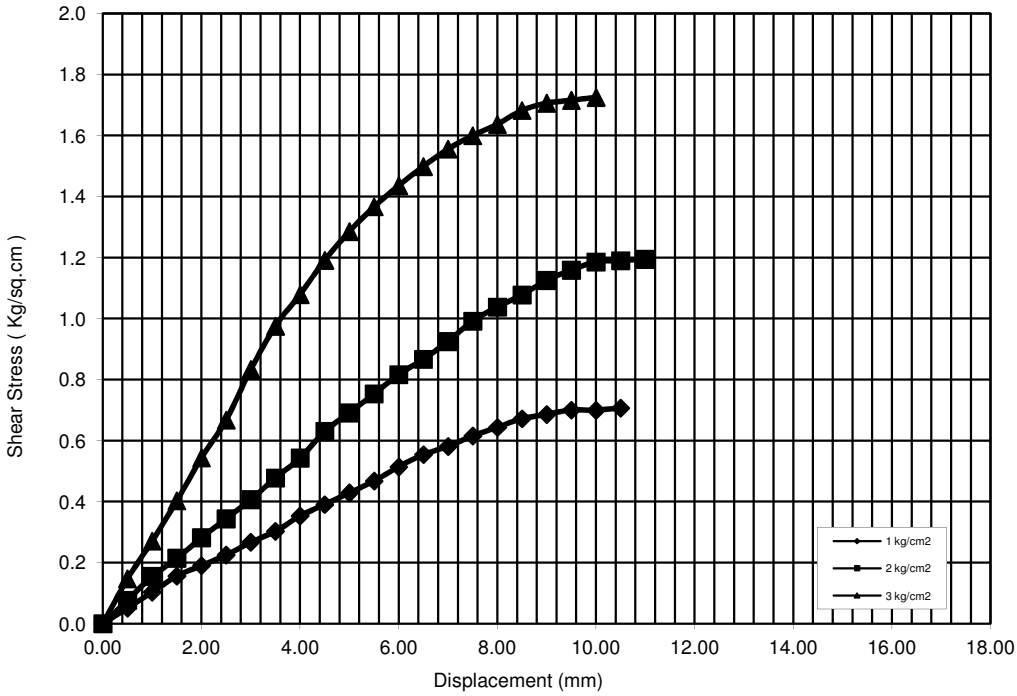
BORE HOLE NO: BH-A-1
CHAINAGE : 3+691 KM
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.11 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



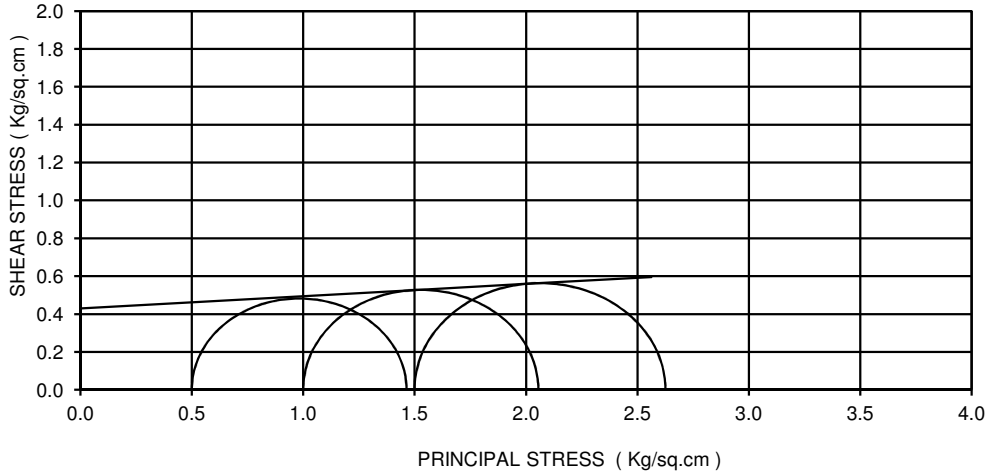


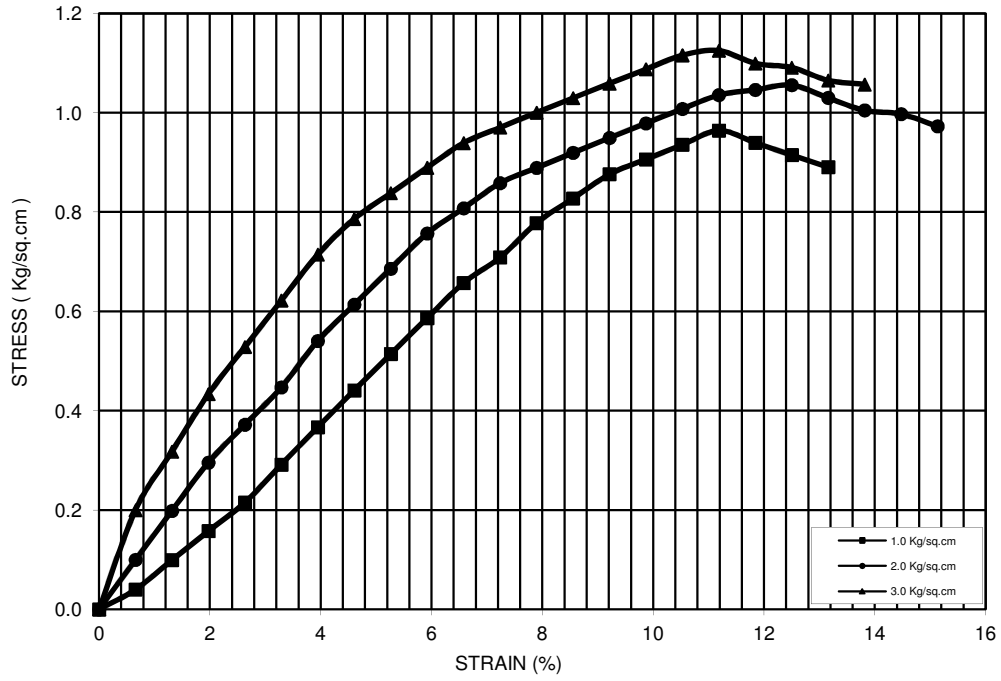
BORE HOLE NO: BH-A-1
CHAINAGE : 3+691KM
SAMPLE NO.: UDS-6
DEPTH: 17.50 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



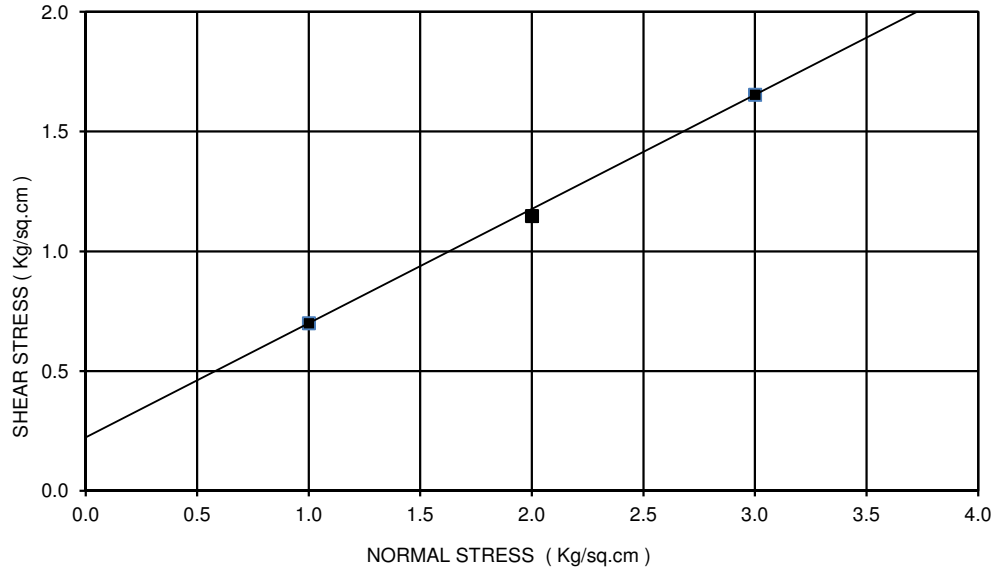


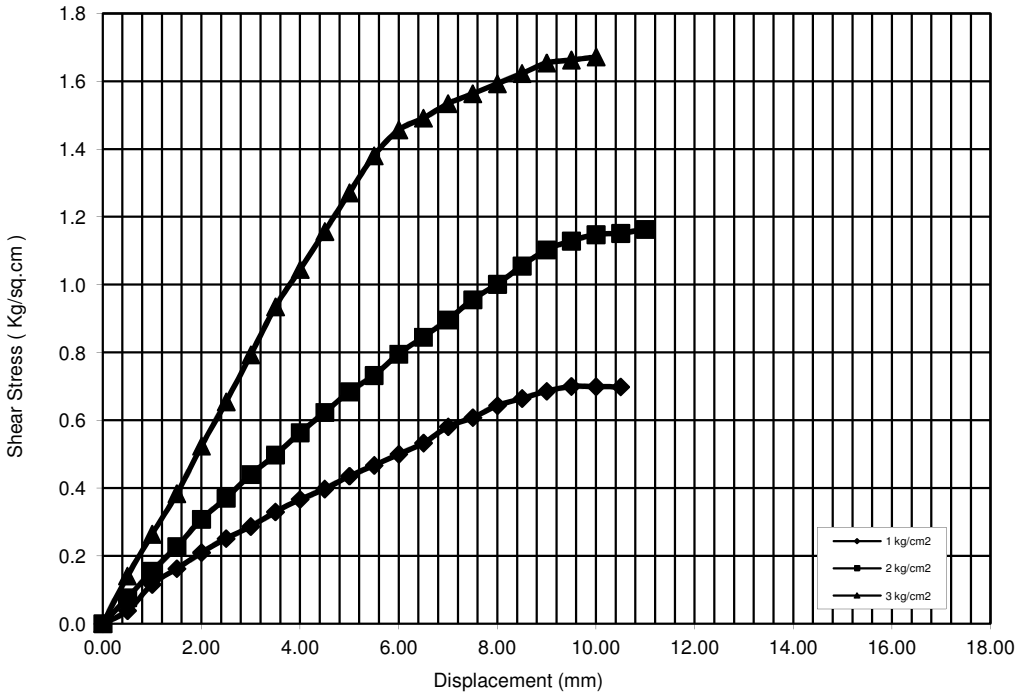
BORE HOLE NO: BH-A-2
CHAINAGE : 3+691 KM
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.43 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



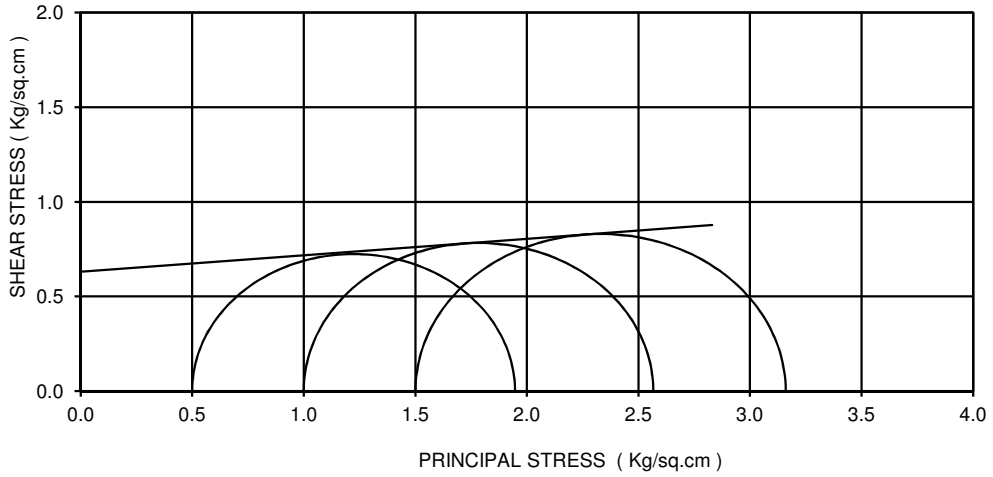


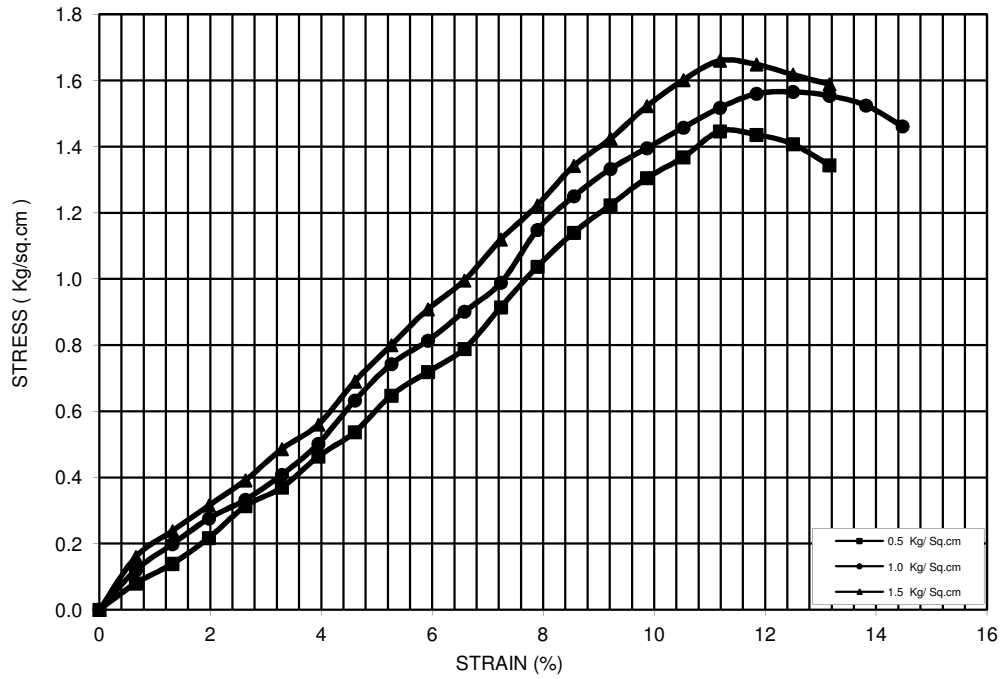
BORE HOLE NO: BH-A-2
CHAINAGE : 3+691 KM
SAMPLE NO.: UDS-7
DEPTH: 19.00 m
COHESION(C)= 0.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



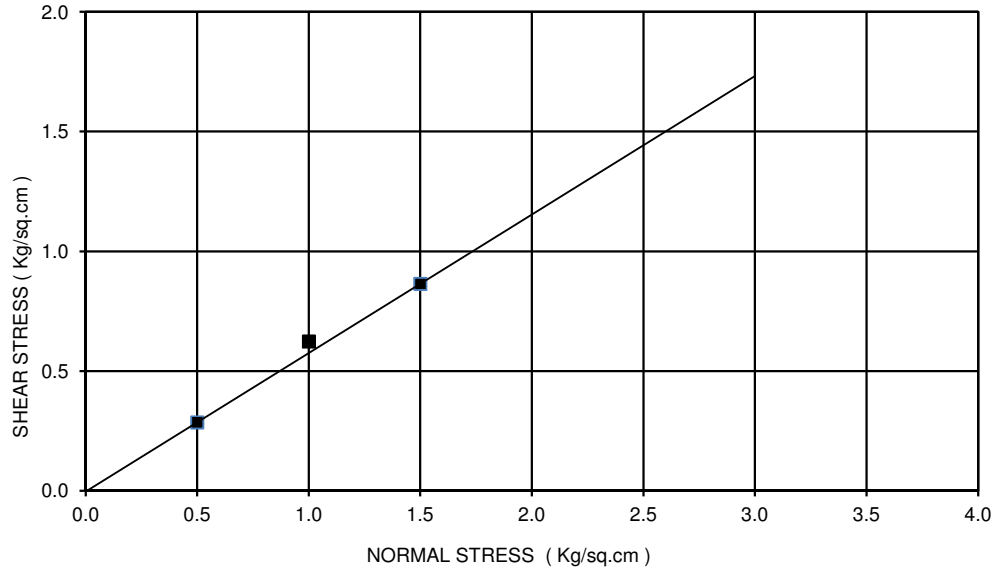


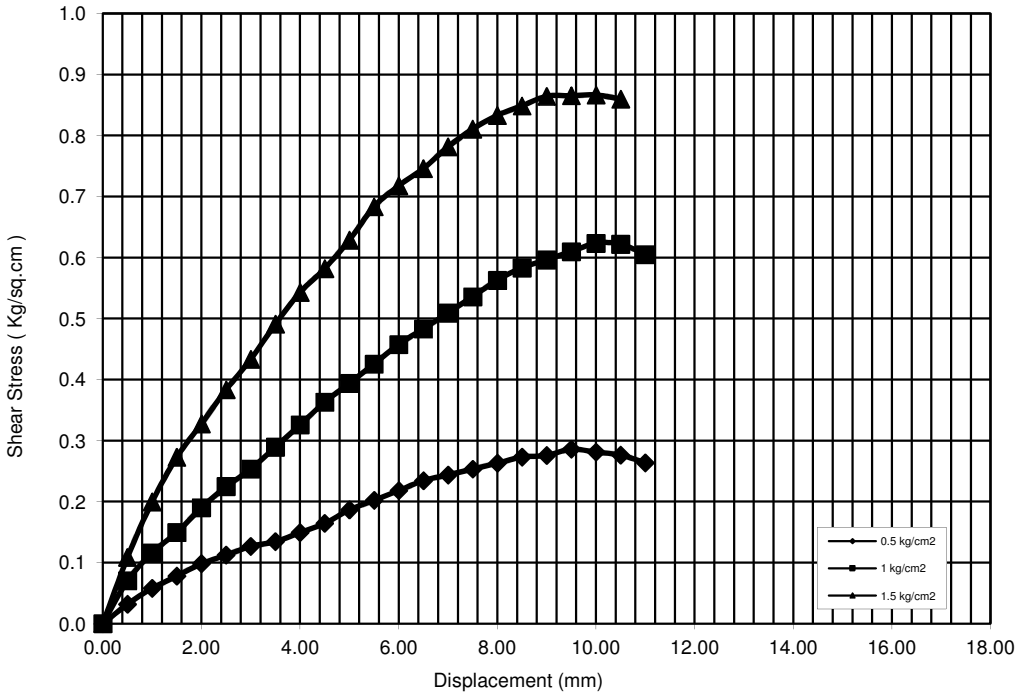
BORE HOLE NO: BH-CL
CHAINAGE : 4+174
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.63 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



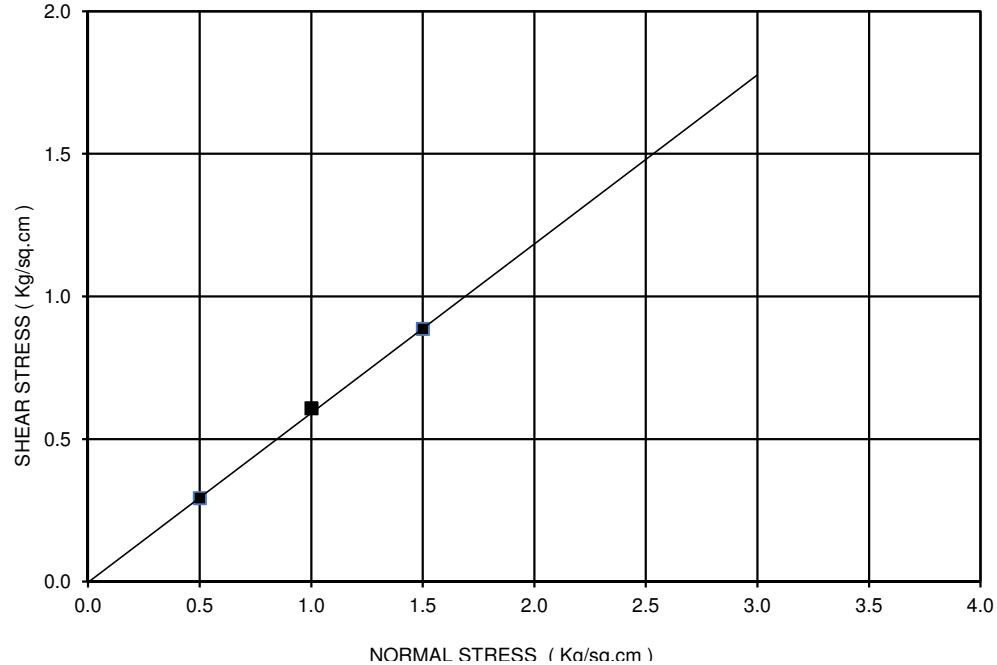


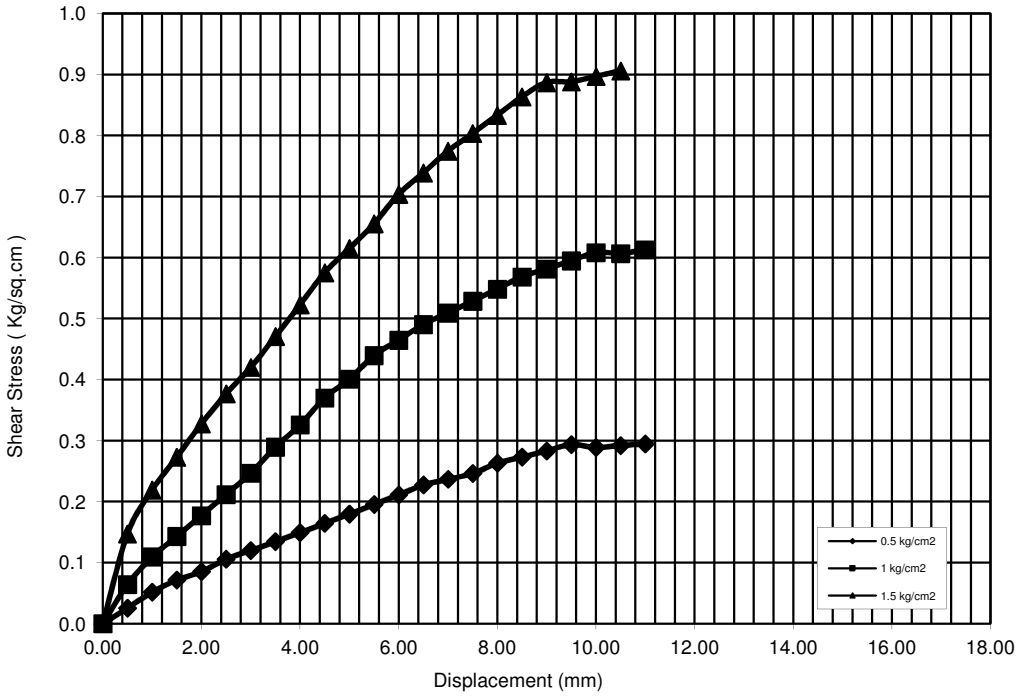
BORE HOLE NO: BH-CL
CHAINAGE : 4+207.23
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



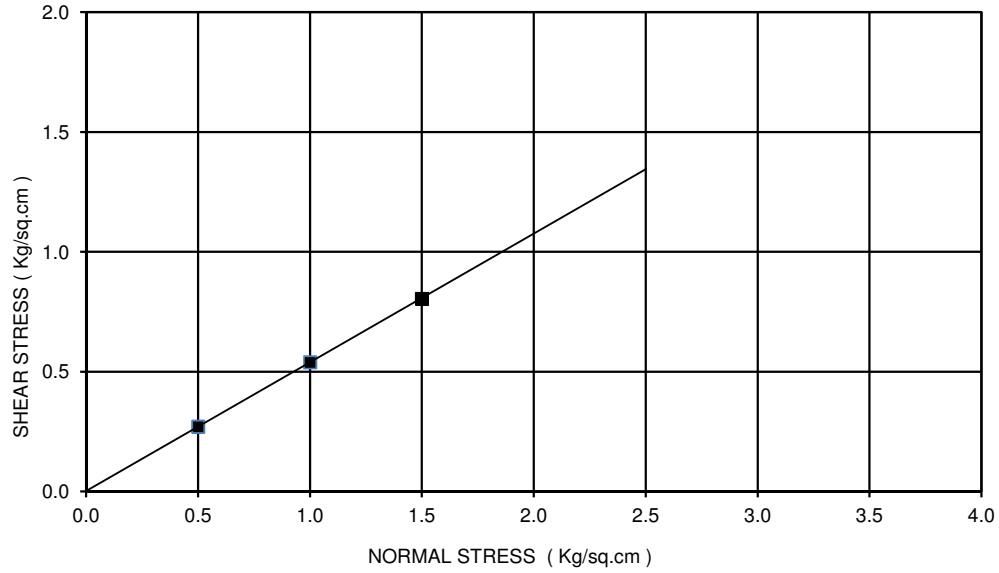


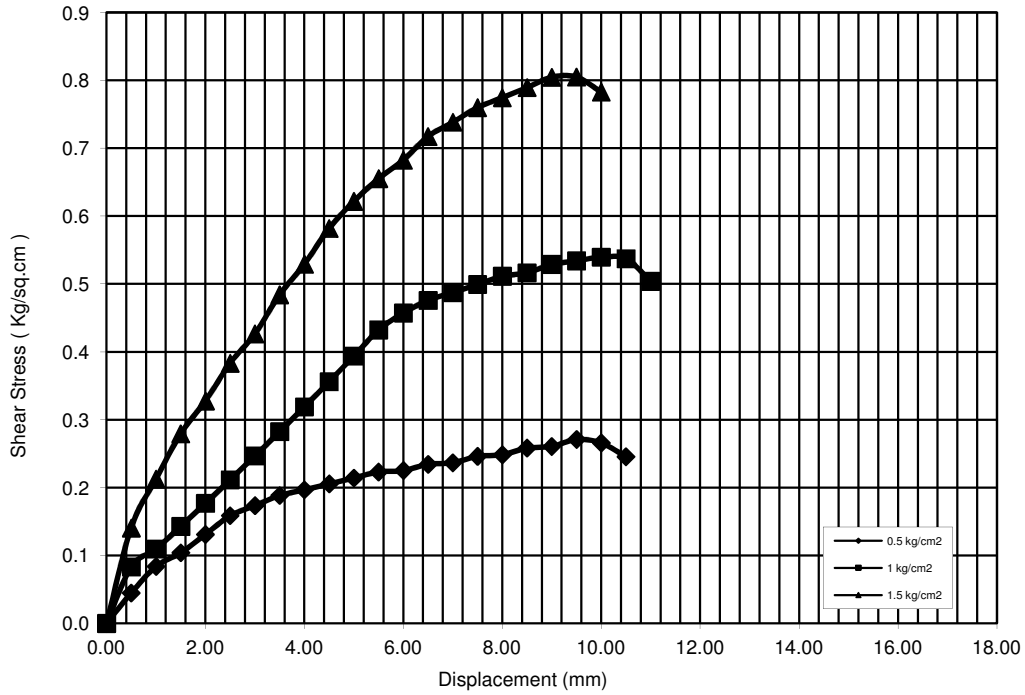
BORE HOLE NO: BH-CL
CHAINAGE : 4+655.51
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 31 deg
TYPE OF THE TEST: DST



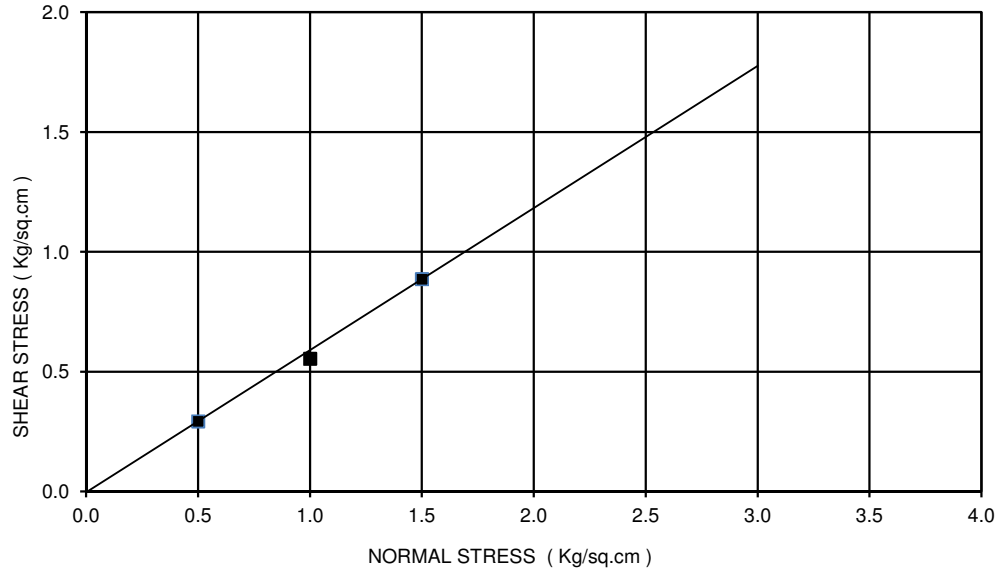


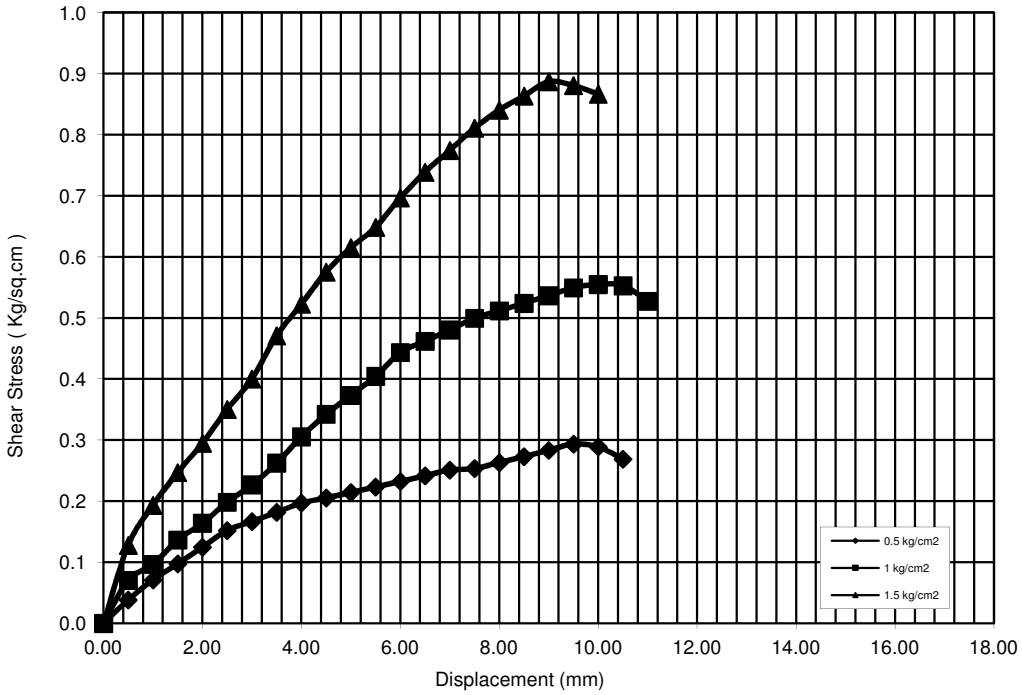
BORE HOLE NO: CL
CHAINAGE : 5+730.2
SAMPLE NO.: UDS-1
DEPTH: 2.5 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 28 deg
TYPE OF THE TEST: DST



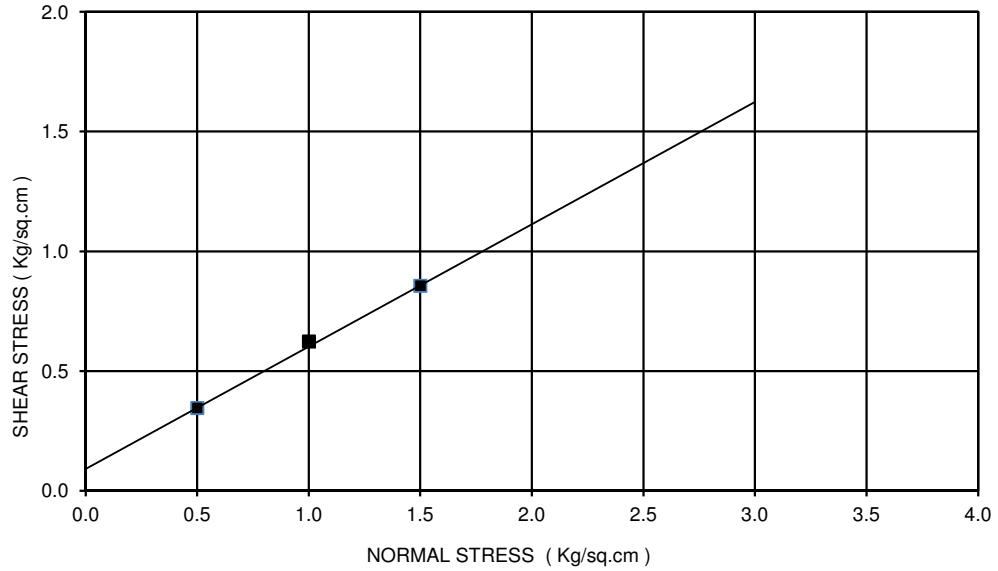


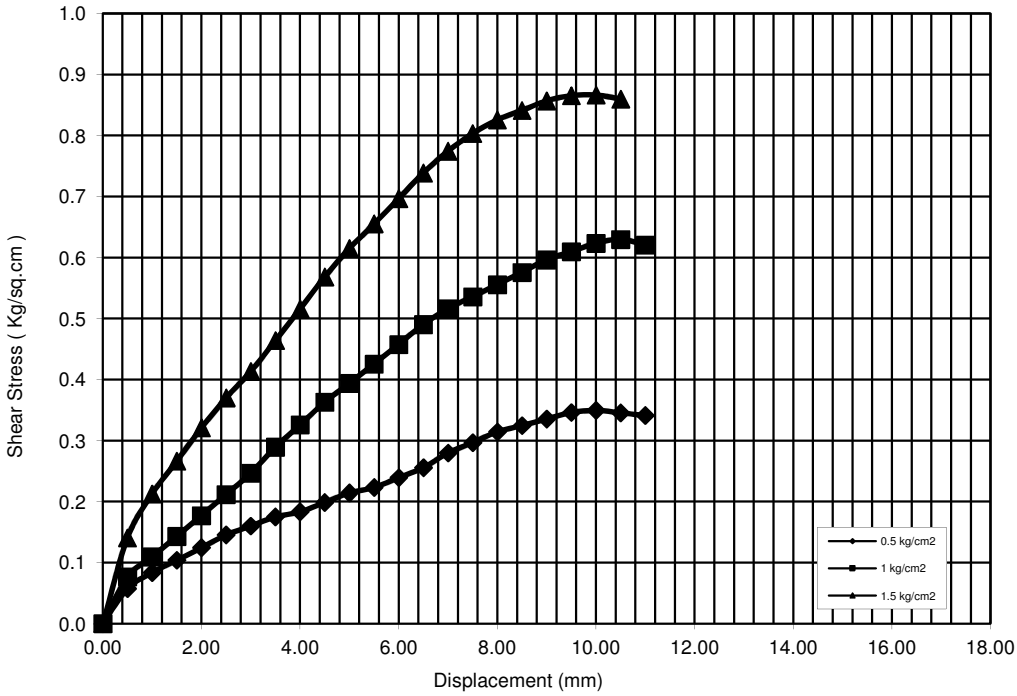
BORE HOLE NO: BH-CL
CHAINAGE : 6+197
SAMPLE NO.: UDS-4
DEPTH: 10.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 31 deg
TYPE OF THE TEST: DST



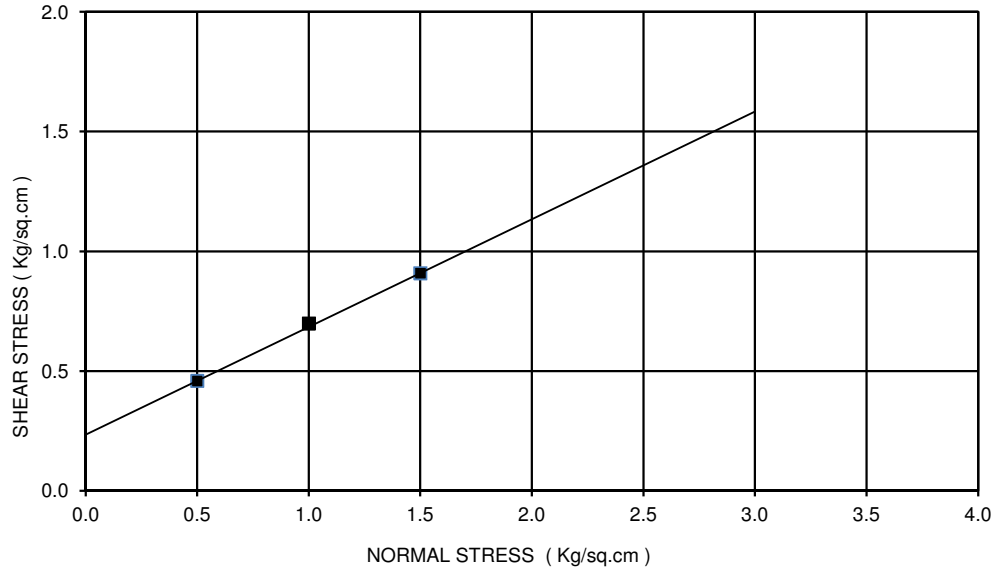


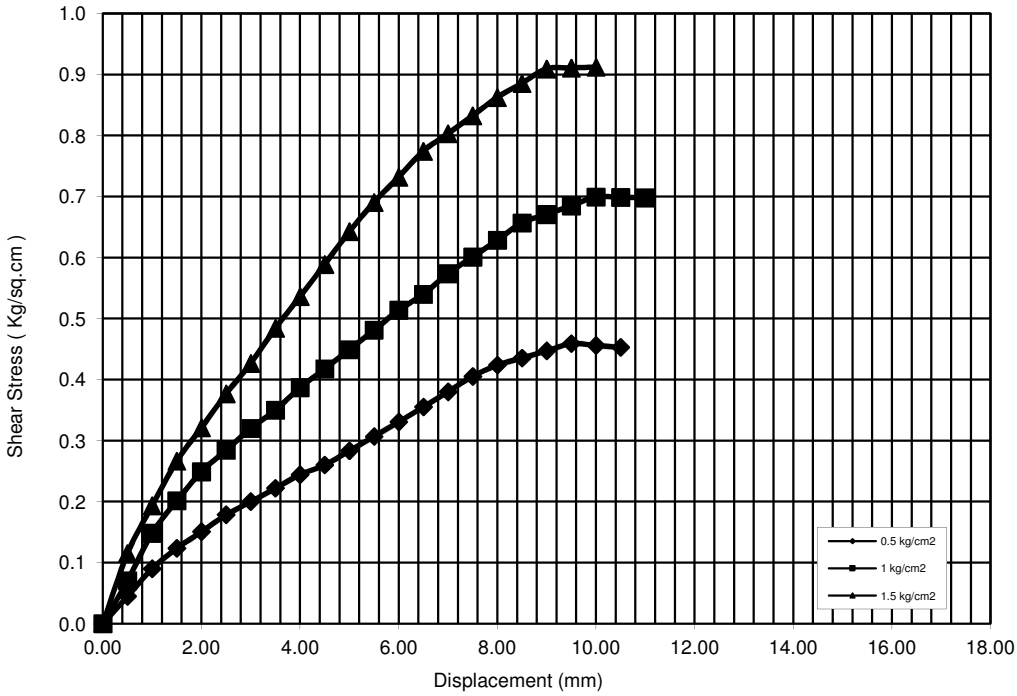
BORE HOLE NO: BH-CL
CHAINAGE :6+877
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



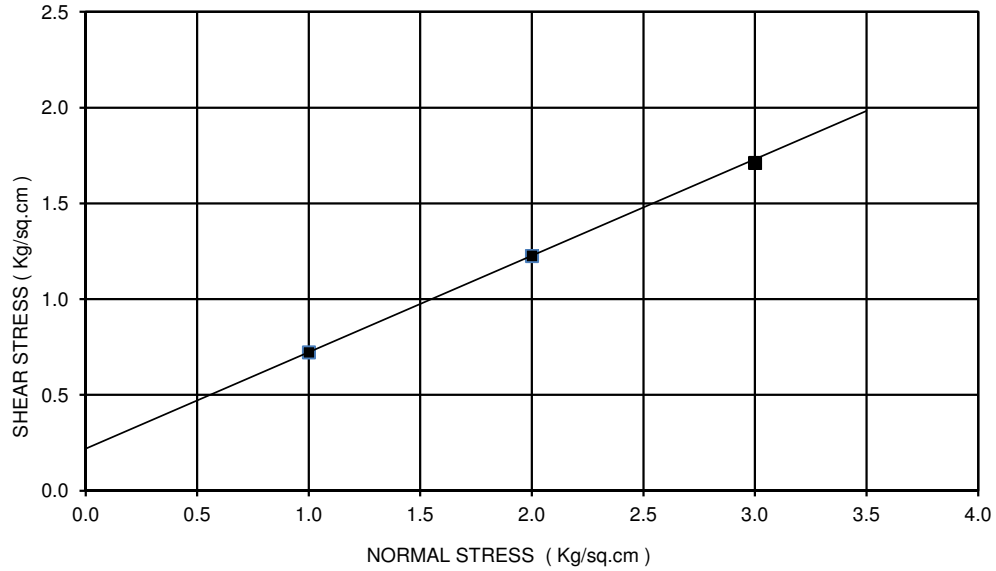


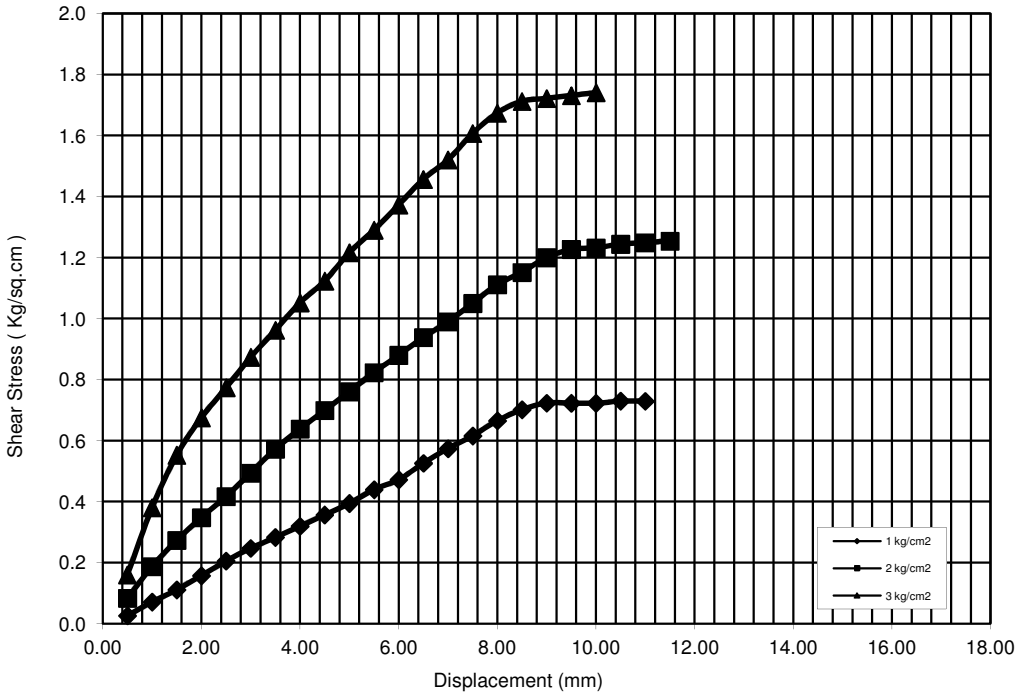
BORE HOLE NO: BH-A-1
CHAINAGE : 7+078 KM
SAMPLE NO.: UDS-3
DEPTH: 10.00 m
COHESION(C)= 0.23 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



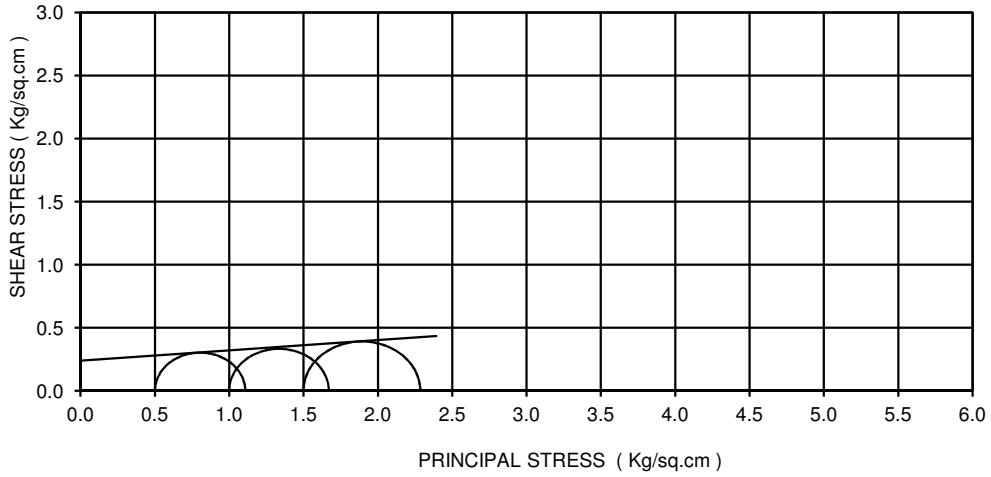


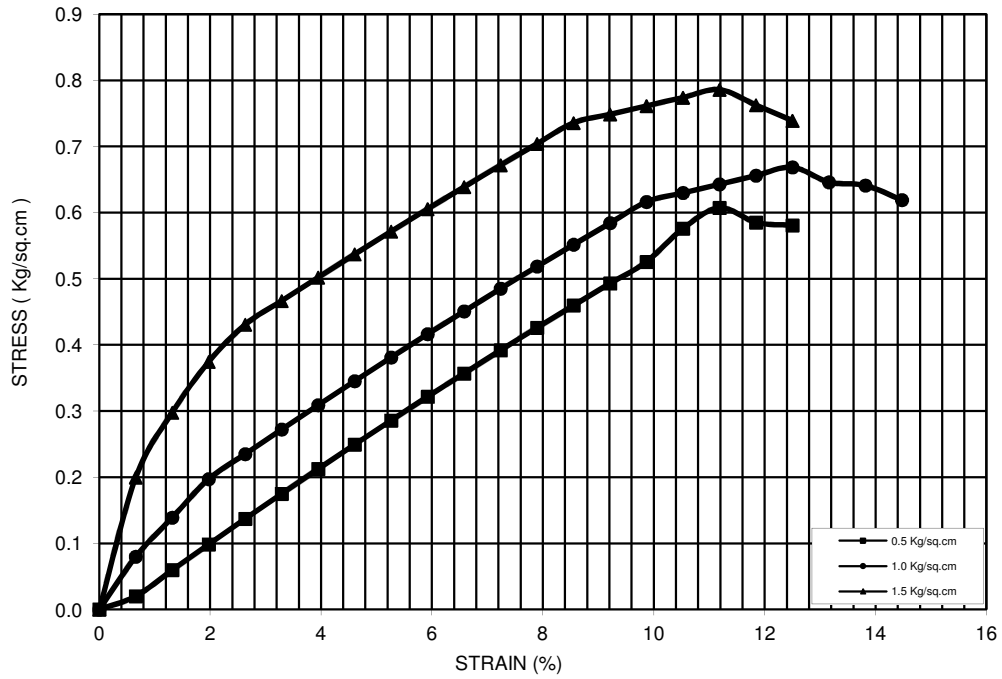
BORE HOLE NO: BH-A-1
CHAINAGE : 7+078 KM
SAMPLE NO.: UDS-5
DEPTH: 16.00 m
COHESION(C)= 0.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



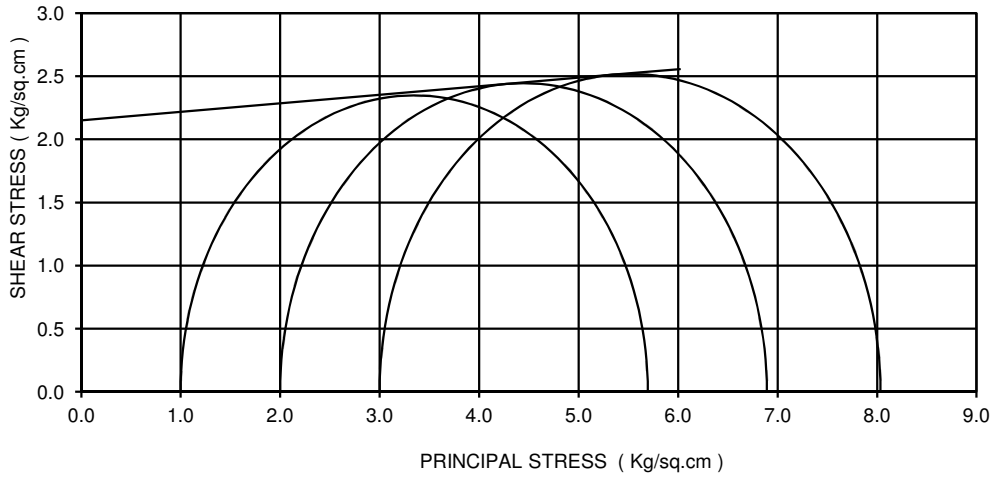


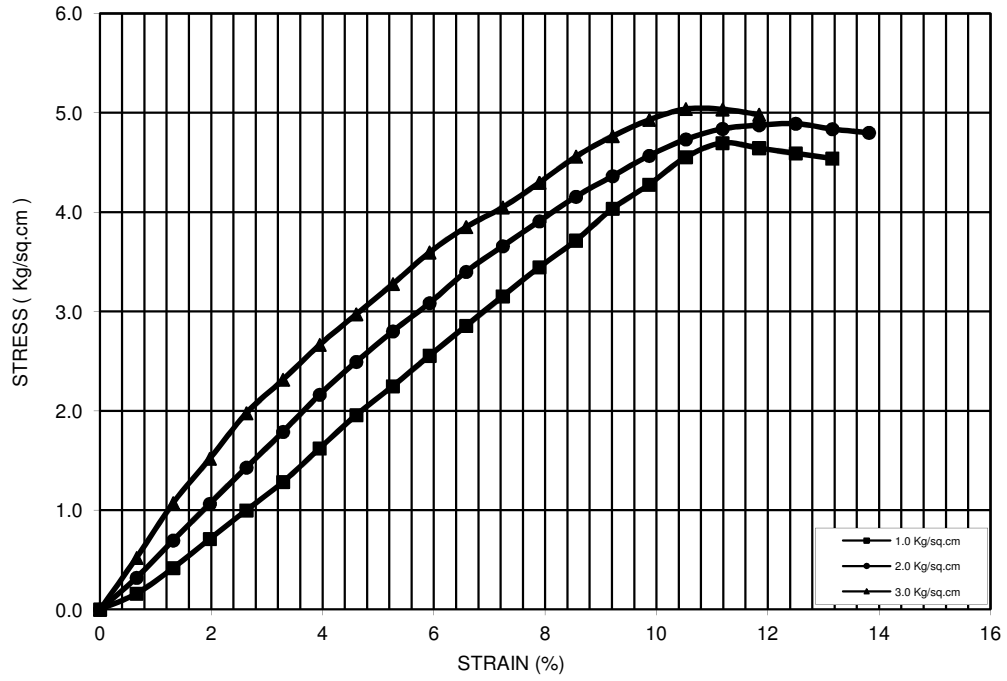
BORE HOLE NO: BH-A-2
CHAINAGE :7+078 KM
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.24 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



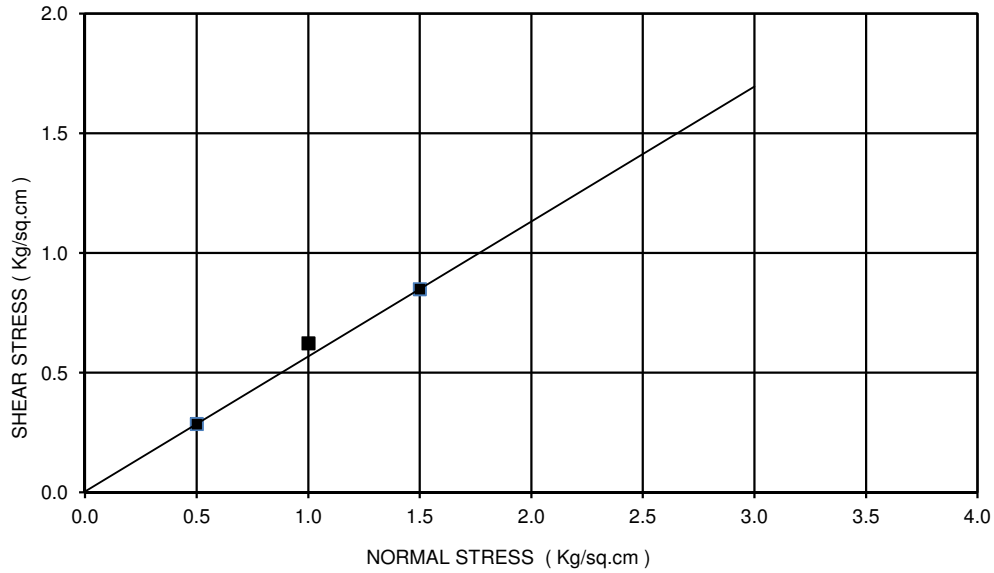


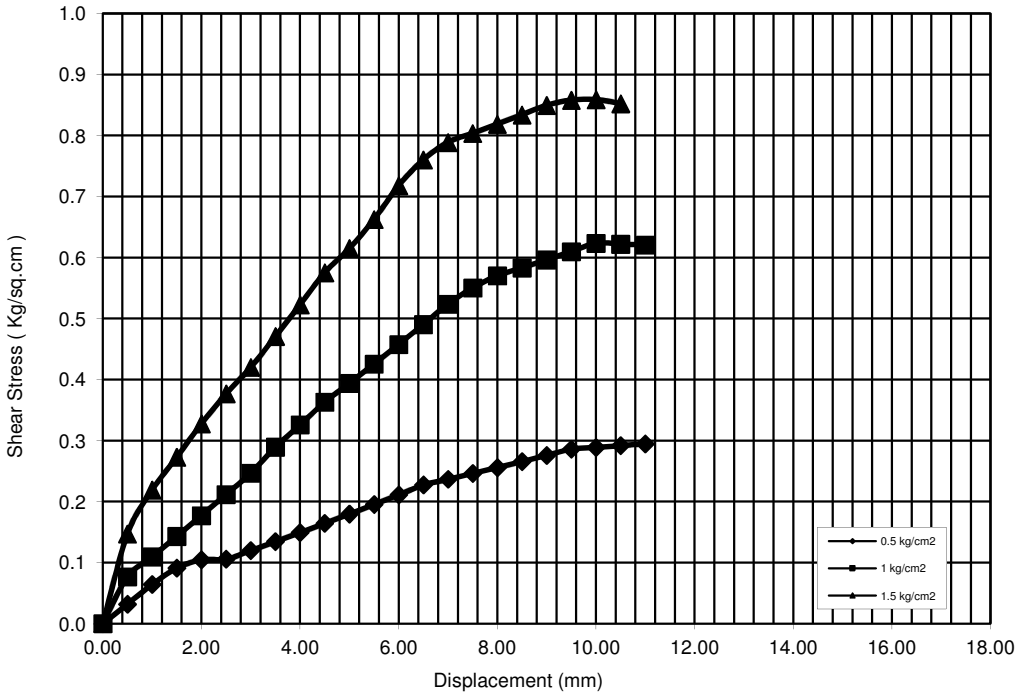
BORE HOLE NO: BH-A-2
CHAINAGE: 7+078 KM
SAMPLE NO.: UDS-5
DEPTH: 23.50 m
COHESION(C)= 2.15 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



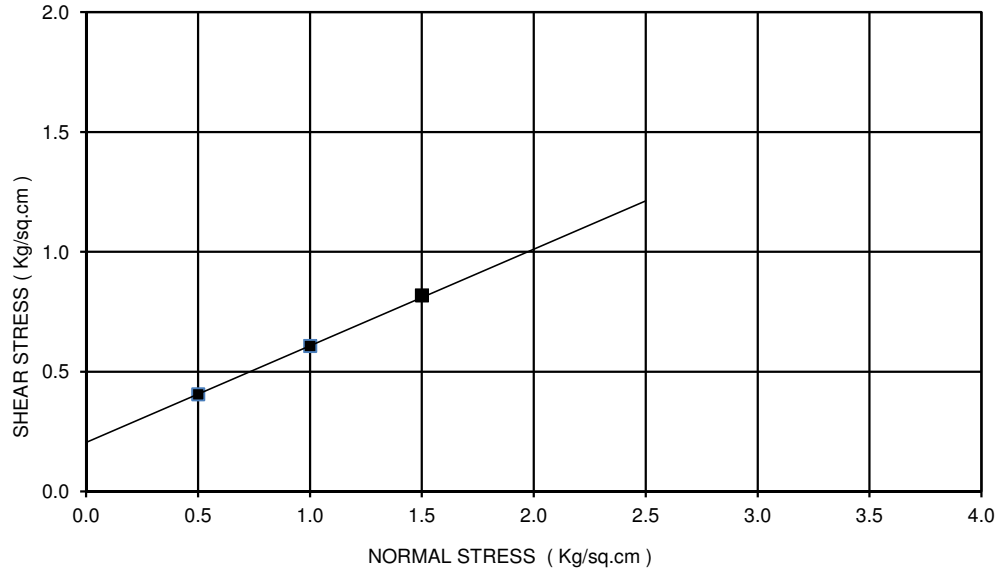


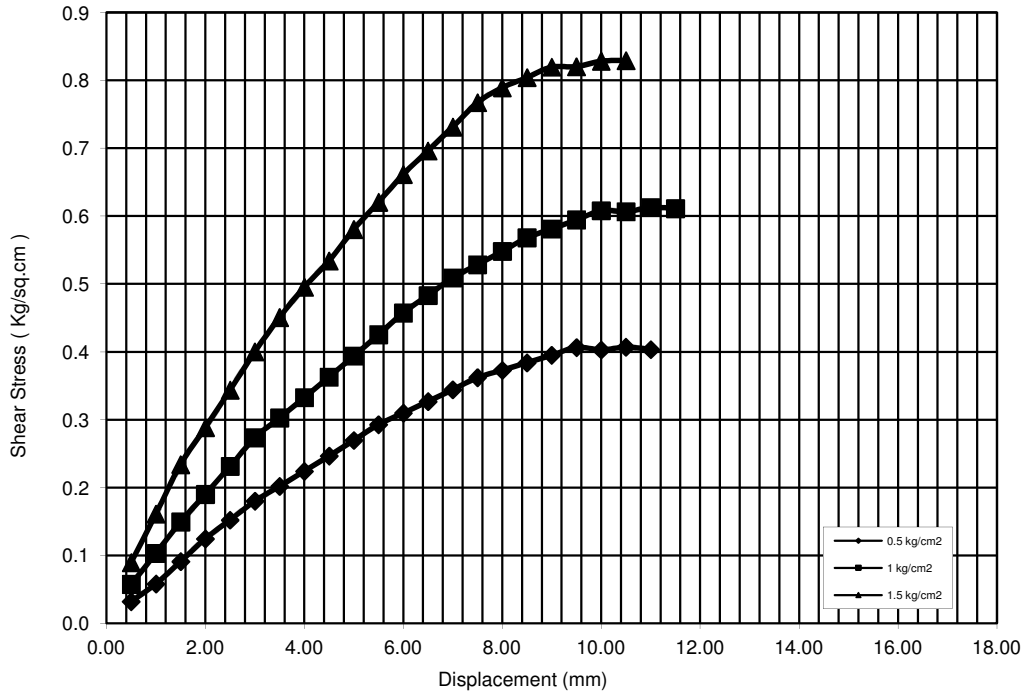
BORE HOLE NO: BH-CL
CHAINAGE : 7+256
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST



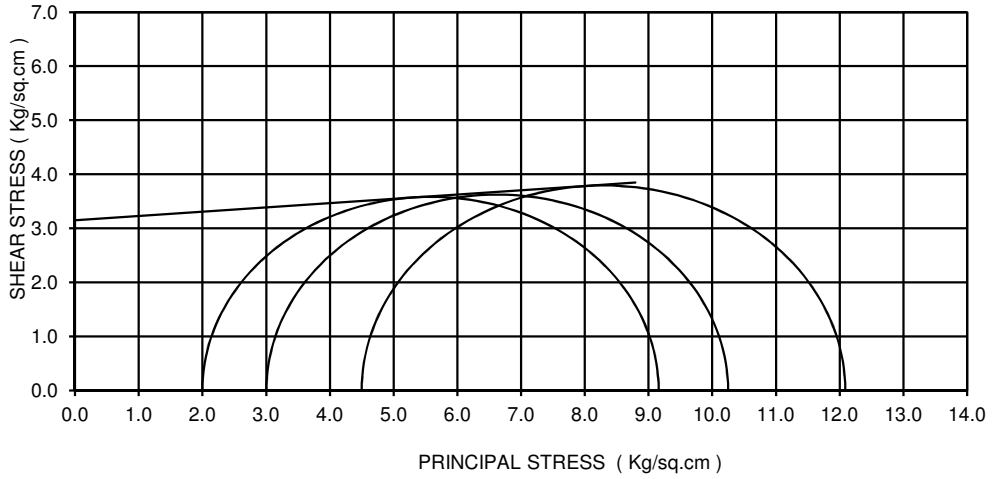


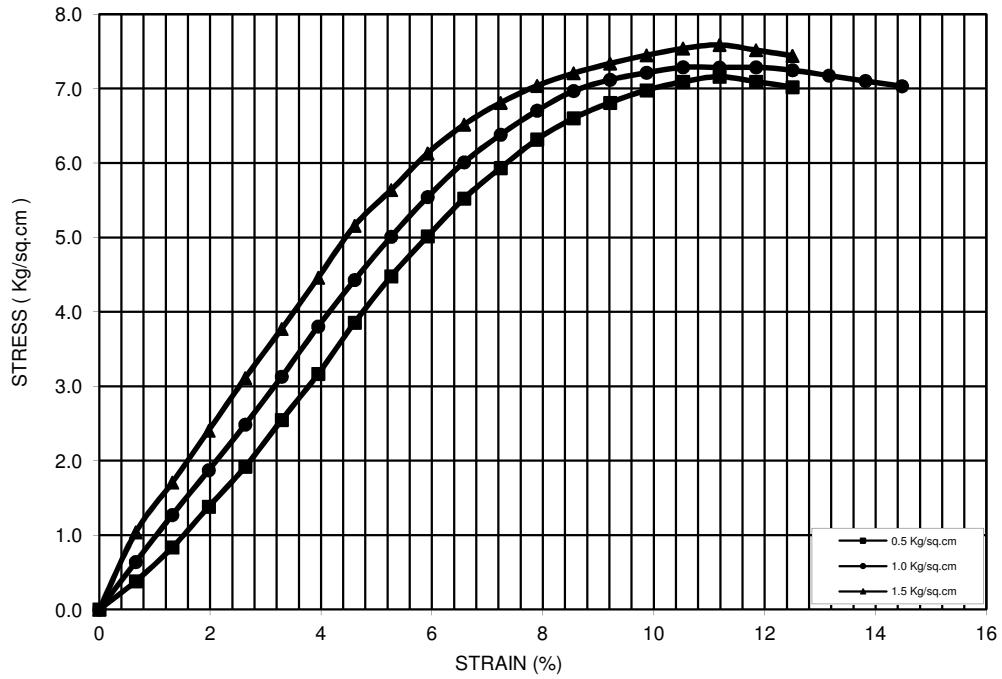
BORE HOLE NO: BH-A-1
CHAIANGE : 7+351
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 22 deg
TYPE OF THE TEST: DST



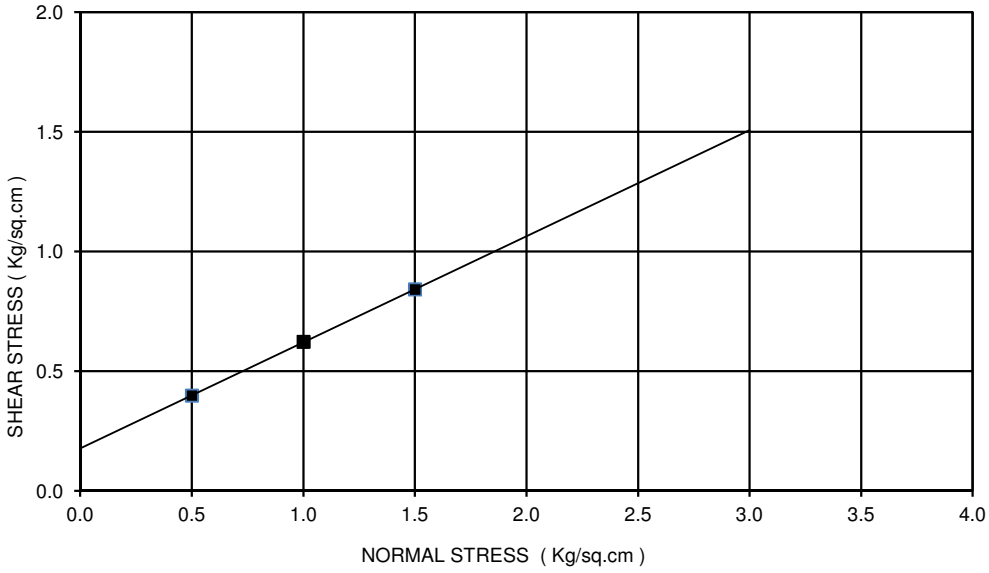


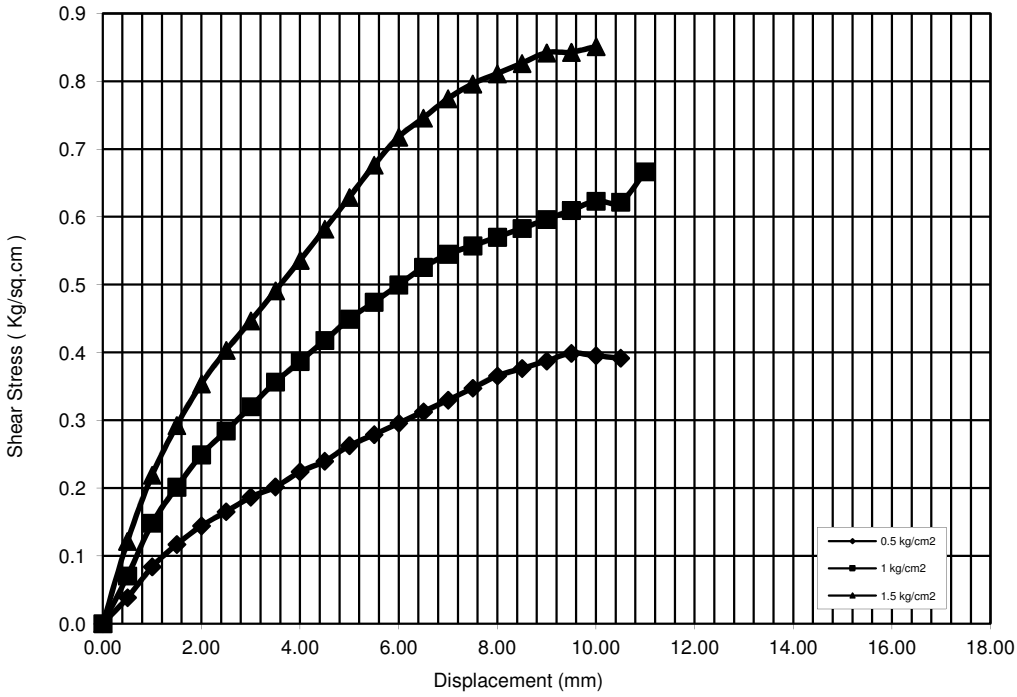
BORE HOLE NO: BH-A-1
CHAINAGE : 7+351
SAMPLE NO.: UDS-10
DEPTH: 35.50 m
COHESION(C)= 3.15 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



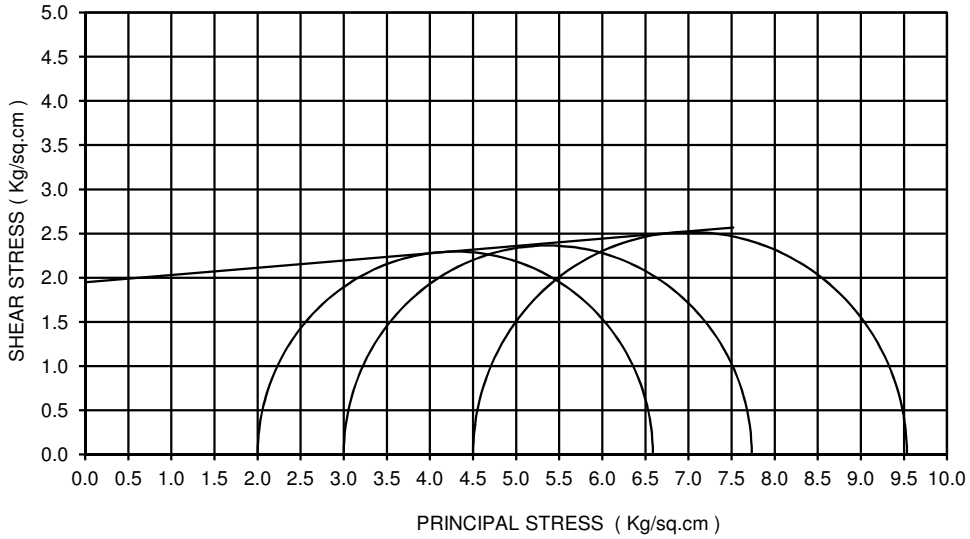


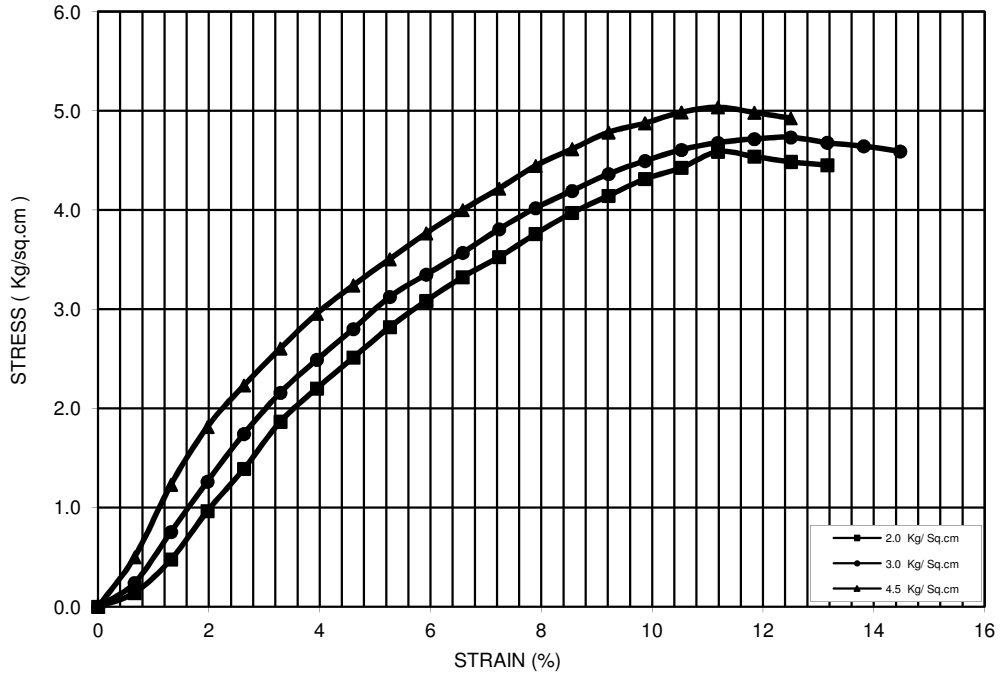
BORE HOLE NO: BH-P-1
CHAIANGE : 7+351
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



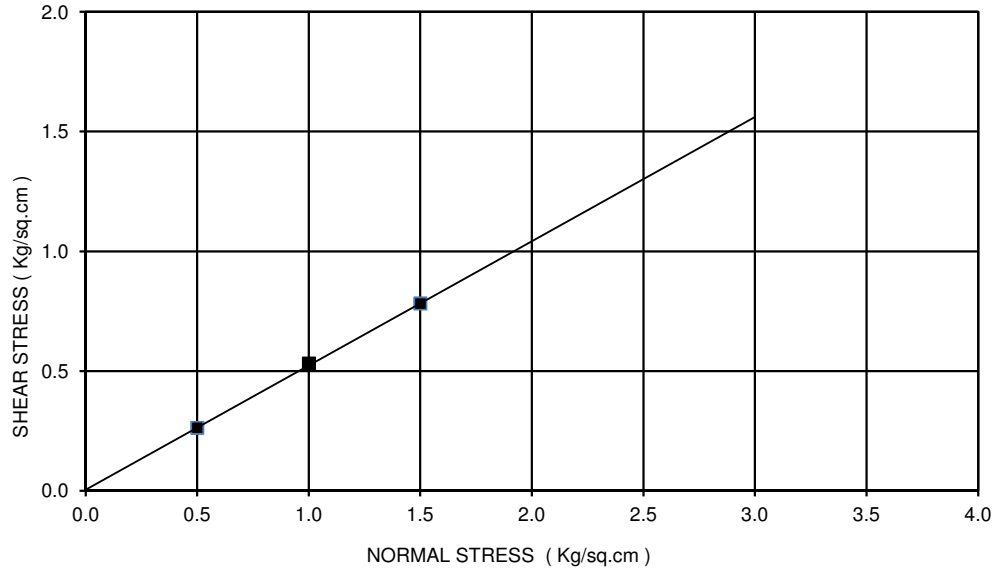


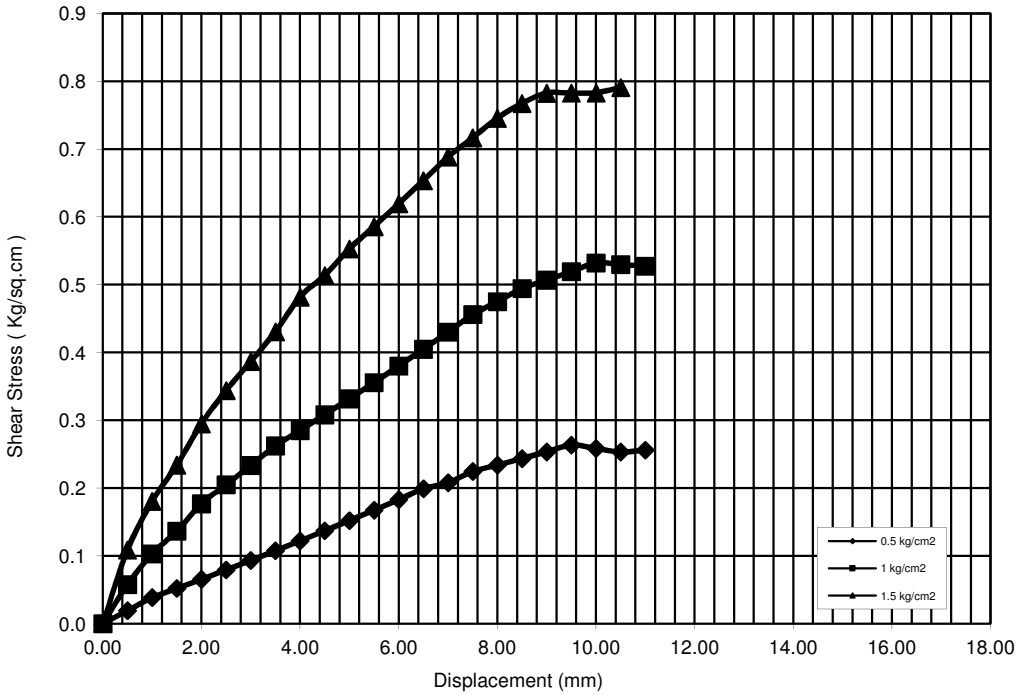
BORE HOLE NO: BH-P-1
CHAIANGE : 7+351
SAMPLE NO.: UDS-10
DEPTH: 31.00 m
COHESION(C)= 1.95 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



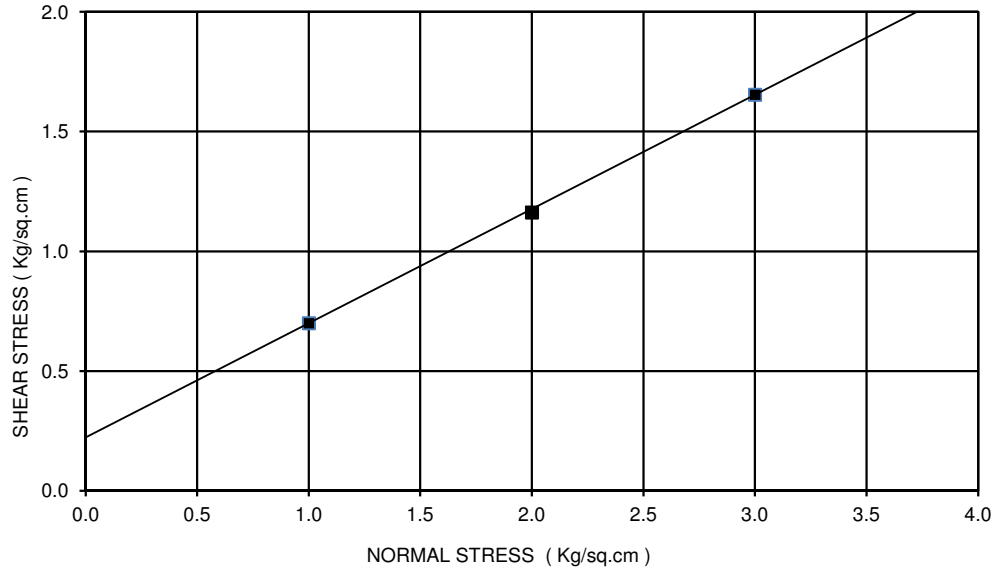


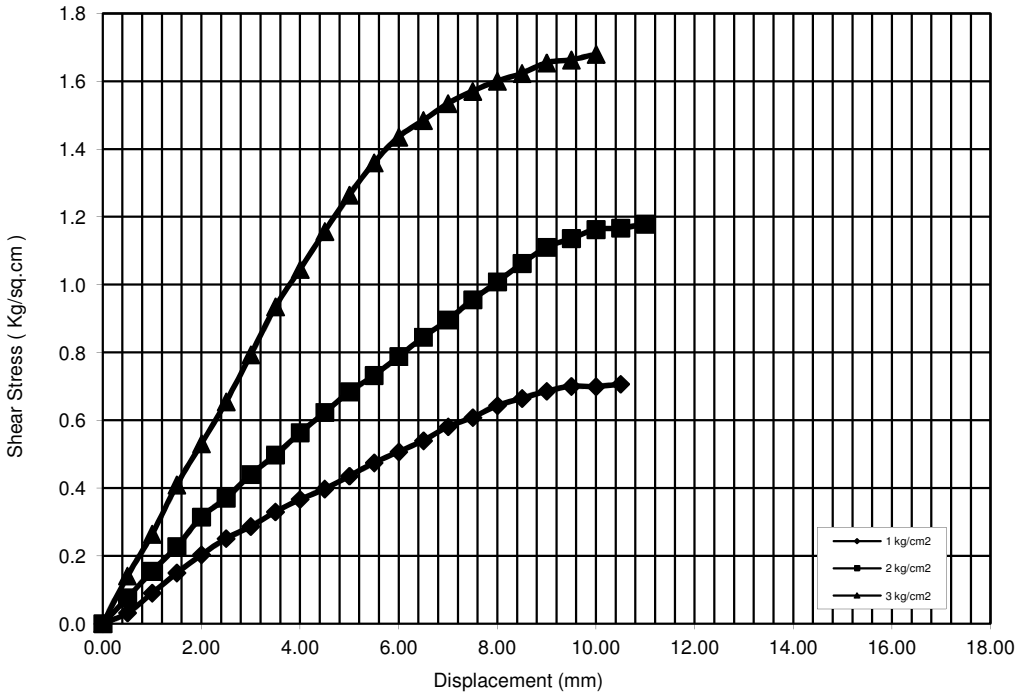
BORE HOLE NO: BH-A-2
CHAIANGE : 7+351
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



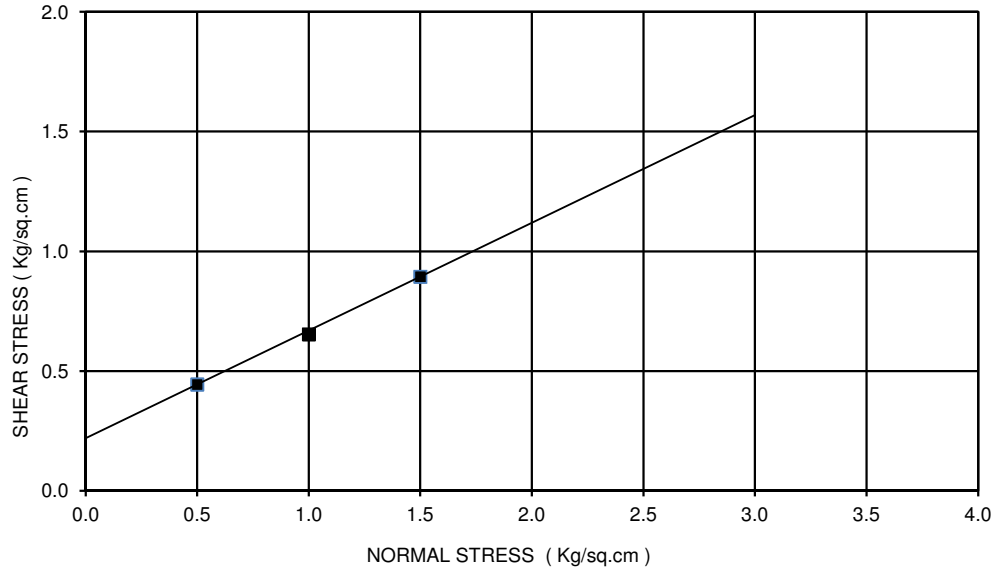


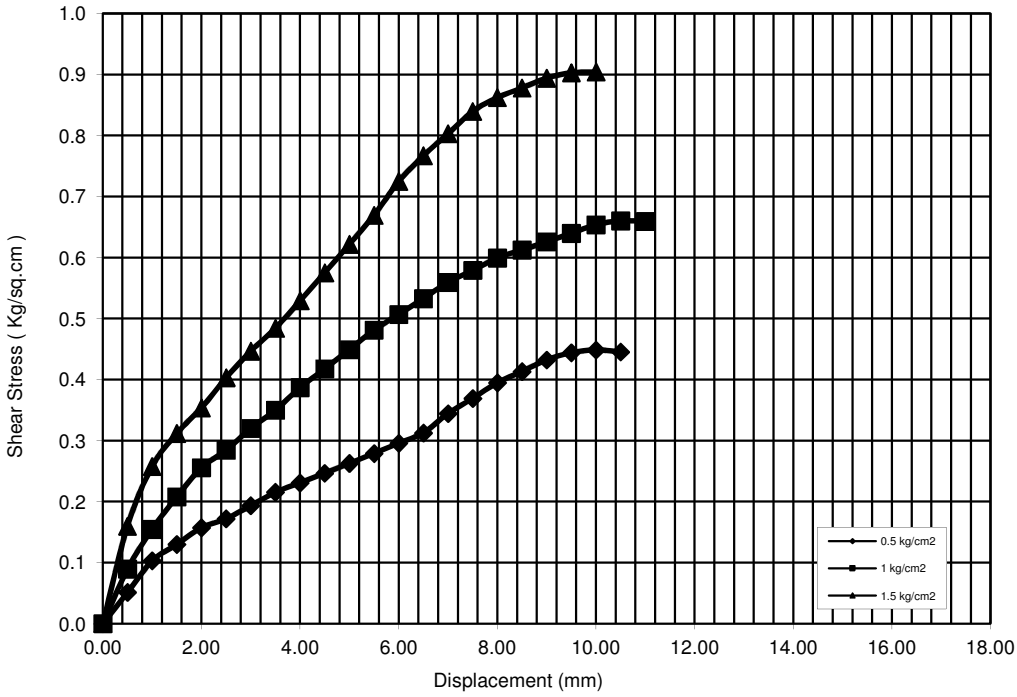
BORE HOLE NO: BH-A-2
CHAIANGE : 7+351
SAMPLE NO.: UDS-5
DEPTH: 14.50 m
COHESION(C)= 0.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



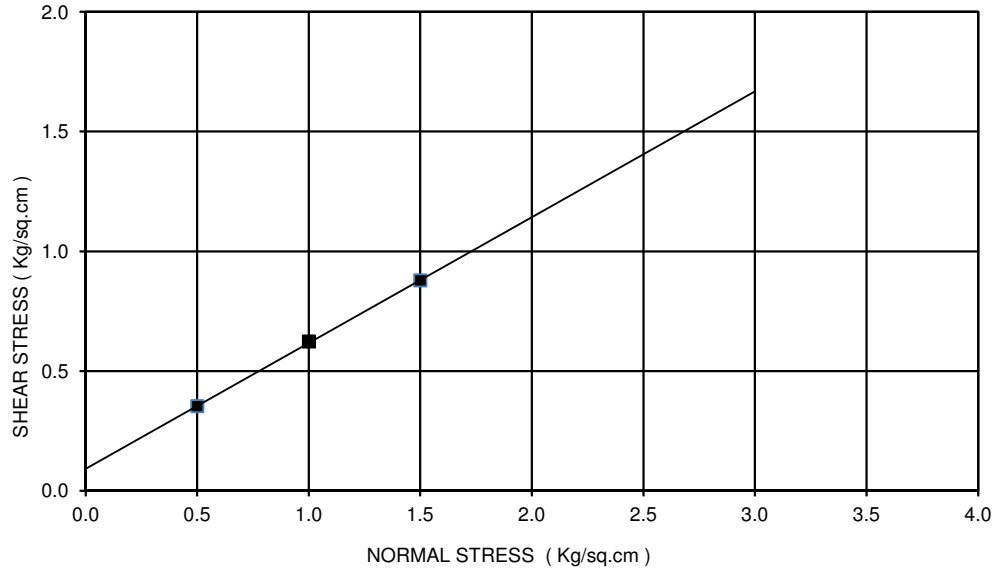


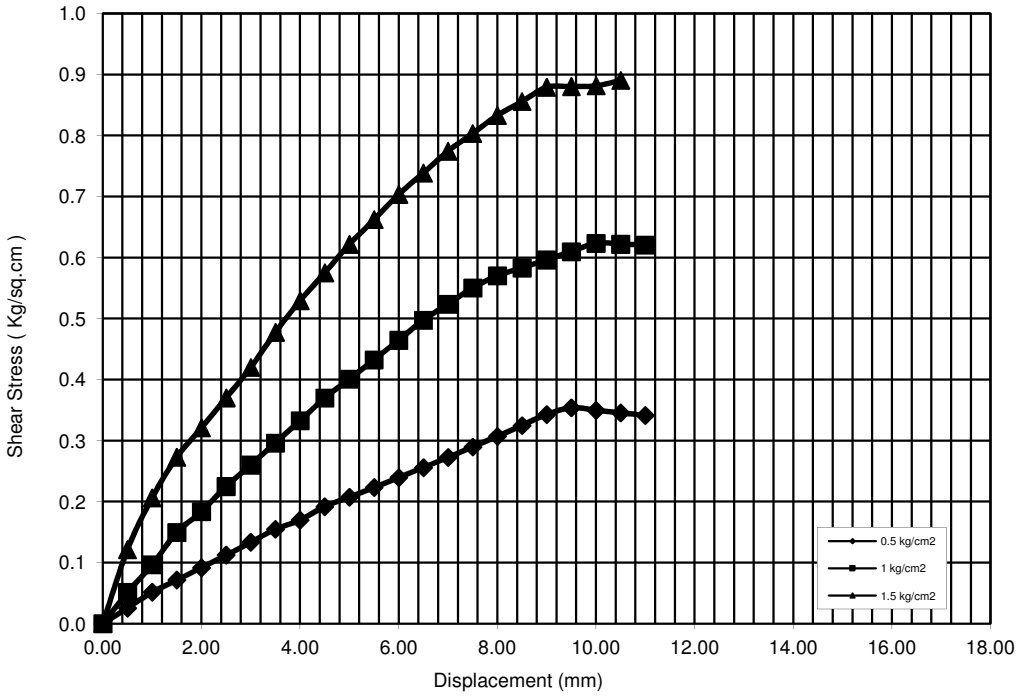
BORE HOLE NO: BH-CL
CHAIANGE : 7+457
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



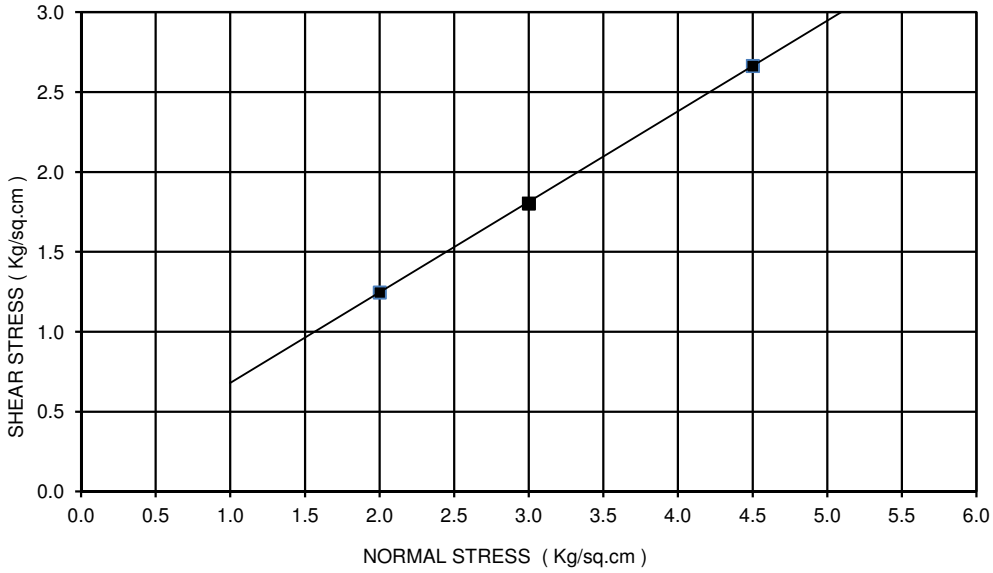


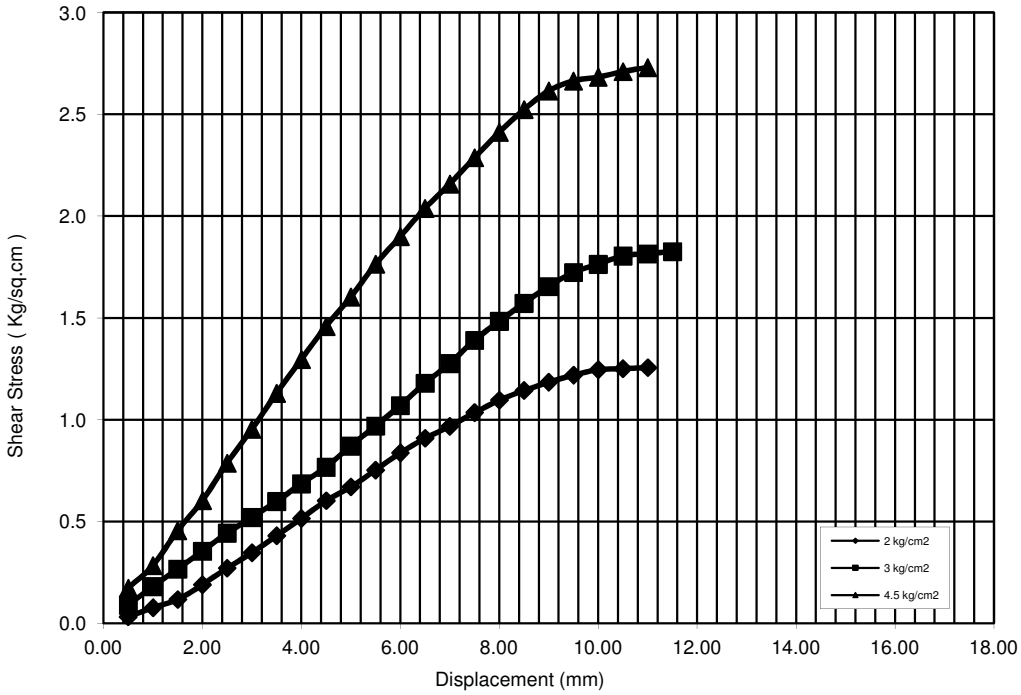
BORE HOLE NO: BH-A-1
CHAIANGE : 7+613
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 28 deg
TYPE OF THE TEST: DST



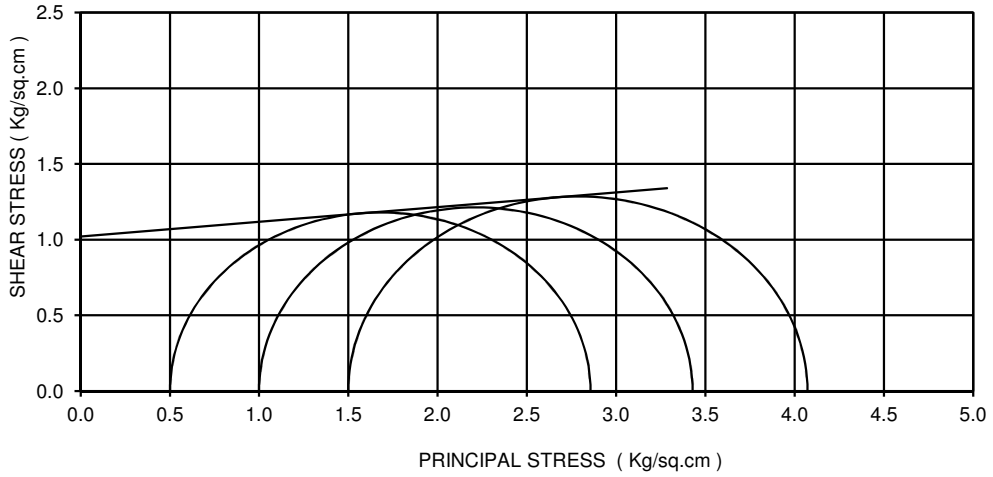


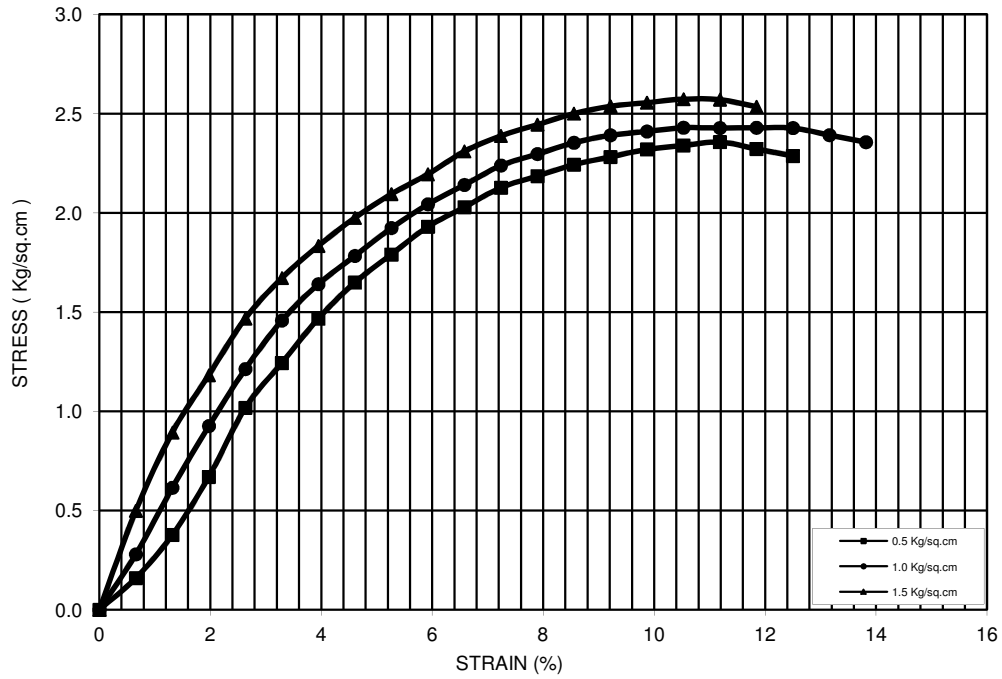
BORE HOLE NO: BH-A-1
CHAIANGE : 7+613
SAMPLE NO.: UDS-10
DEPTH: 32.50 m
COHESION(C)= 0.11 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



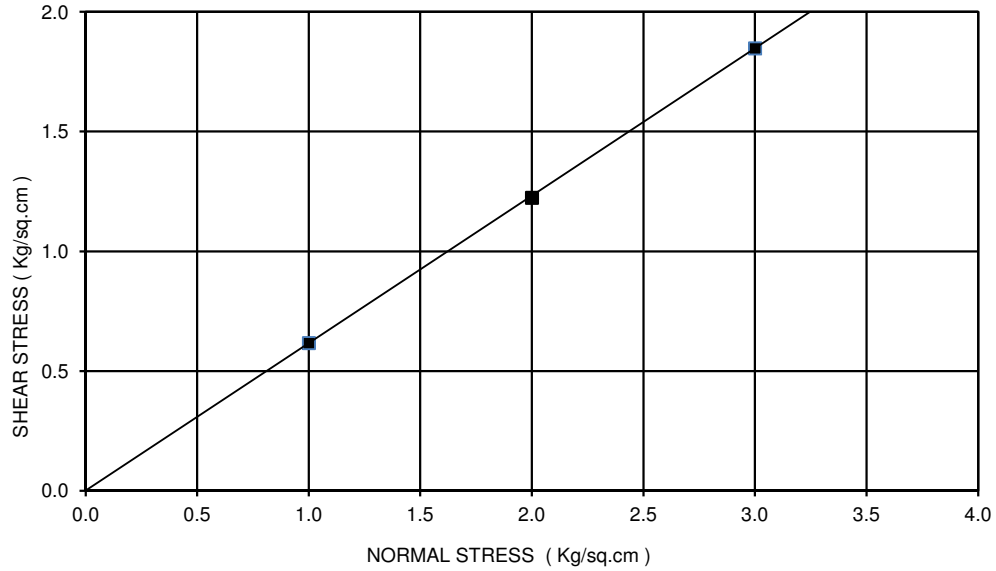


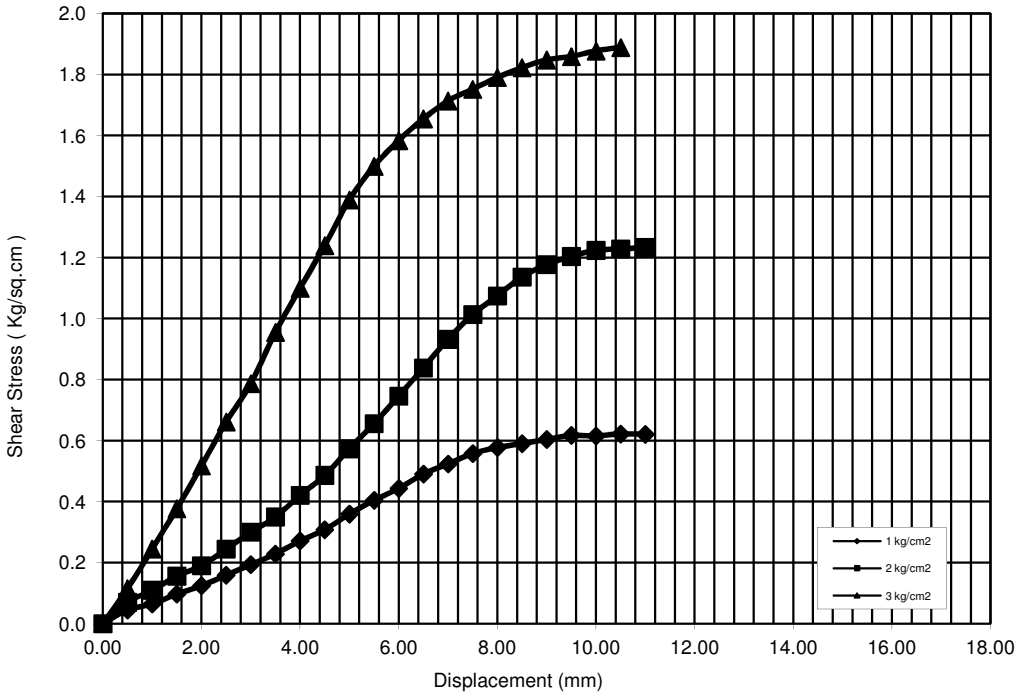
BORE HOLE NO: BH-A-2
CHAIANGE : 7+613
SAMPLE NO.: UDS-3
DEPTH: 7.00 m
COHESION(C)= 1.02 kg/sq.cm
ANGLE OF FRICTION(Phi): 6 deg
TYPE OF THE TEST: UUT



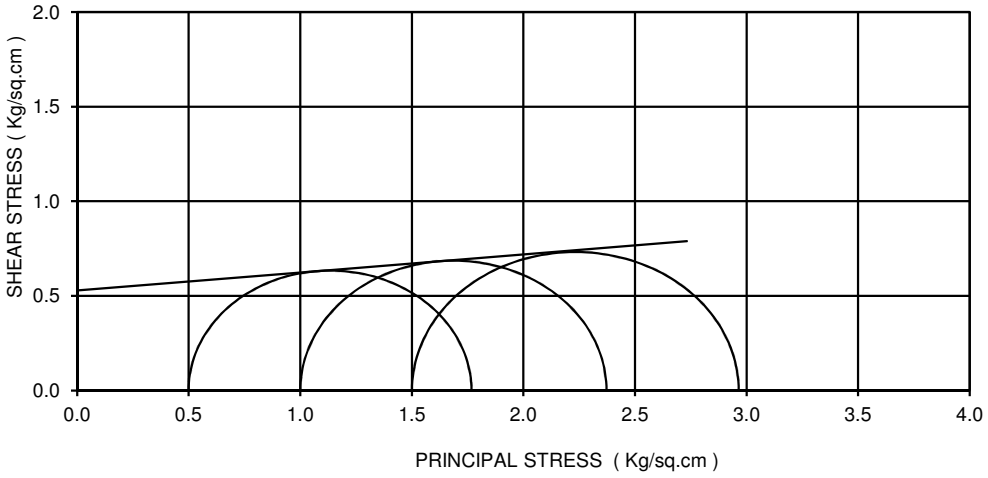


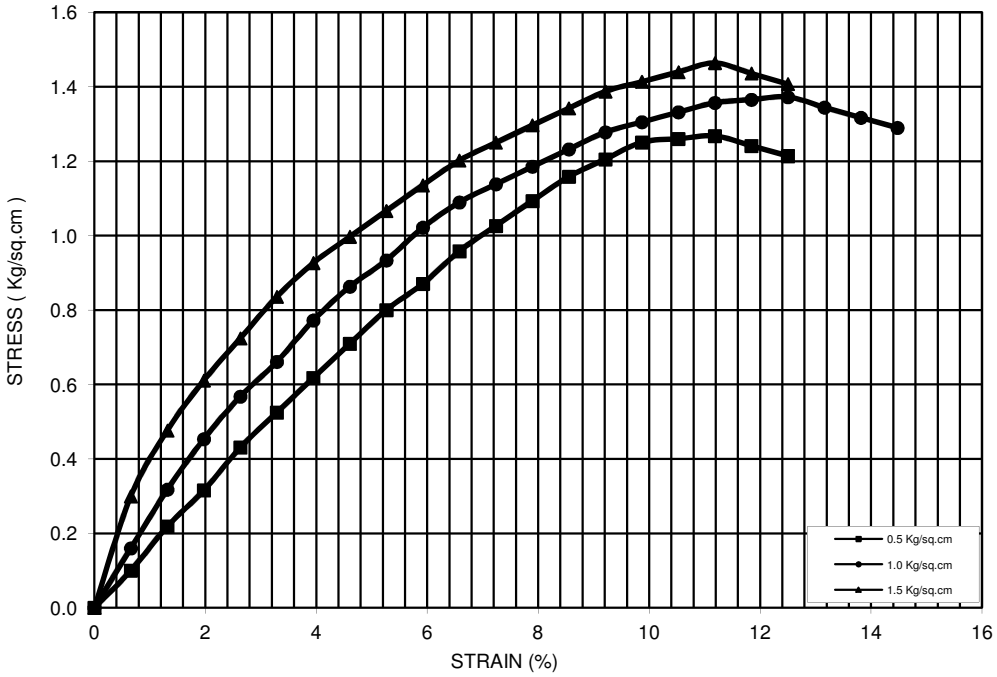
BORE HOLE NO: BH-A-2
CHAIANGE : 7+613
SAMPLE NO.: UDS-7
DEPTH: 19.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi):32 deg
TYPE OF THE TEST: DST



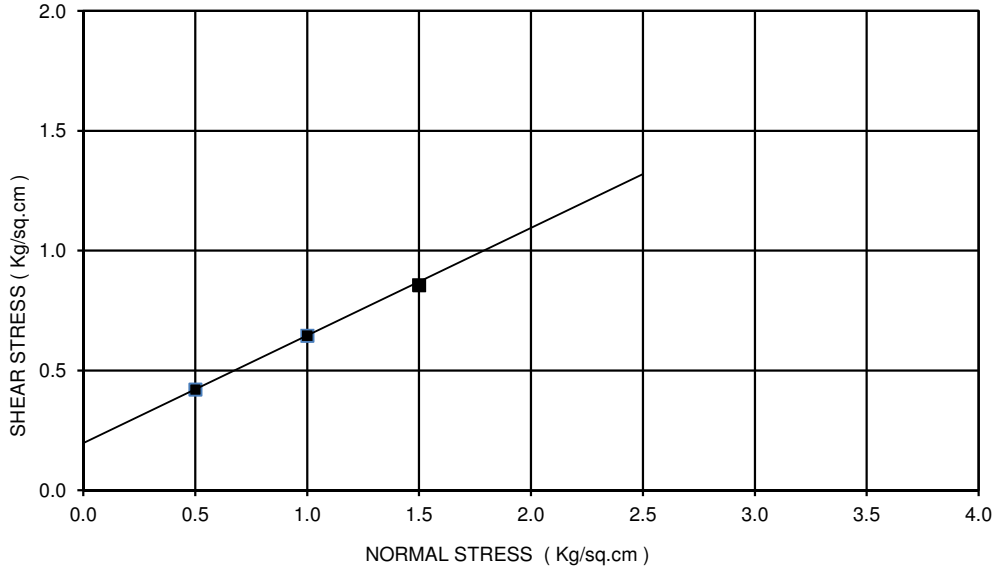


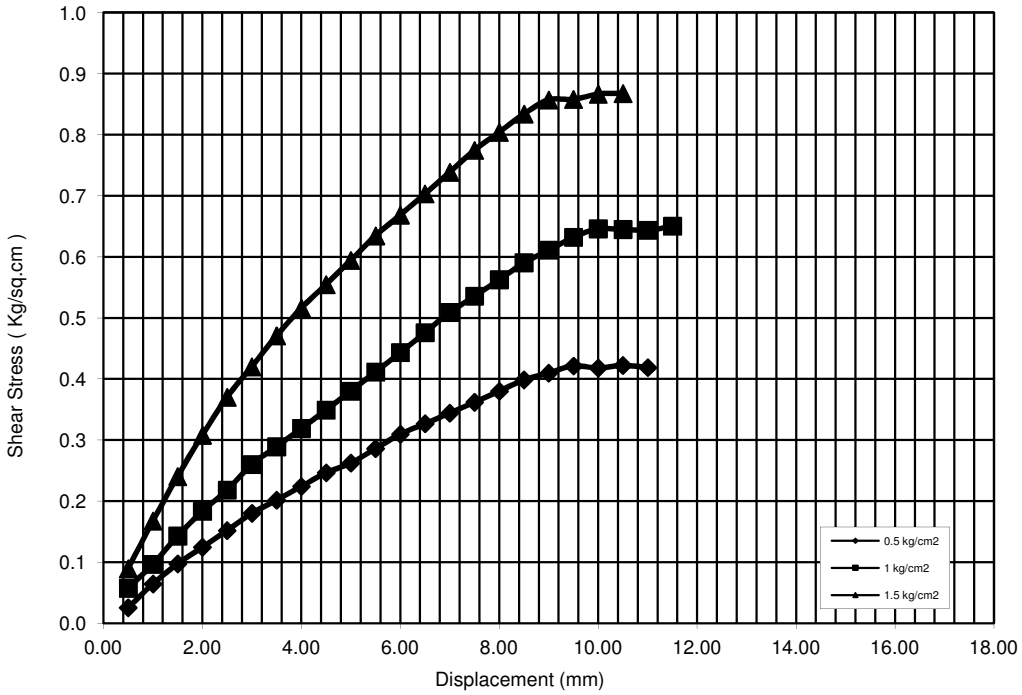
BORE HOLE NO: BH-CL
CHAIANGE : 7+907
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.53 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



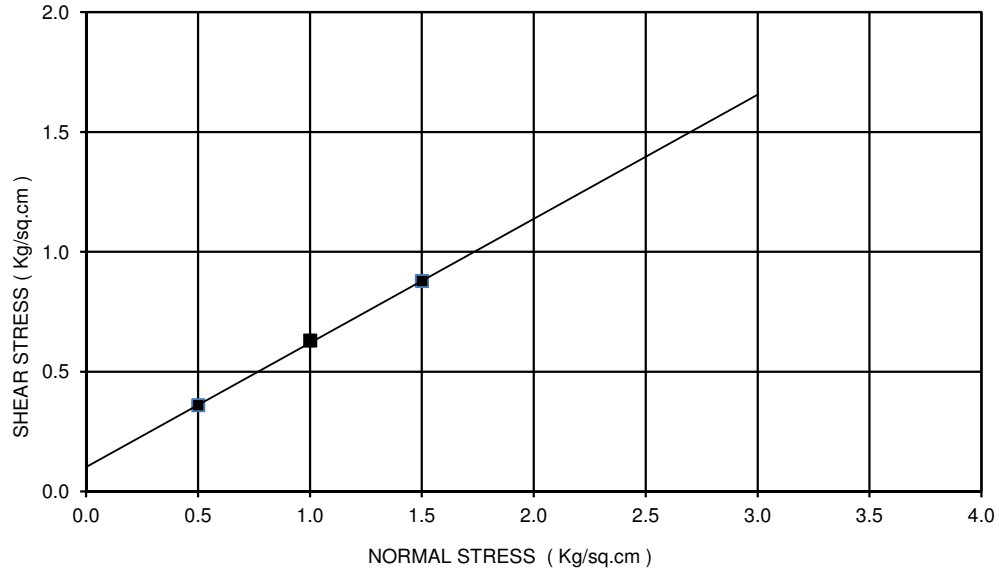


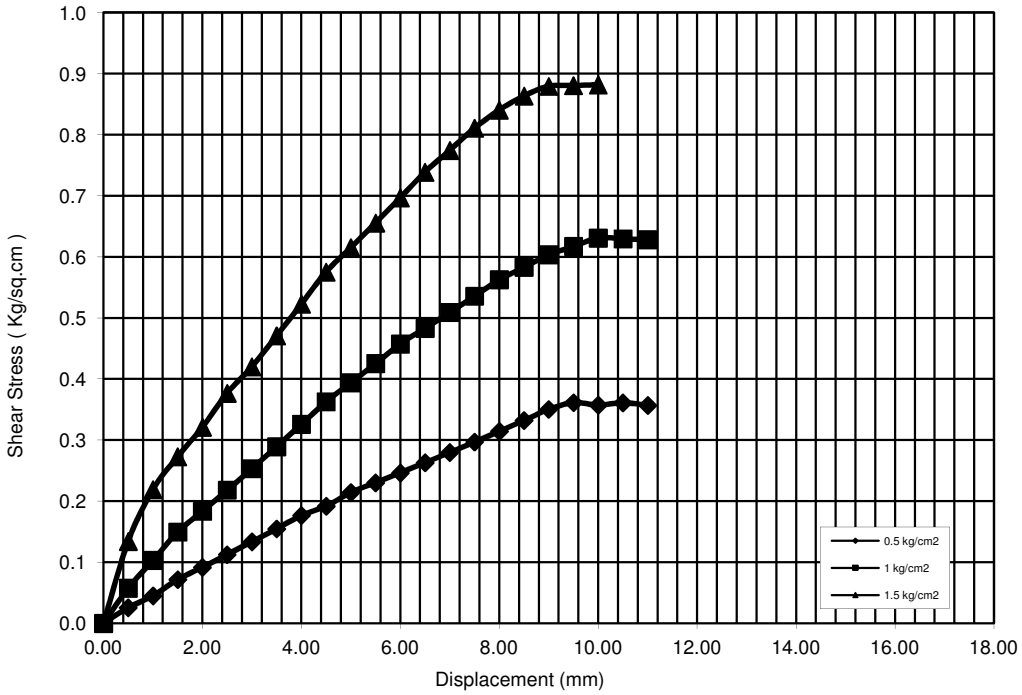
BORE HOLE NO: BH-CL
CHAIANGE : 8+207
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



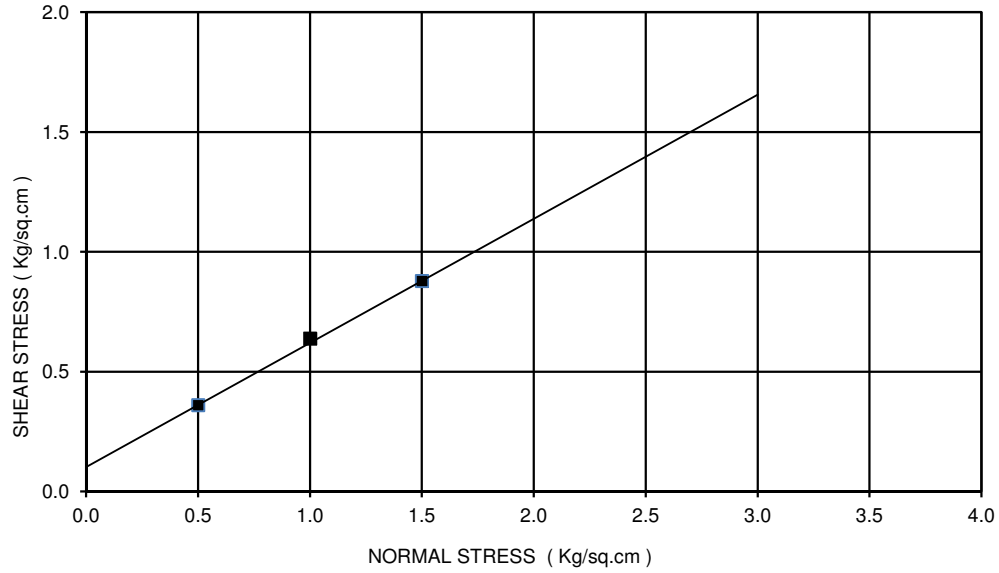


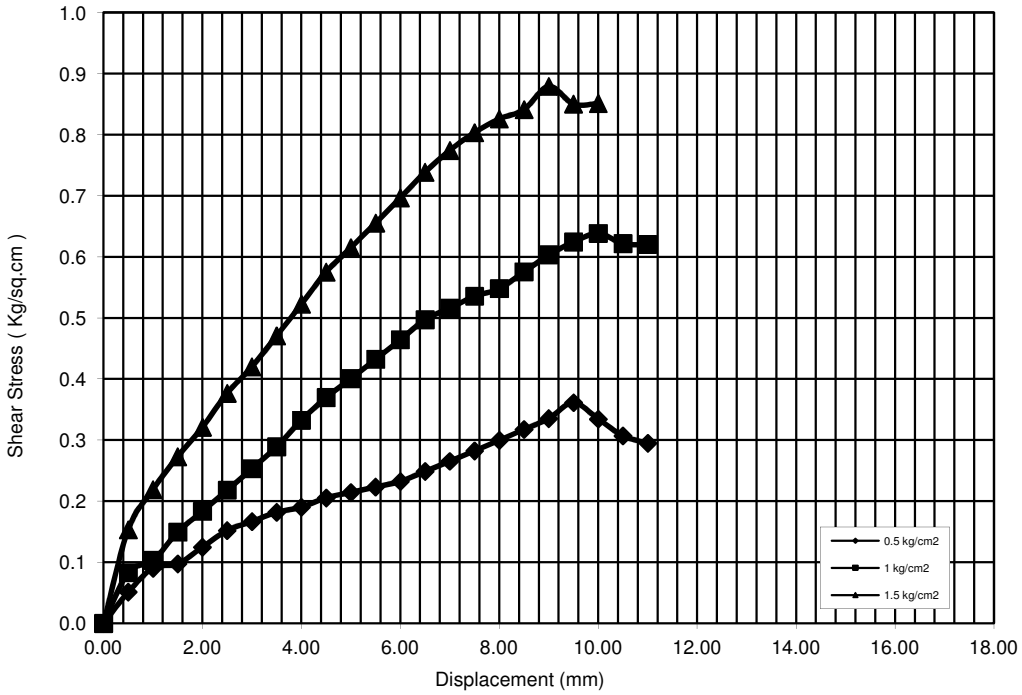
BORE HOLE NO: BH-CL
CHAIANGE : 8+610
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.10 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



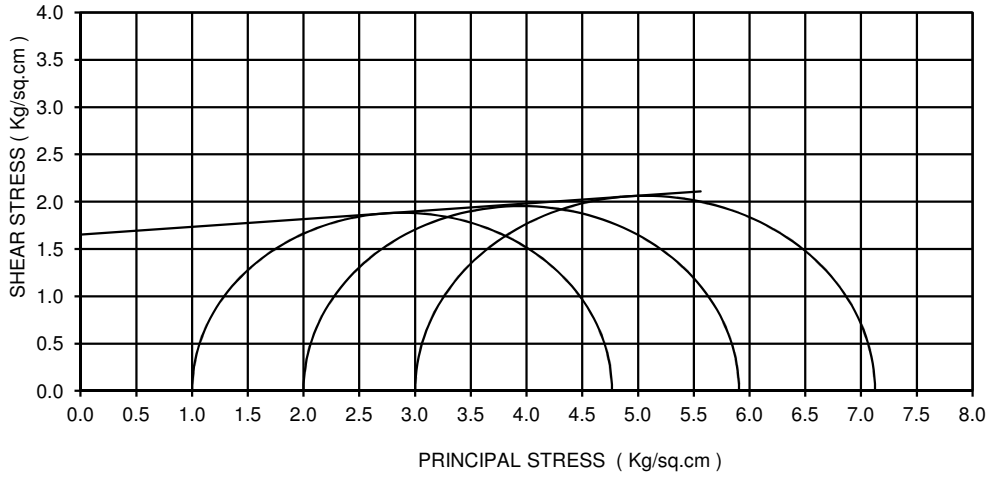


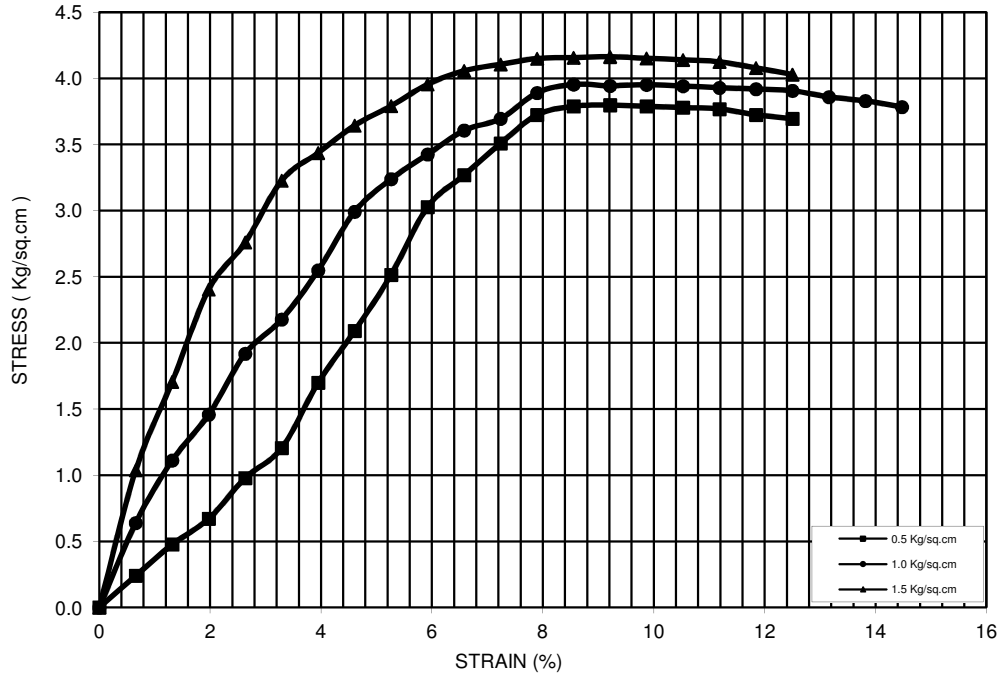
BORE HOLE NO: BH-A1
CHAIANGE : 8+852
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.10 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



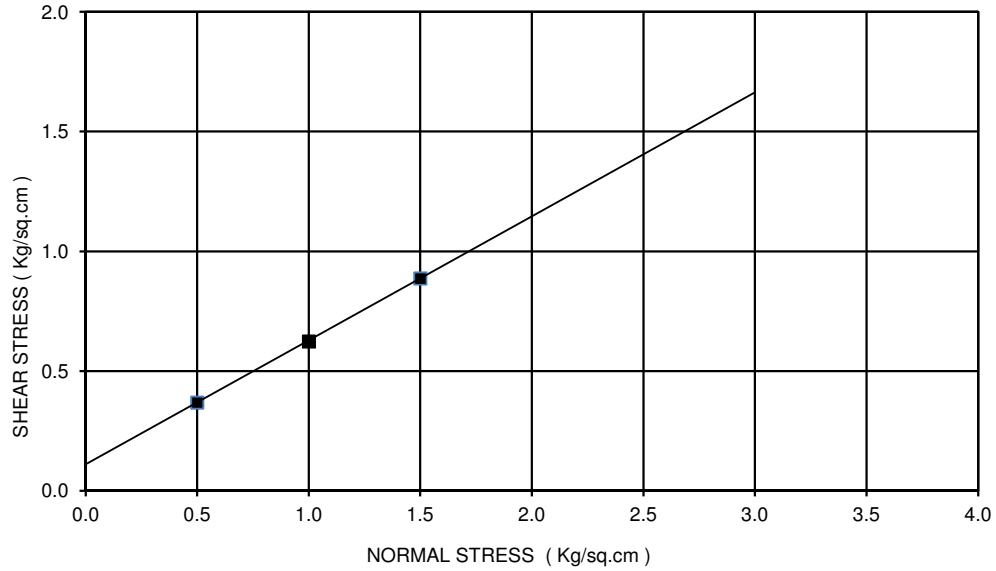


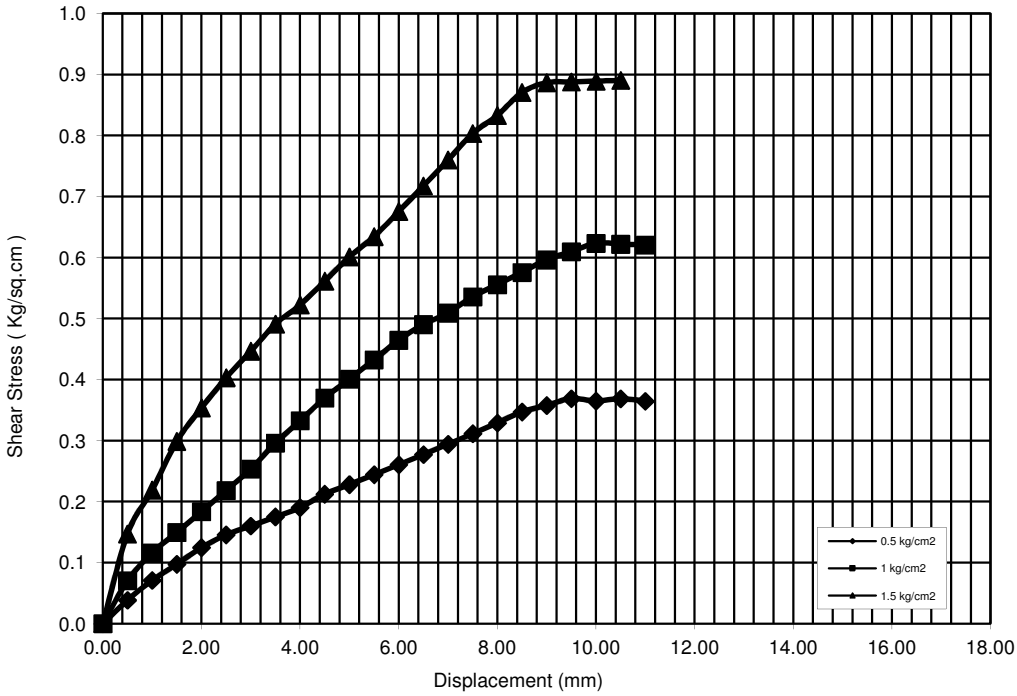
BORE HOLE NO: BH-A1
CHAINAGE : 8+852
SAMPLE NO.: UDS-8
DEPTH: 26.50 m
COHESION(C)= 1.65 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



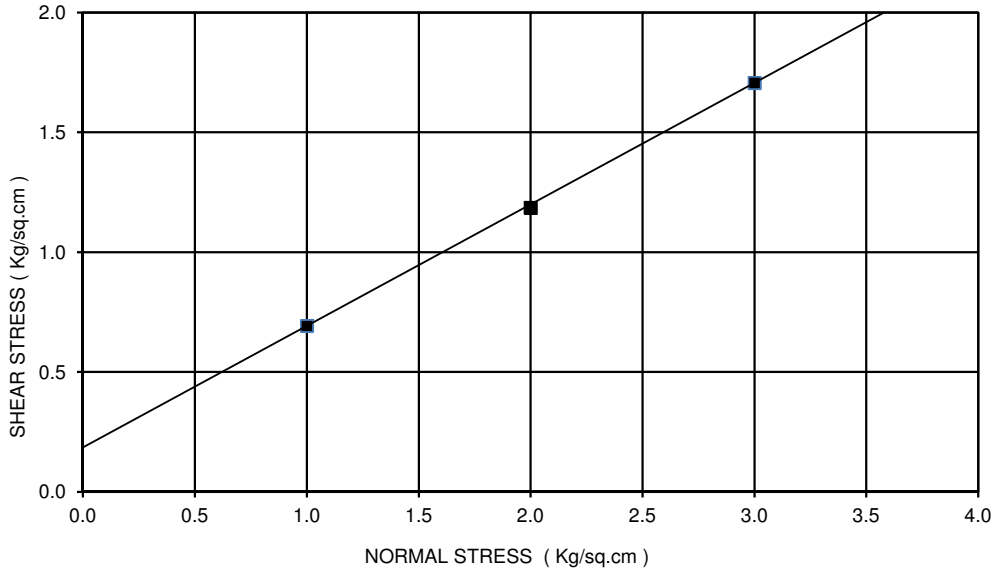


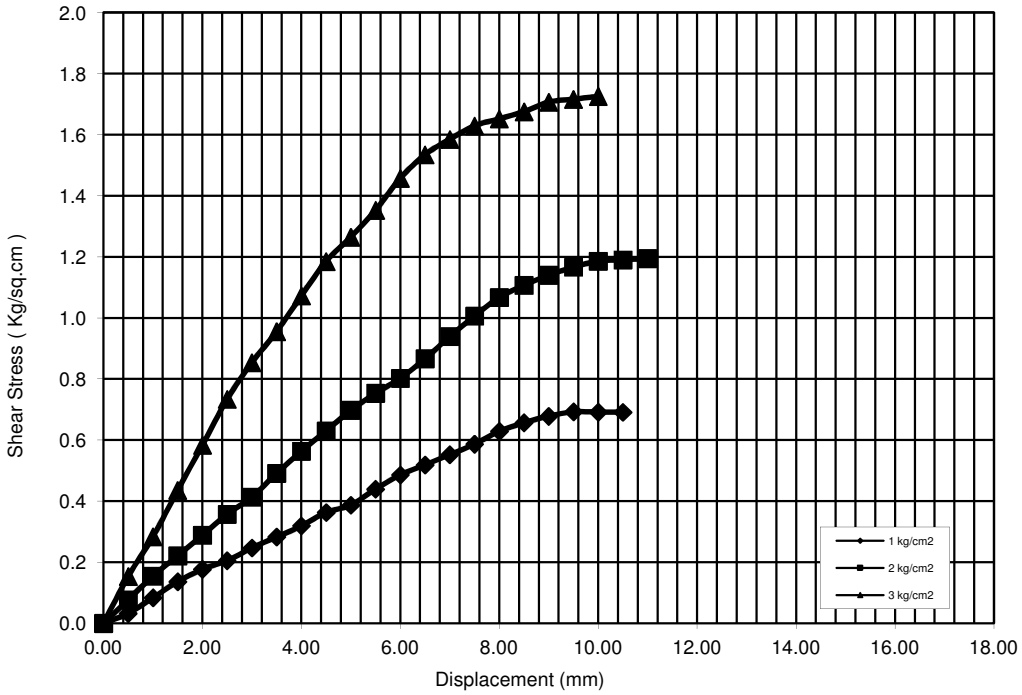
BORE HOLE NO: BH-A2
CHAINAGE : 8+852
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.11 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST

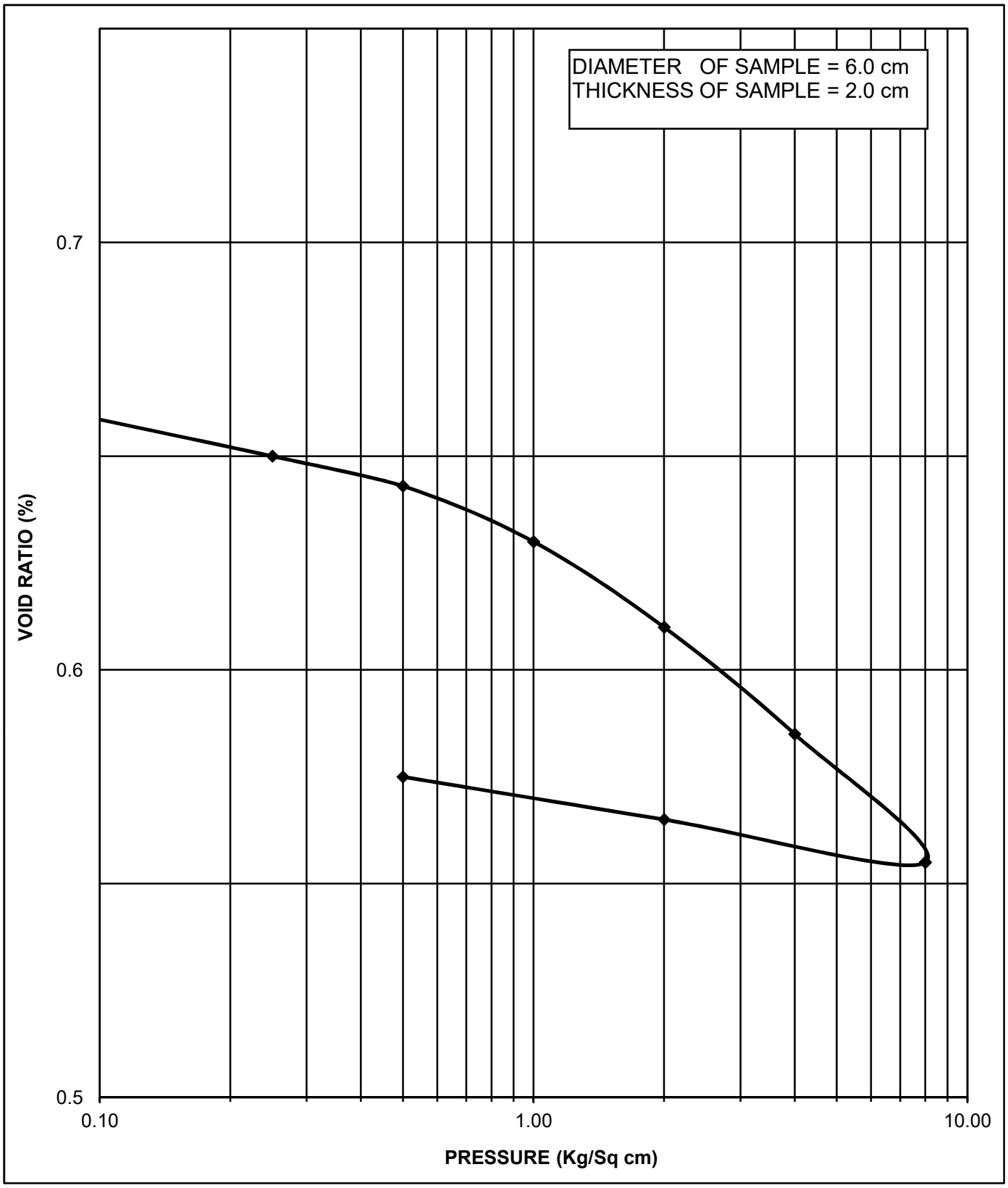




BORE HOLE NO: BH-A-2
CHAINAGE : 8+852
SAMPLE NO.: UDS-8
DEPTH: 22.00 m
COHESION(C)= 0.19 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST







BORE HOLE NO. = BH-A1

CHAINAGE = 3+691

SAMPLE NO. = UDS-05

DEPTH = 14.50 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 19.72%

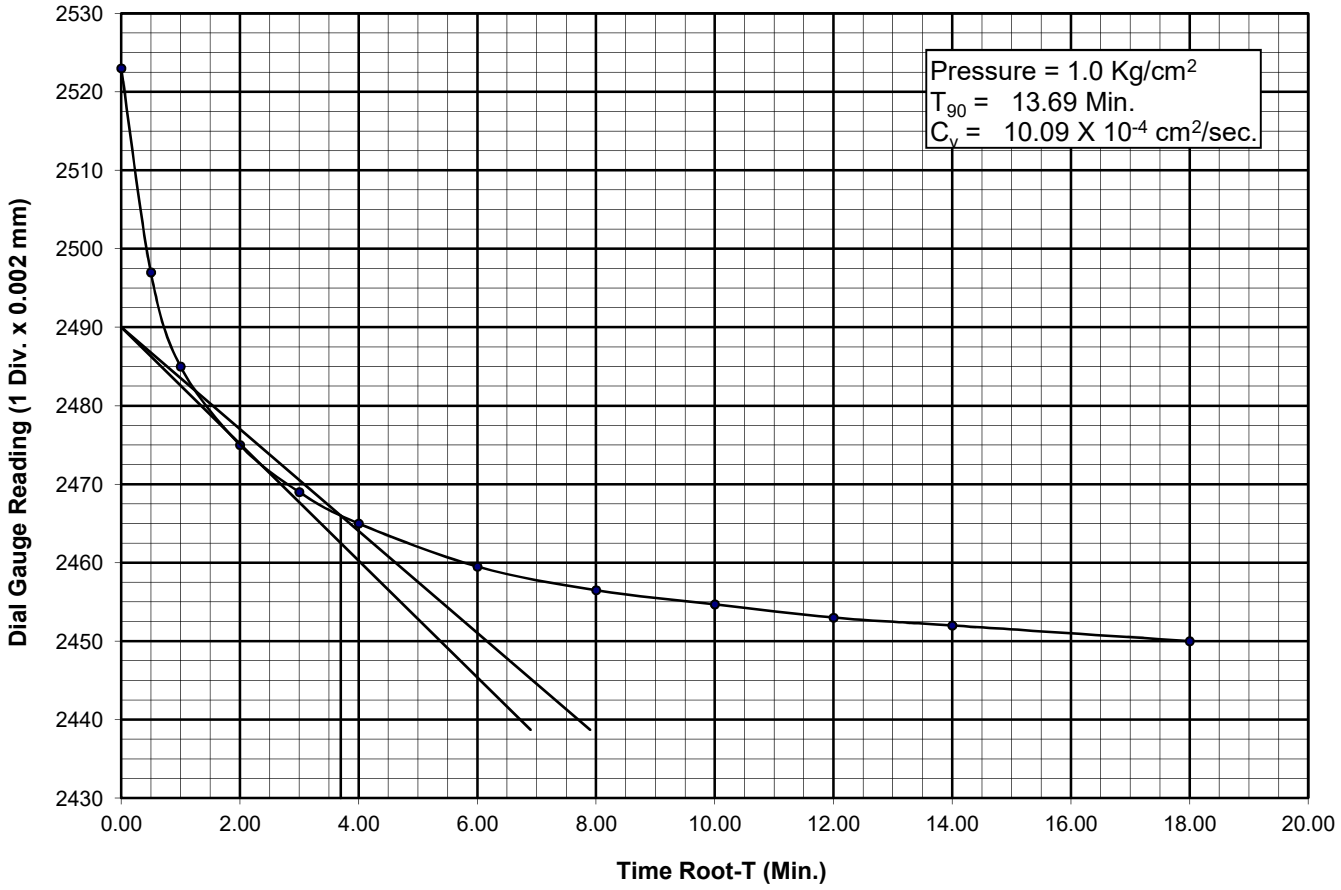
DRY DENSITY = 1.62 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESSION INDEX (C_c) = 0.100

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-A1
CHAINAGE = 3+691
SAMPLE NO. = UDS-05
DEPTH = 14.50 M



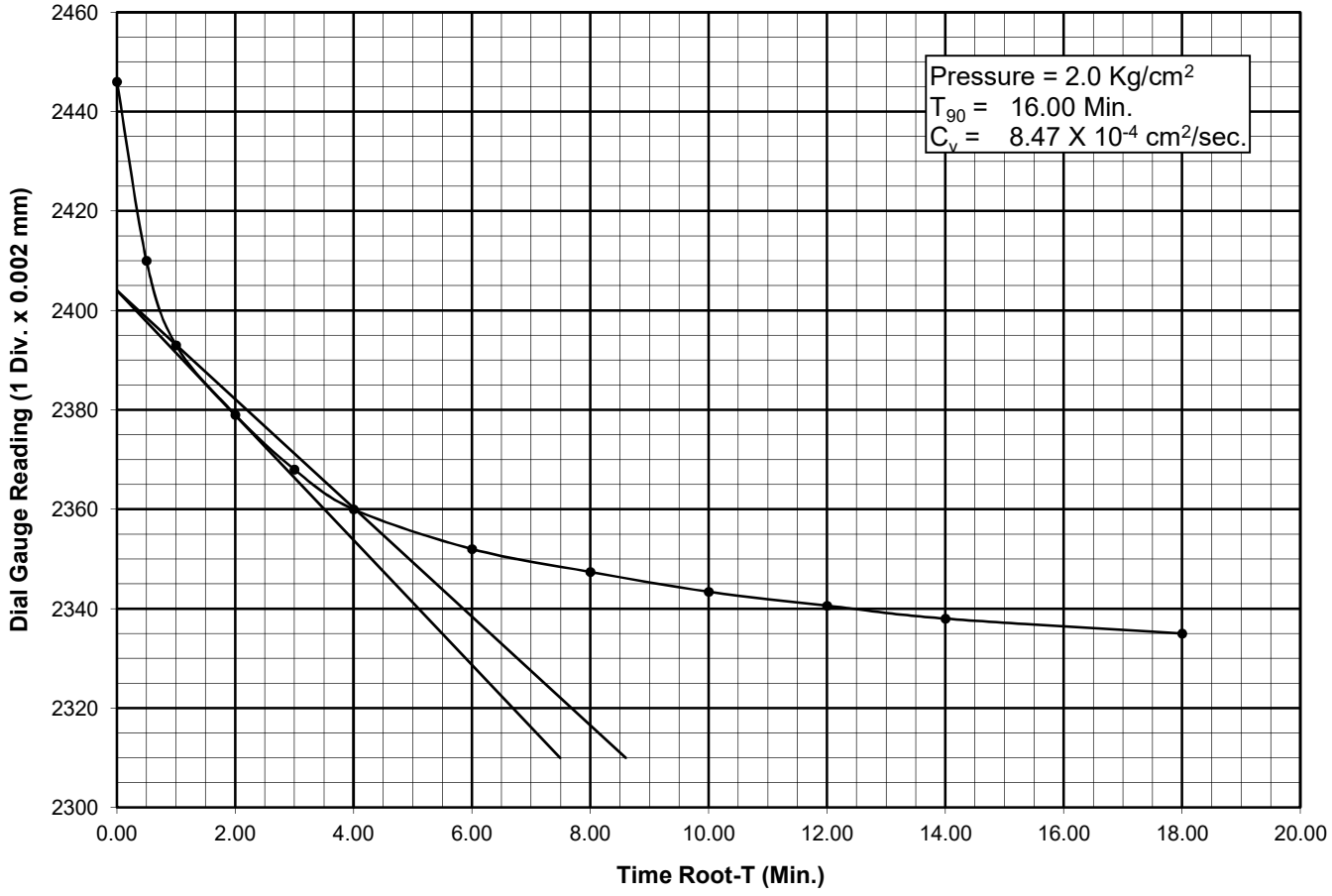
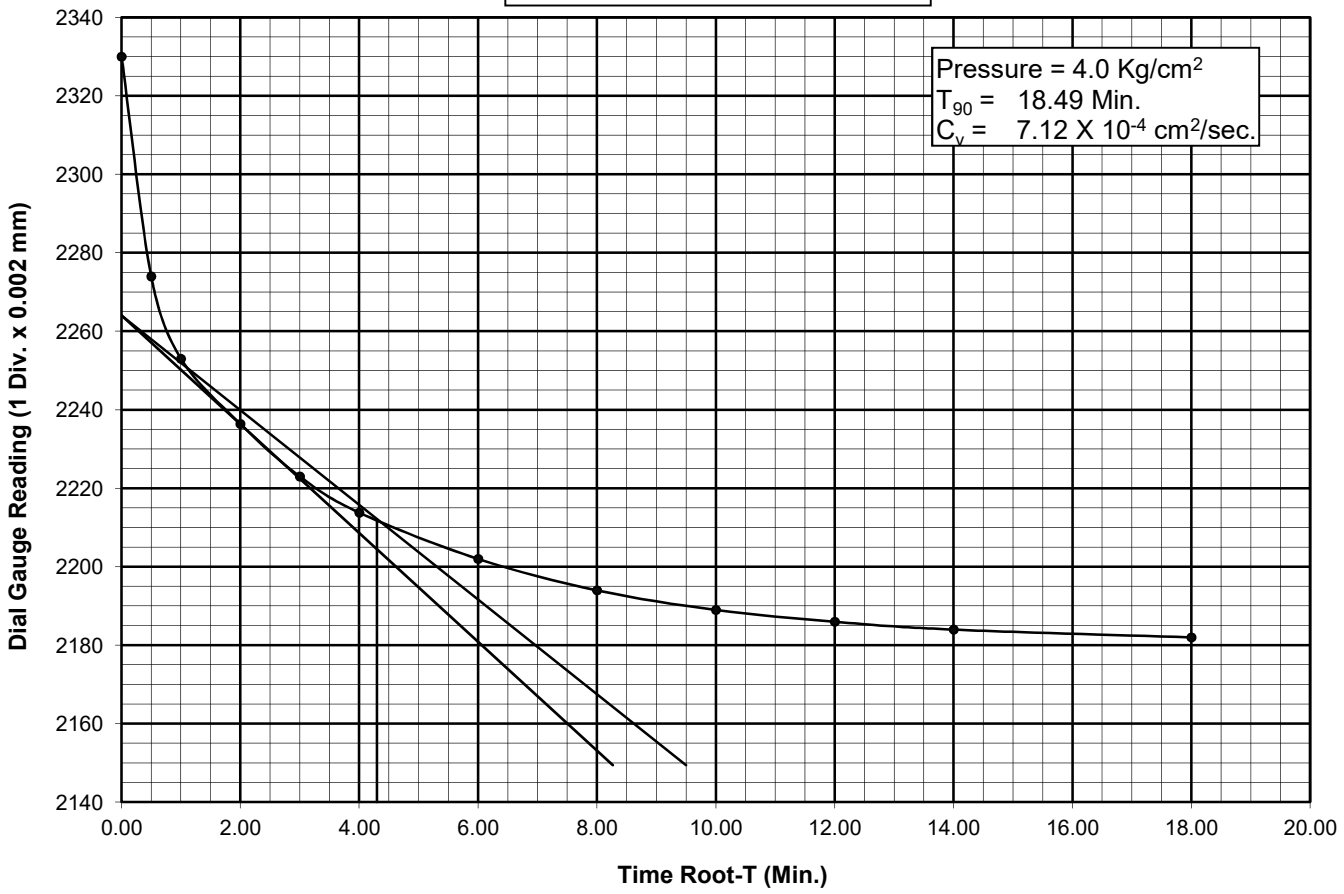


Figure No. -

BORE HOLE NO. = BH-A1
CHAINAGE = 3+691
SAMPLE NO. = UDS-05
DEPTH = 14.50 M



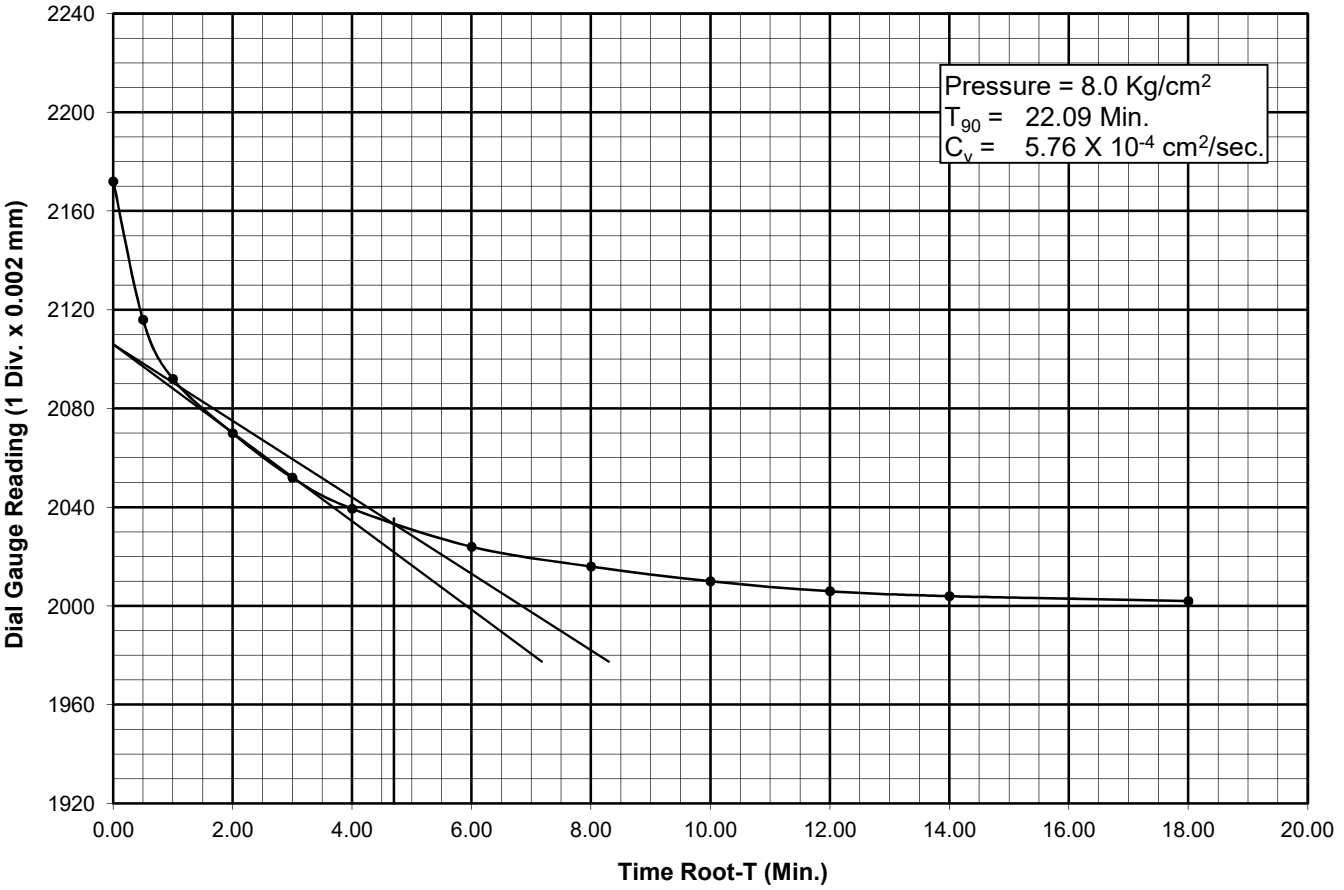
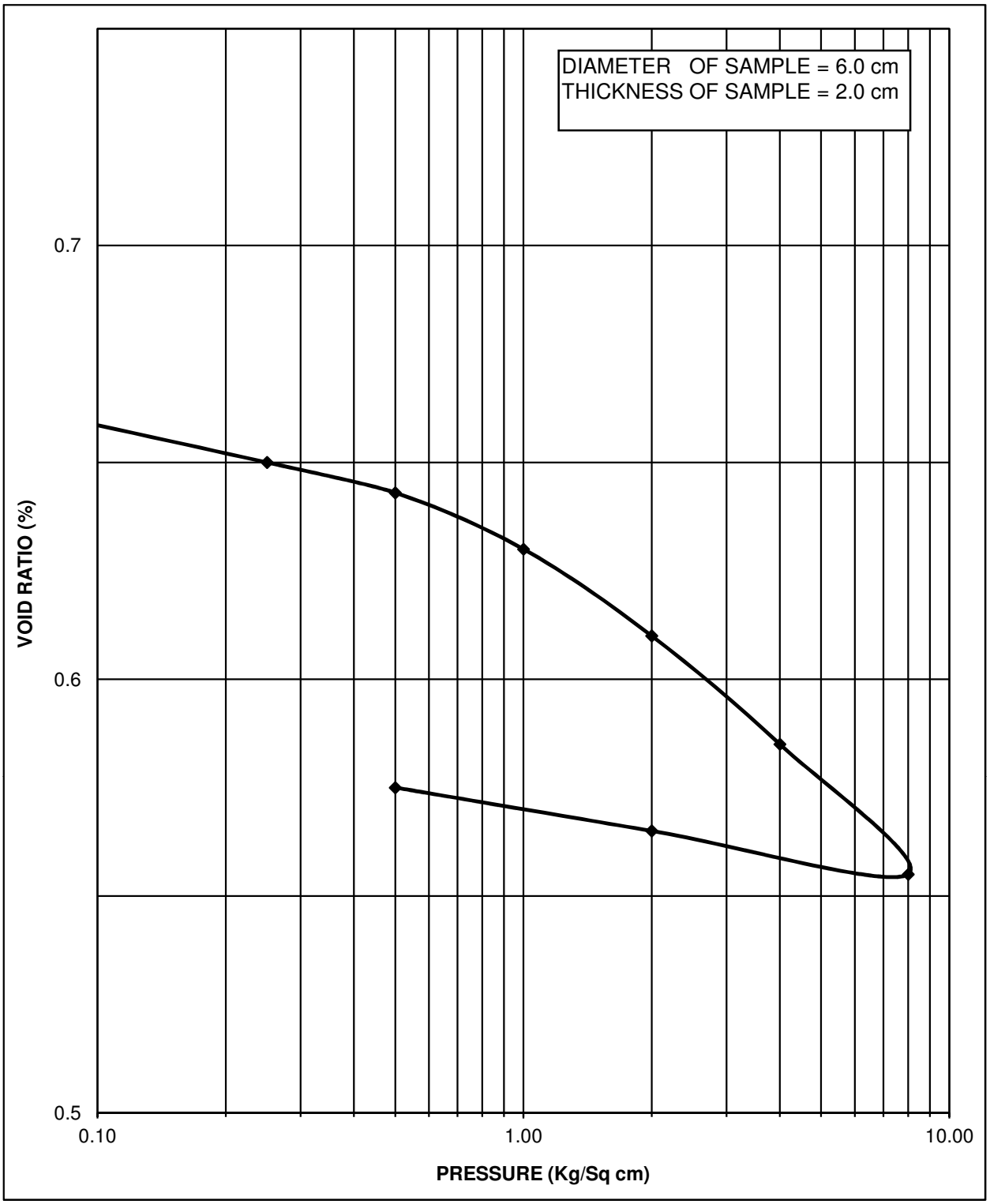


Figure No. -



BORE HOLE NO. = BH-A1

CHAINAGE = 3+691

SAMPLE NO. = UDS-05

DEPTH = 14.50 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 19.72%

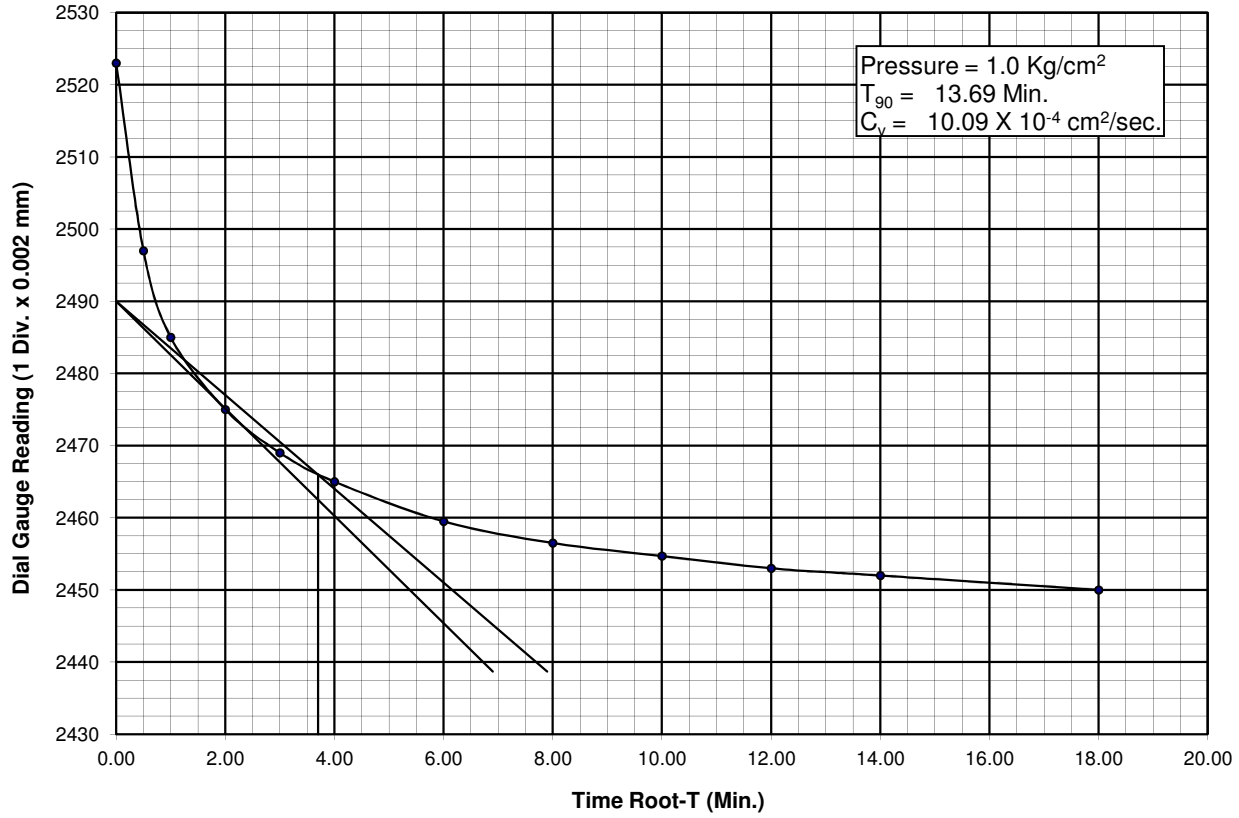
DRY DENSITY = 1.62 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESSION INDEX (C_c) = 0.100

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-A1
CHAINAGE = 3+691
SAMPLE NO. = UDS-05
DEPTH = 14.50 M



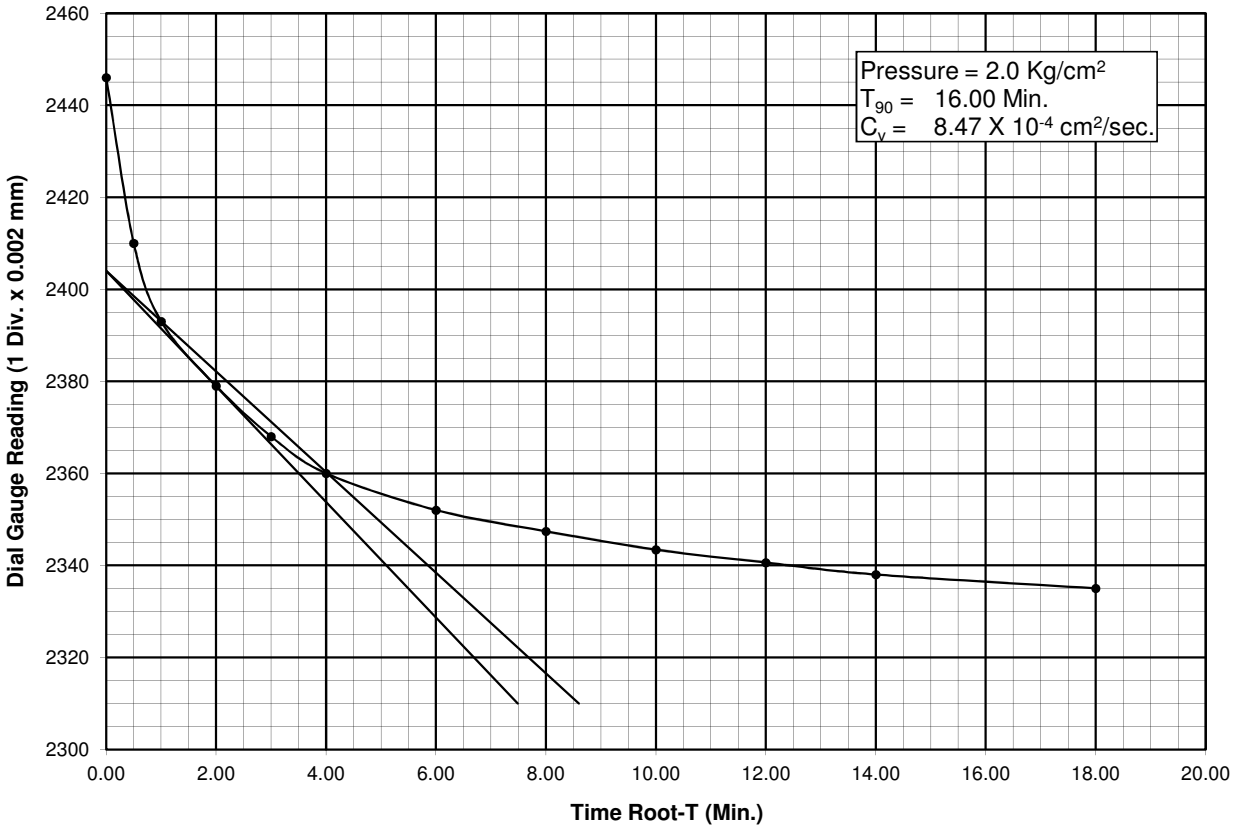
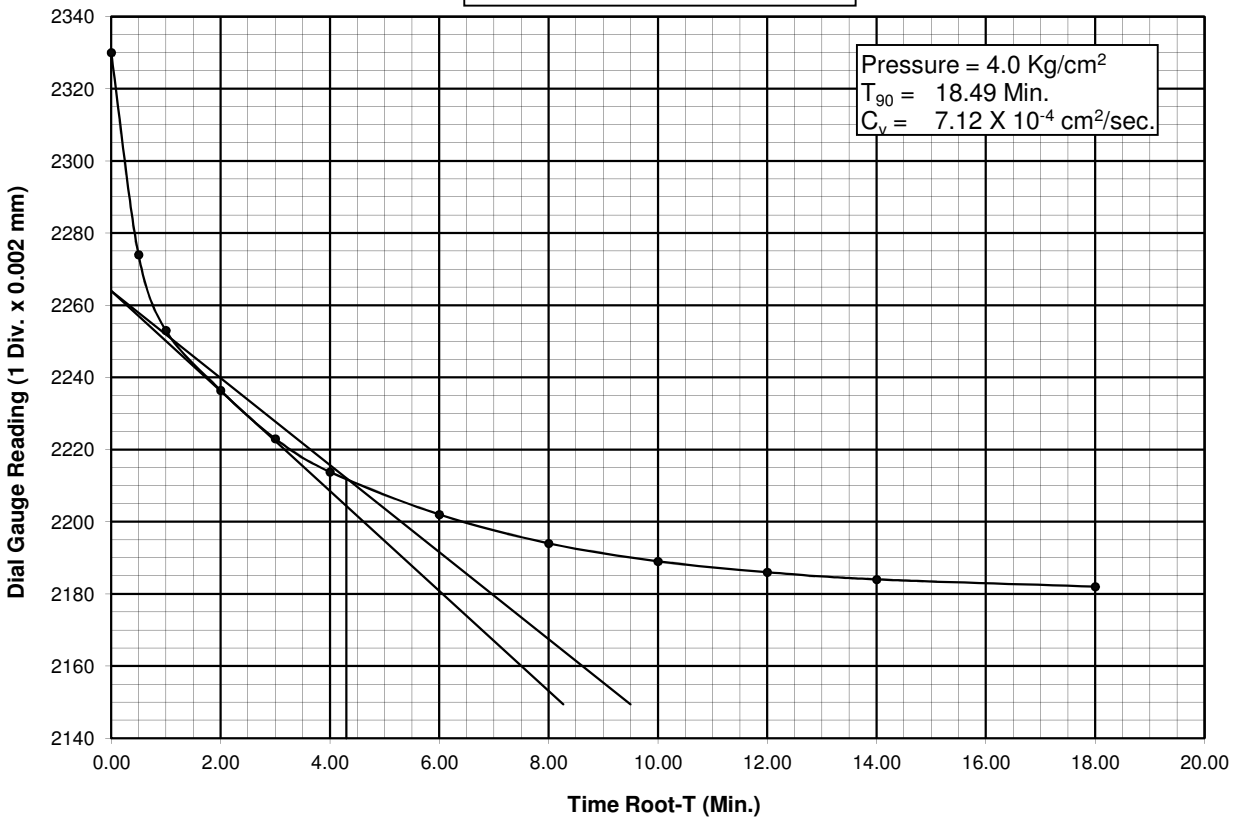


Figure No. -

BORE HOLE NO. = BH-A1
CHAINAGE = 3+691
SAMPLE NO. = UDS-05
DEPTH = 14.50 M



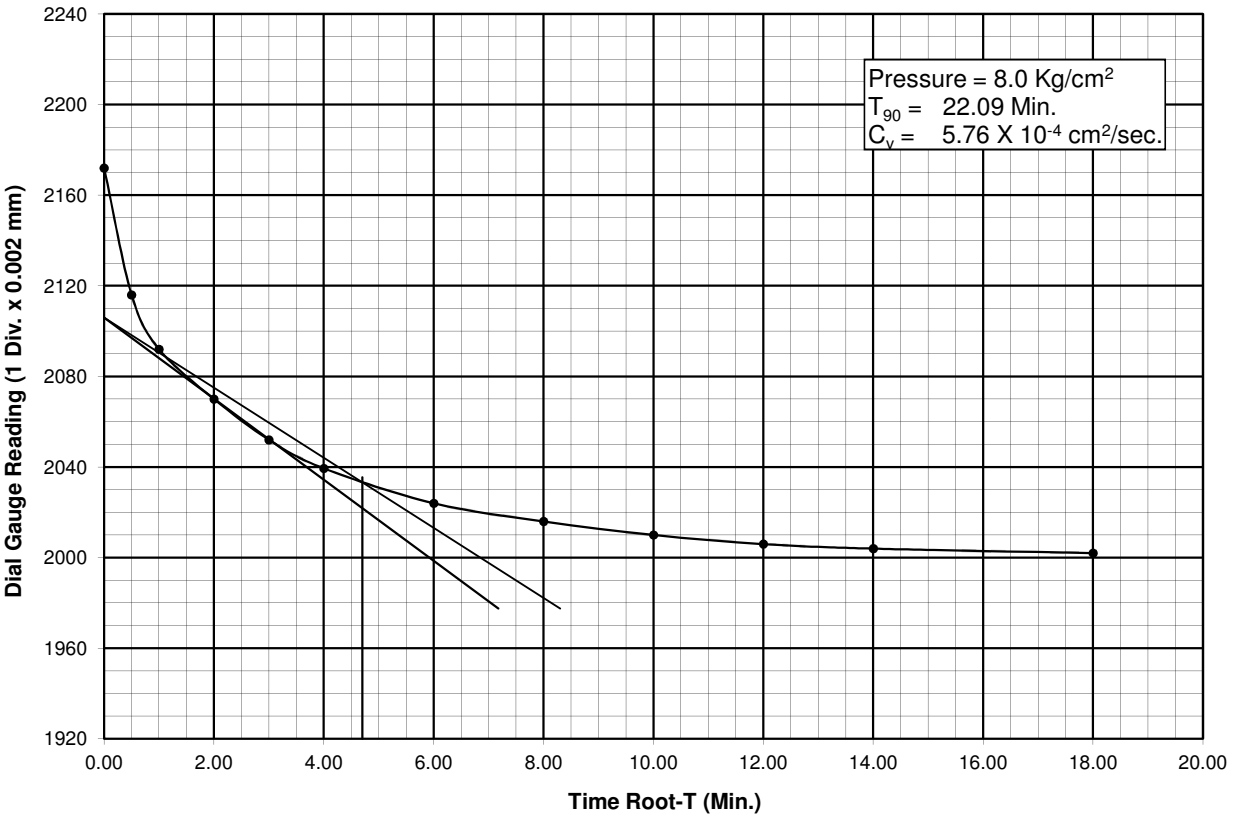
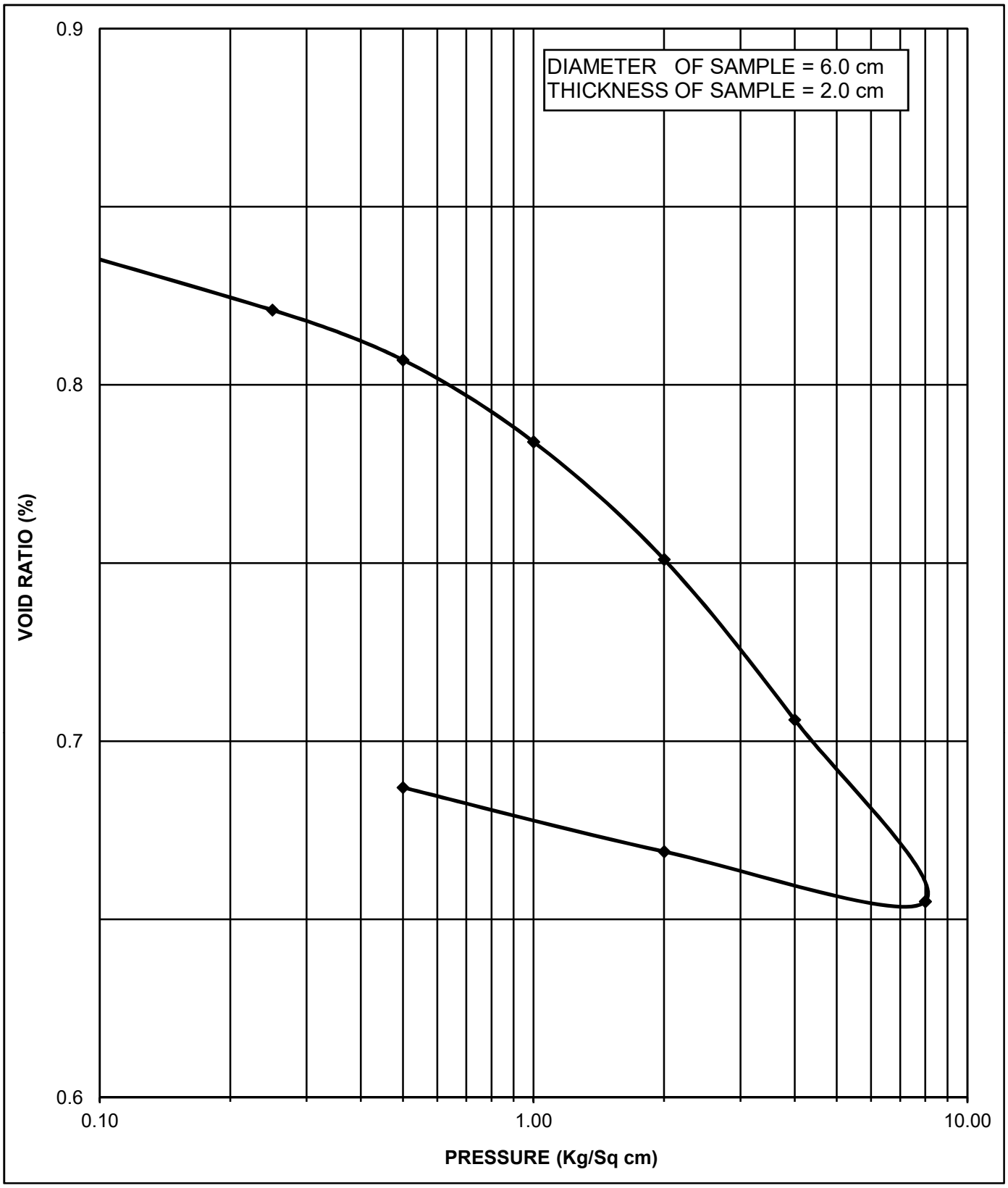


Figure No. -



BORE HOLE NO. = BH-A2

CHAINAGE = 7+078

SAMPLE NO. = UDS-01

DEPTH = 2.50 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 29.10 %

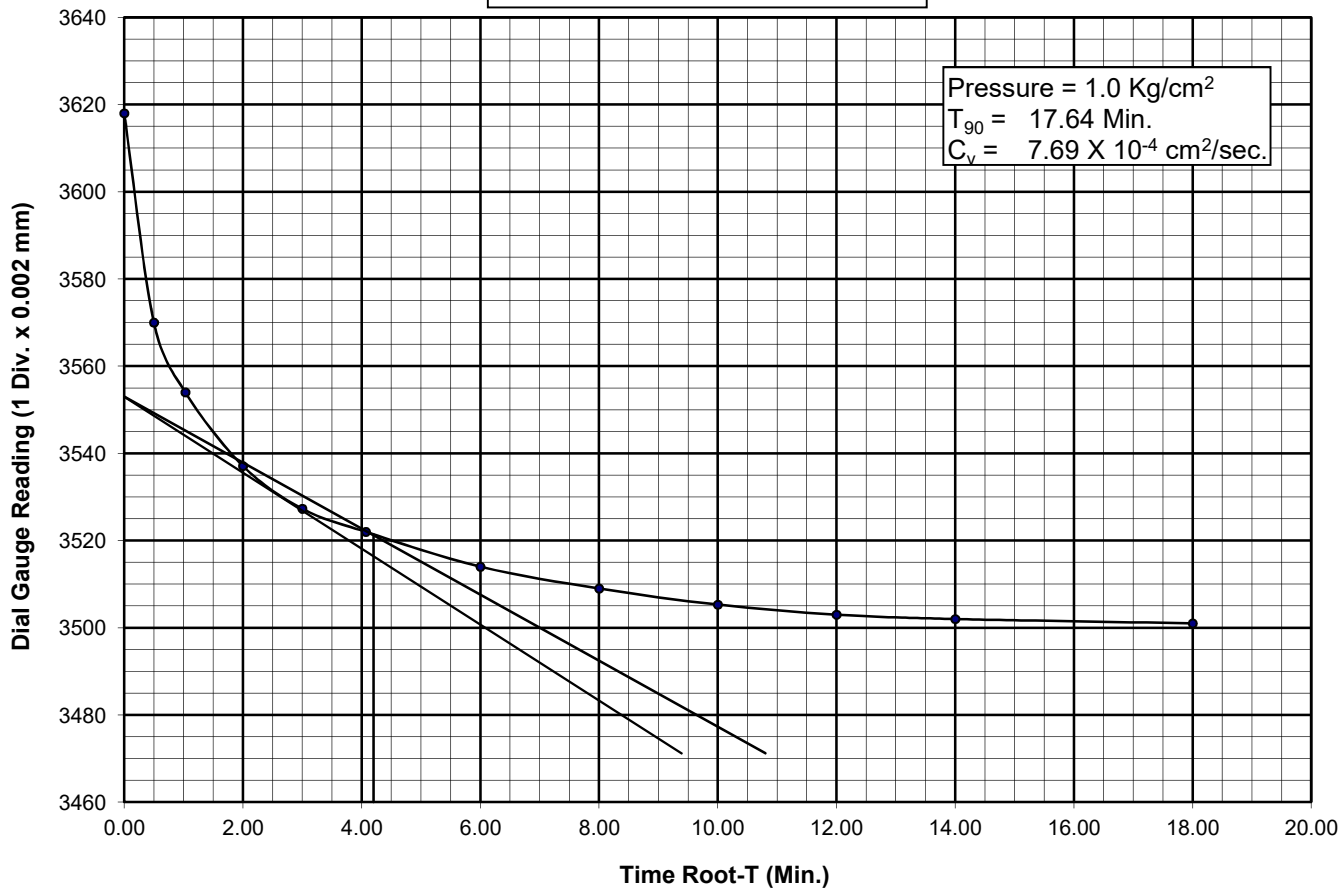
DRY DENSITY = 1.46 gm/cm^3

VOID RATIO (e_o) = 0.835

COMPRESSION INDEX (C_c) = 0.169

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-A2
CHAINAGE = 7+078
SAMPLE NO. = UDS-01
DEPTH = 2.50 M



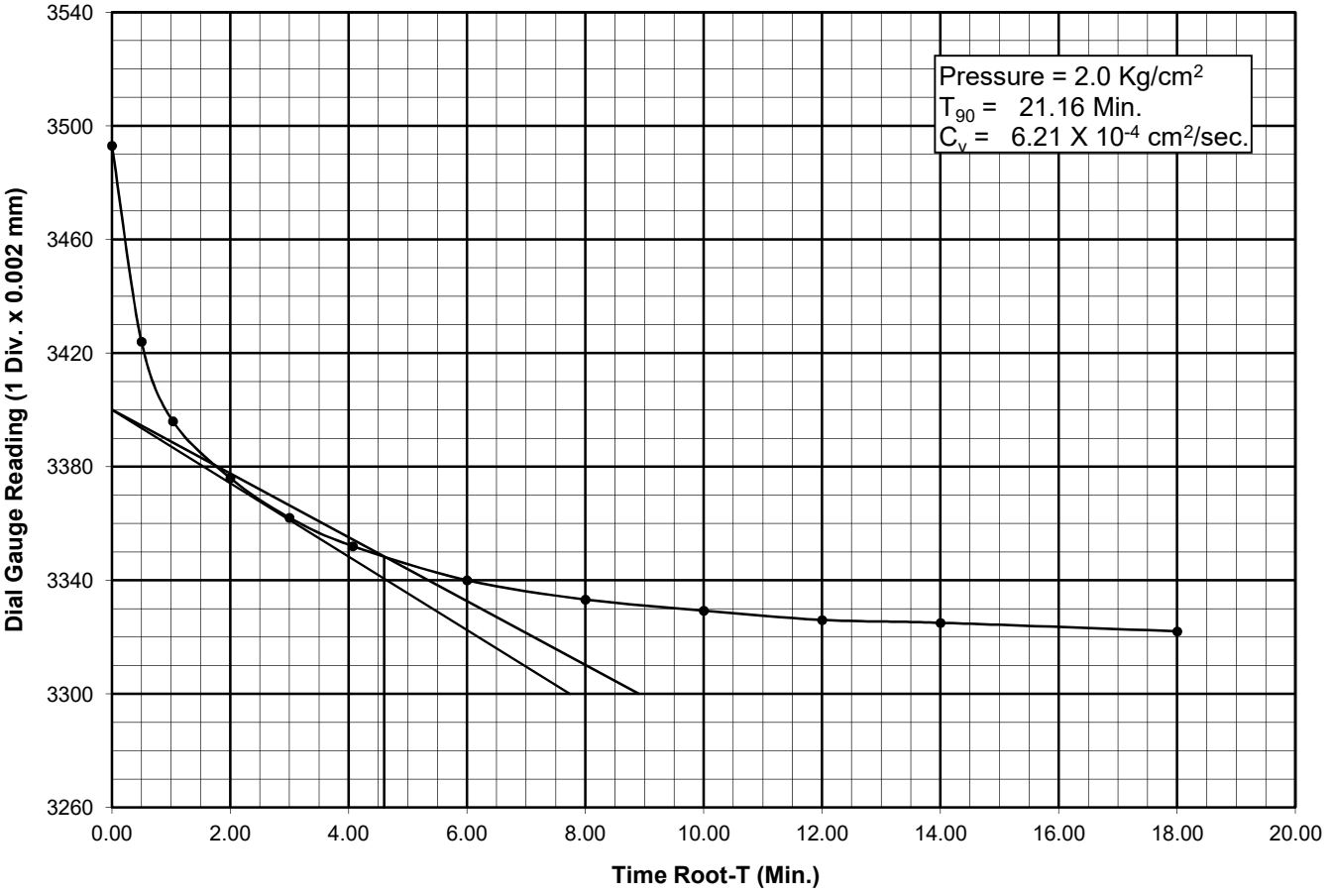
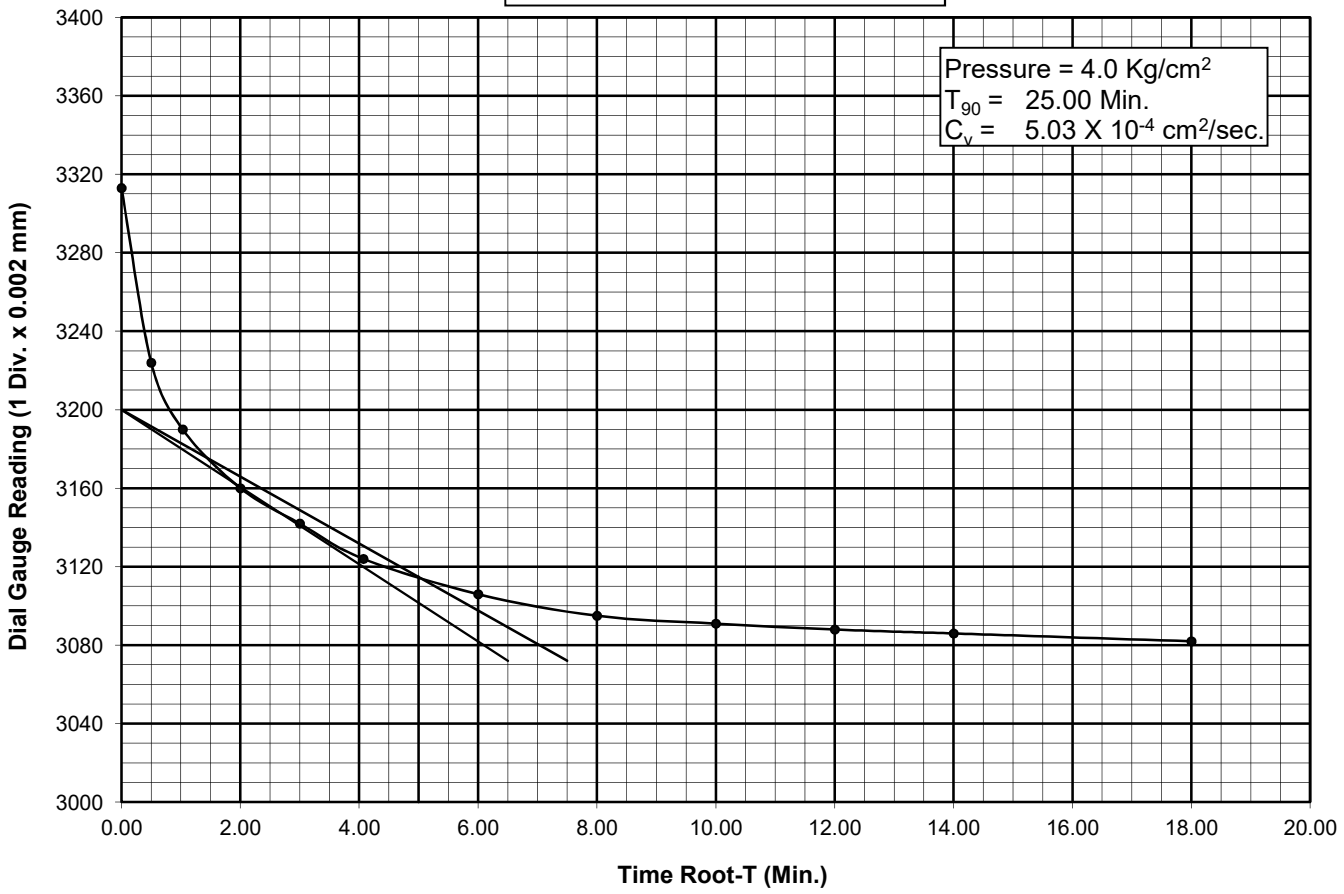


Figure No. -

BORE HOLE NO. = BH-A2
CHAINAGE = 7+078
SAMPLE NO. = UDS-01
DEPTH = 2.50 M



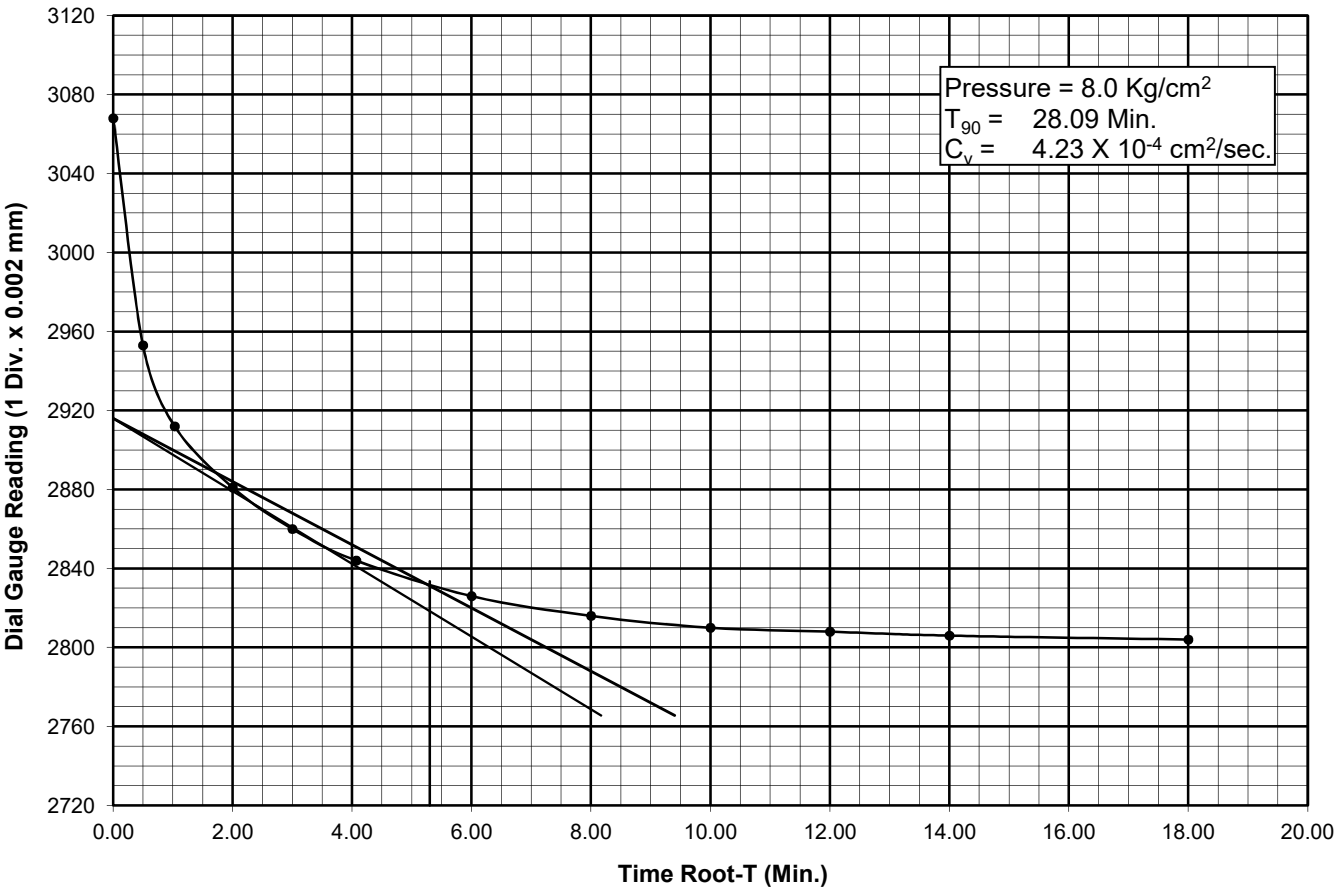
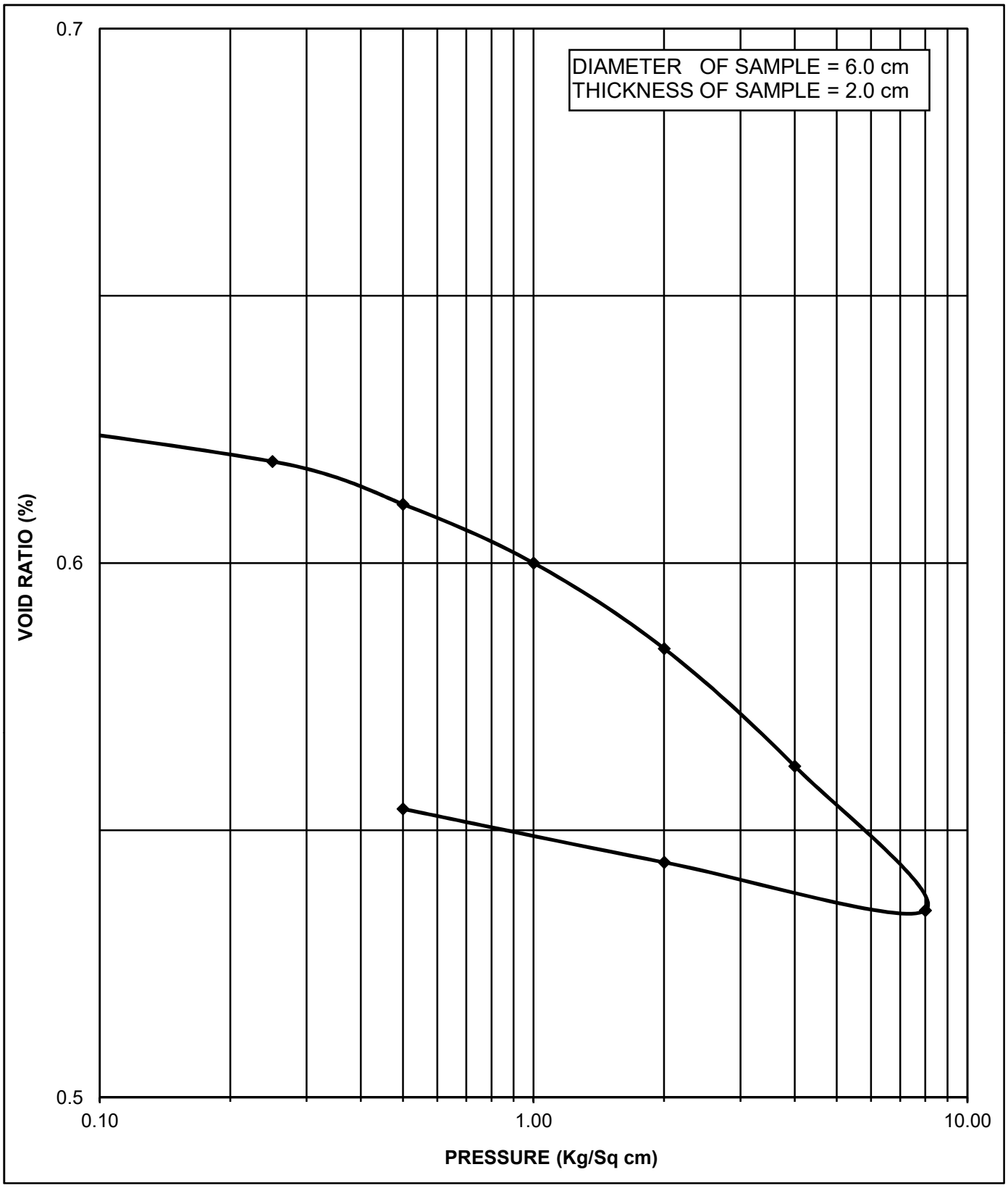


Figure No. -



BORE HOLE NO. = BH-A2

CHAINAGE = 8.852

SAMPLE NO. = UDS-05

DEPTH = 13.00 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 22.67 %

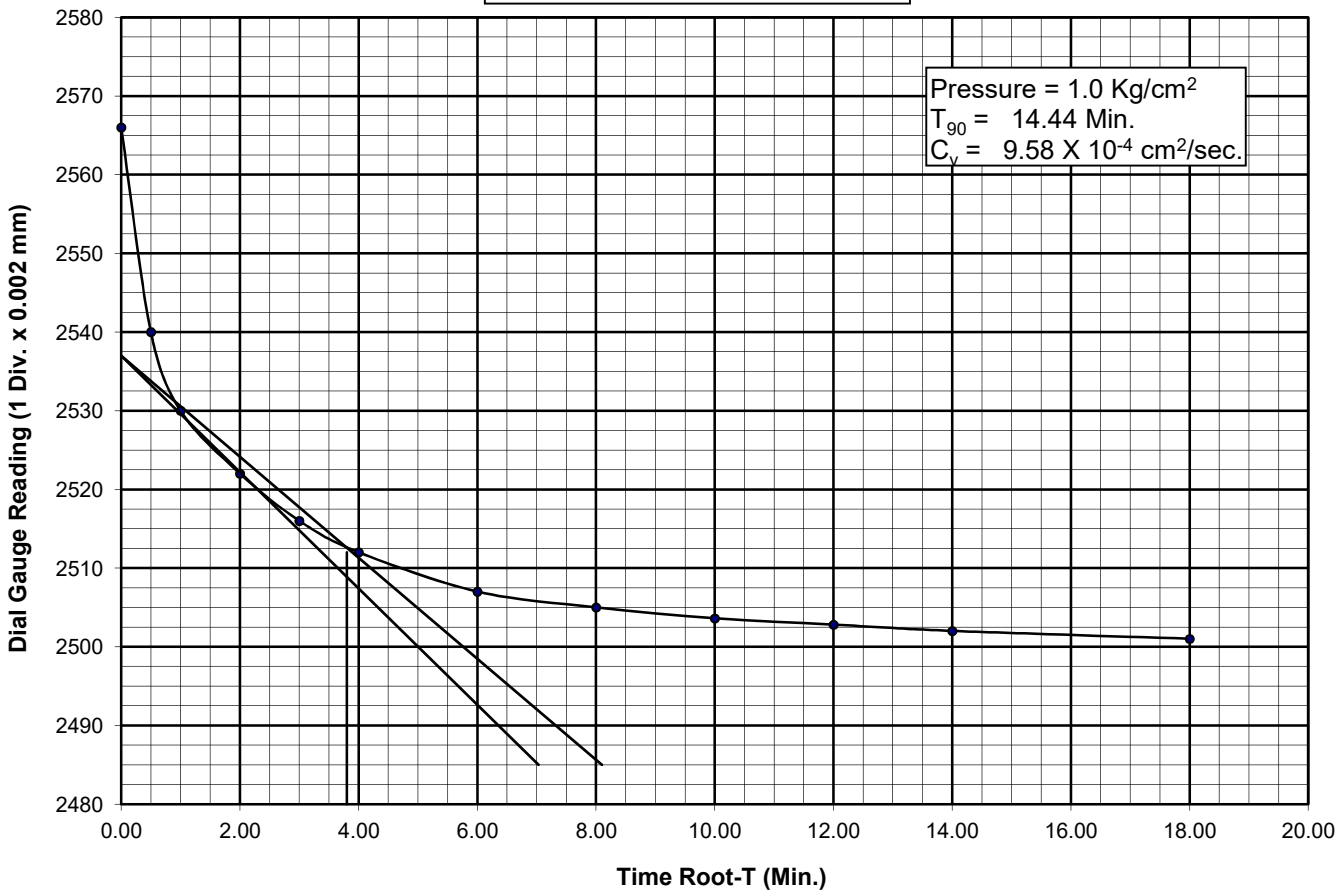
DRY DENSITY = 1.65 gm/cm^3

VOID RATIO (e_o) = 0.625

COMPRESSION INDEX (C_c) = 0.090

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-A2
CHAINAGE = 8+852
SAMPLE NO. = UDS-05
DEPTH = 13.00 M



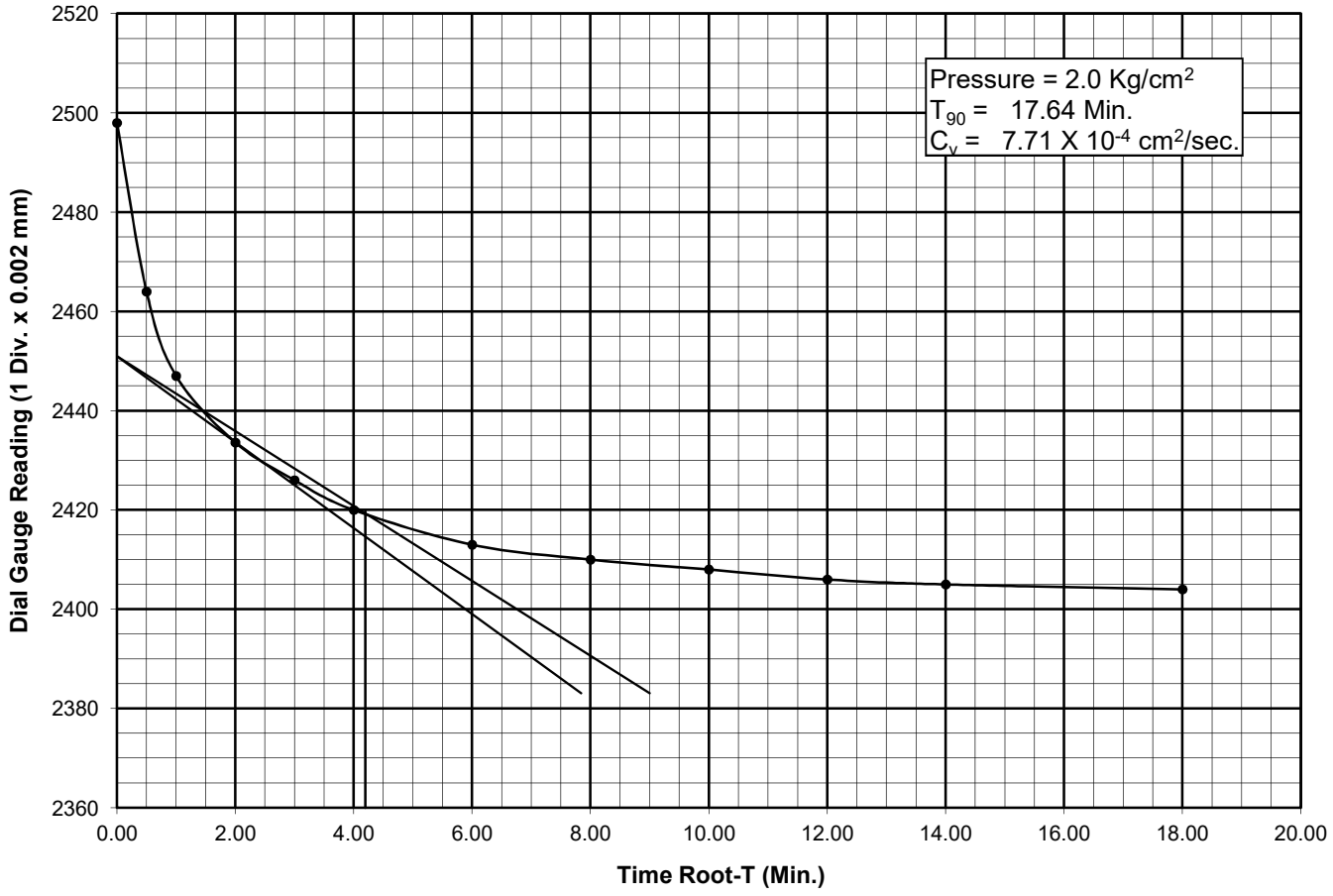
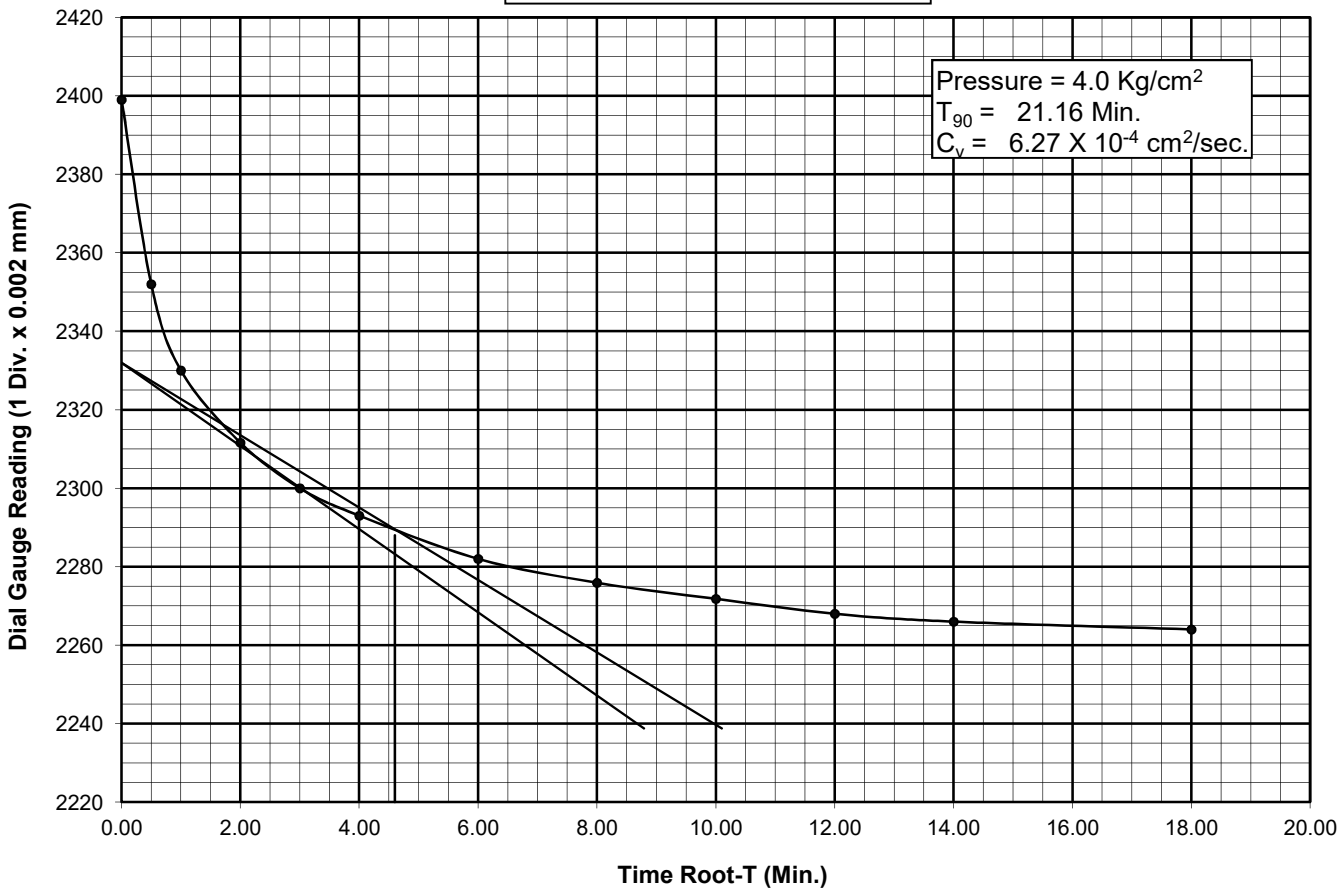


Figure No. -

BORE HOLE NO. = BH-A2
CHAINAGE = 8+852
SAMPLE NO. = UDS-05
DEPTH = 13.00 M



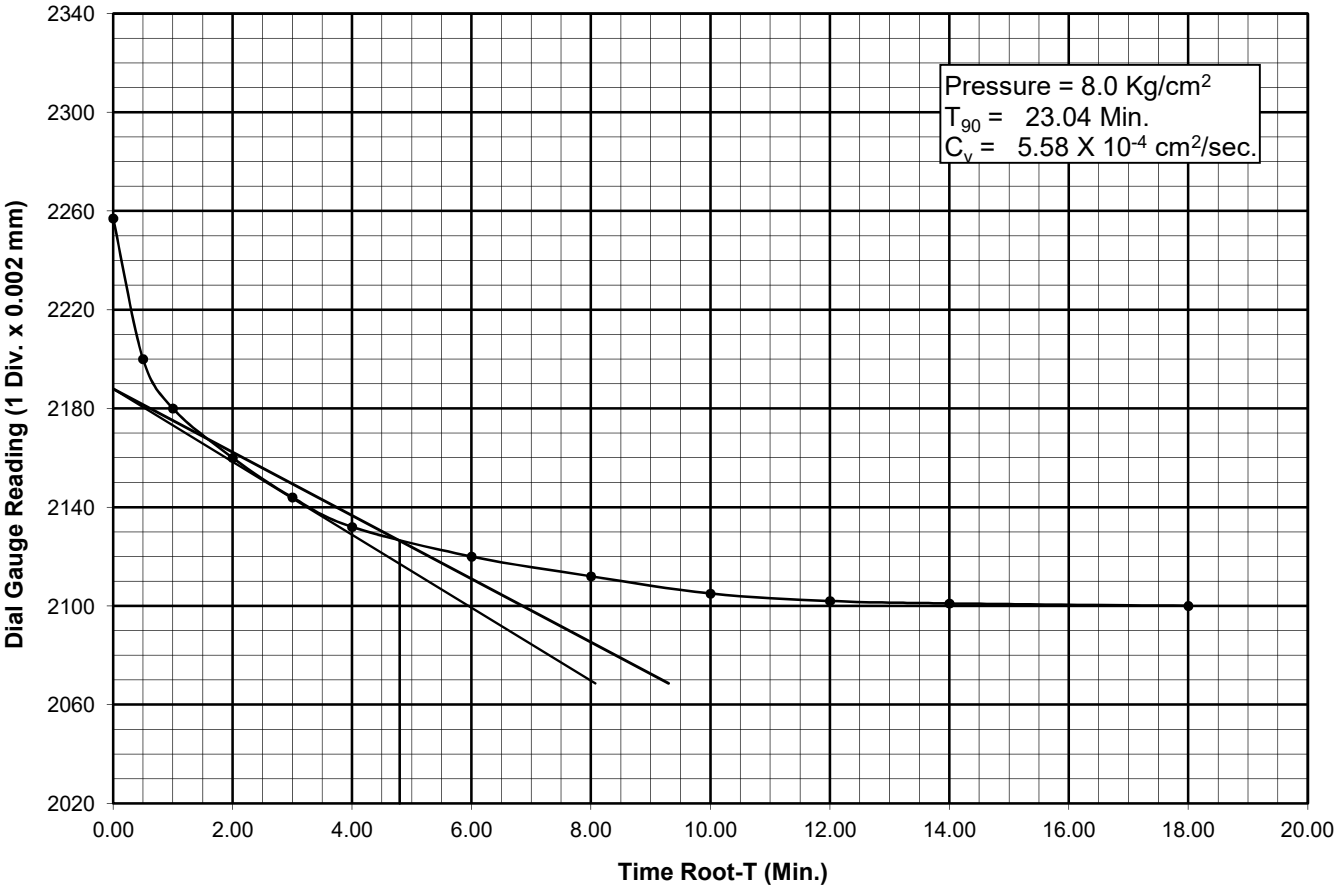
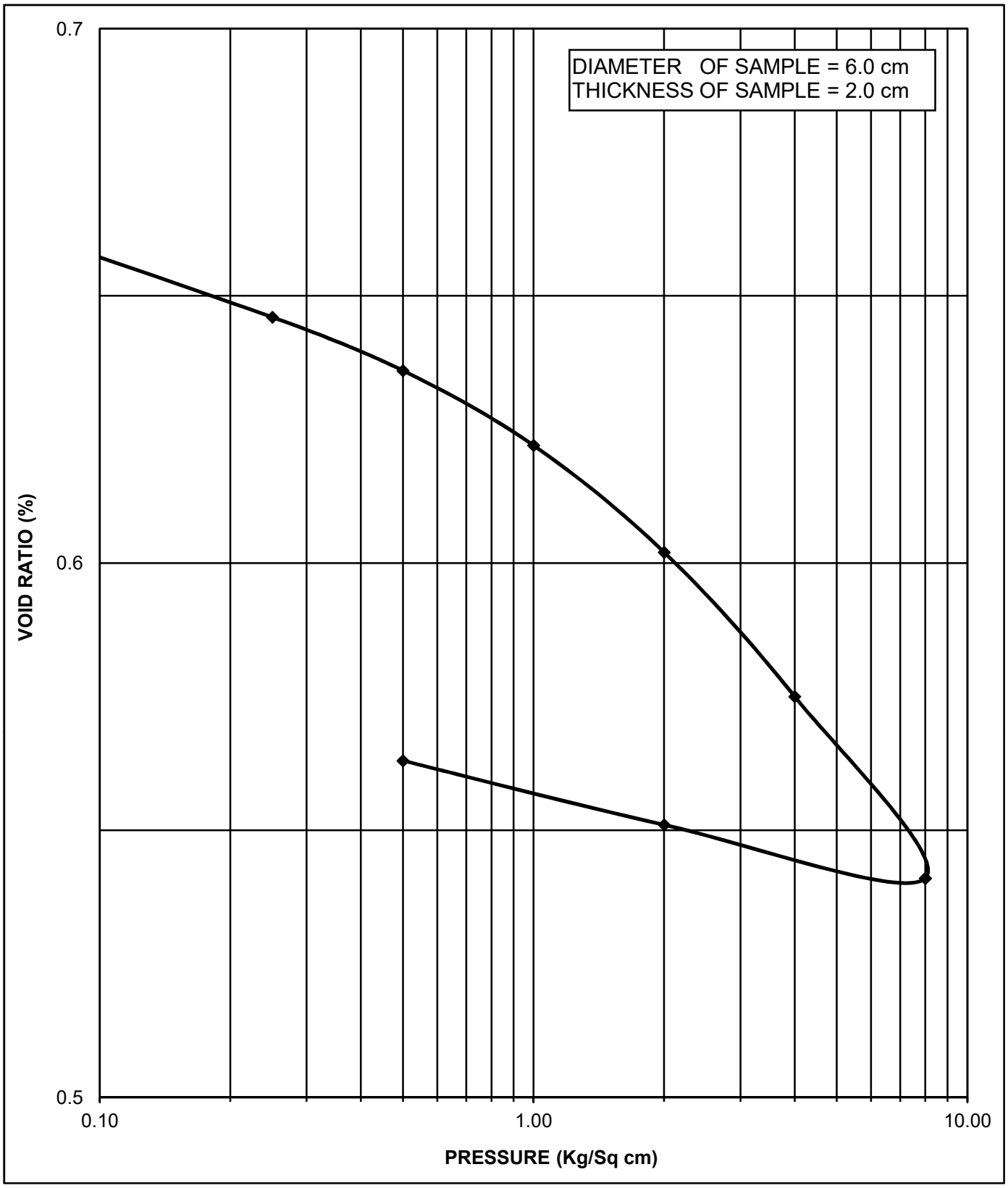


Figure No. -



BORE HOLE NO. = BH-A1

CHAINAGE = 9+726

SAMPLE NO. = UDS-07

DEPTH = 20.50 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 23.40 %

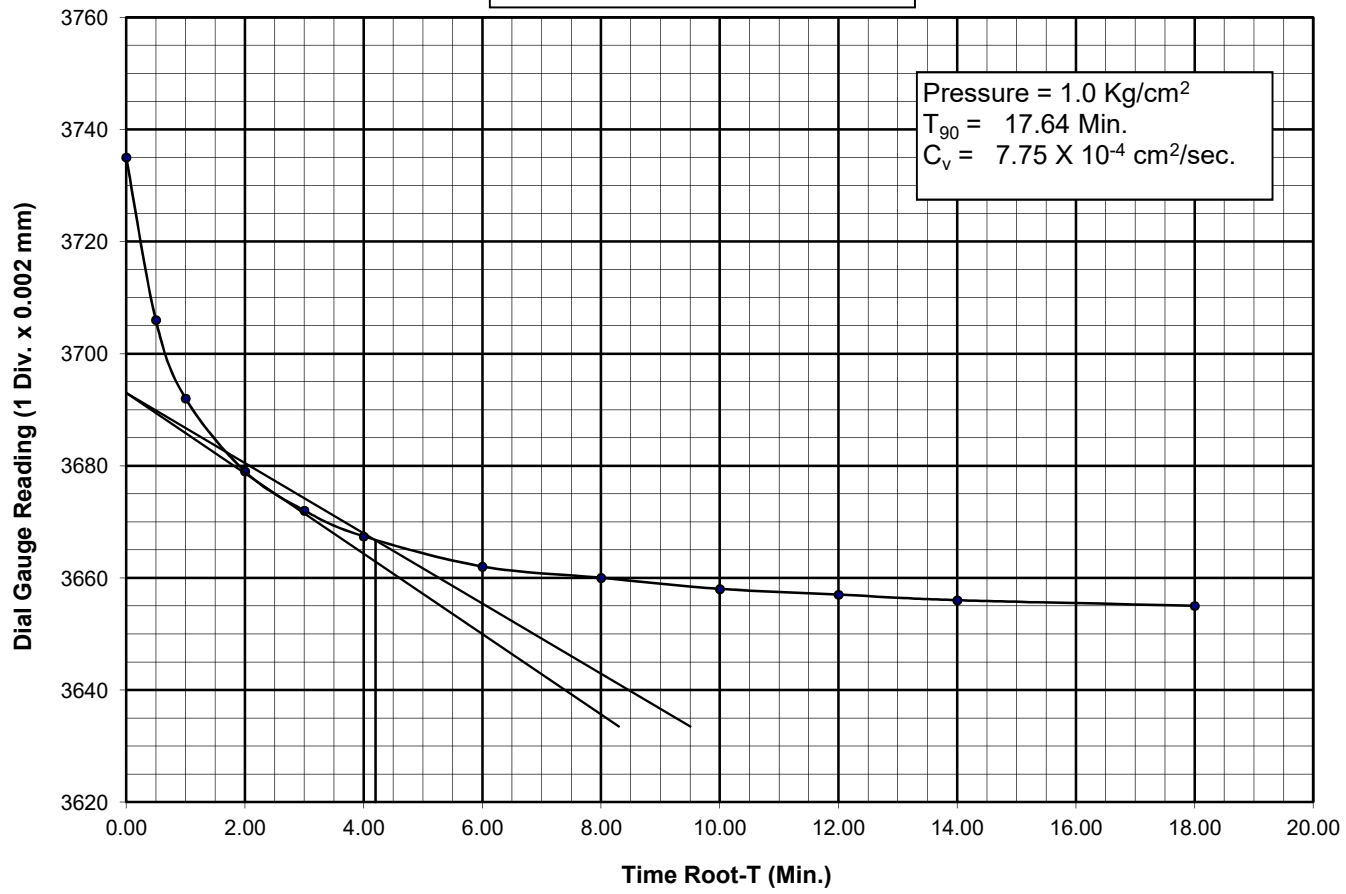
DRY DENSITY = 1.62 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESSION INDEX (C_c) = 0.113

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-A1
CHAINAGE = 9+726
SAMPLE NO. = UDS-07
DEPTH = 20.50 M



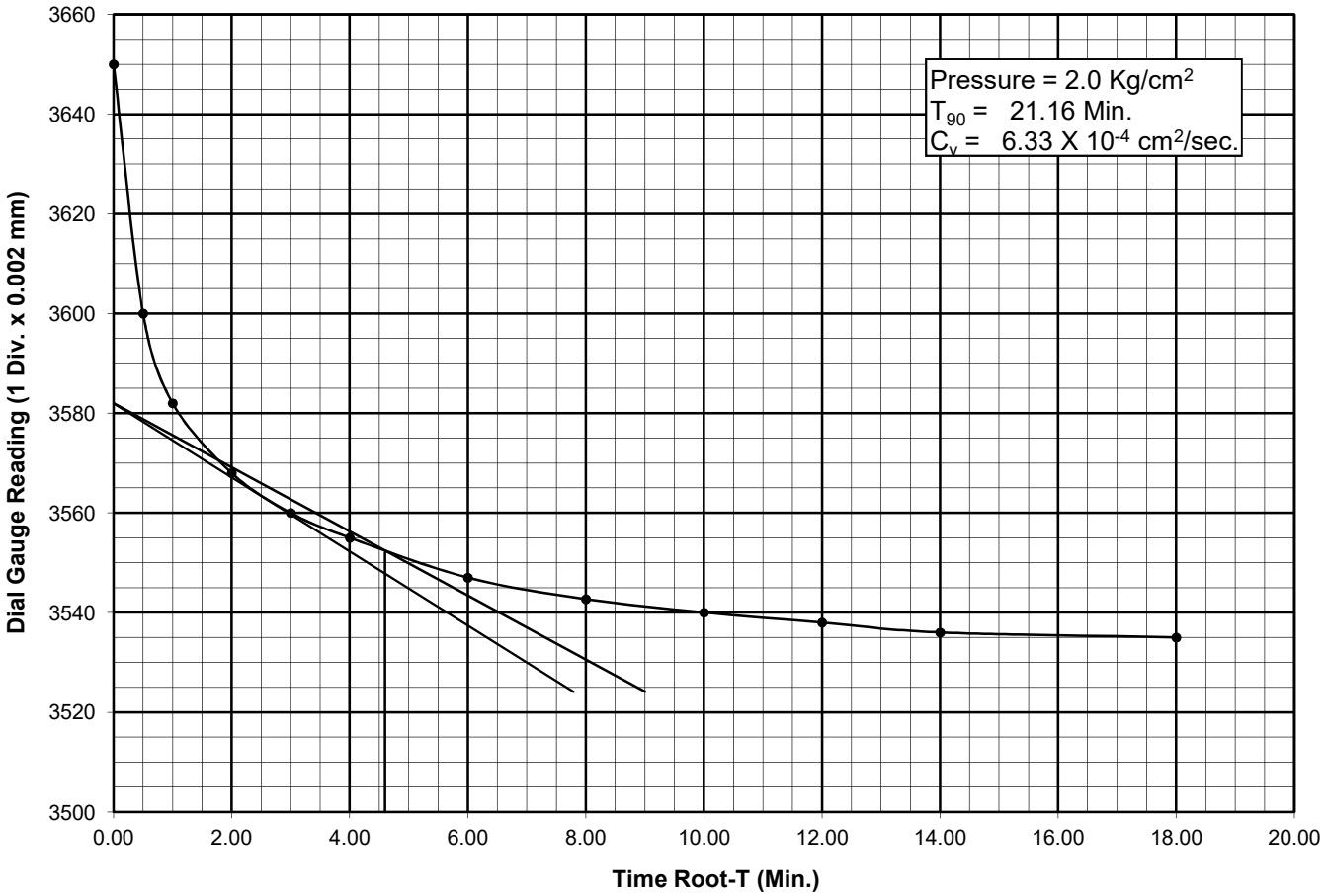
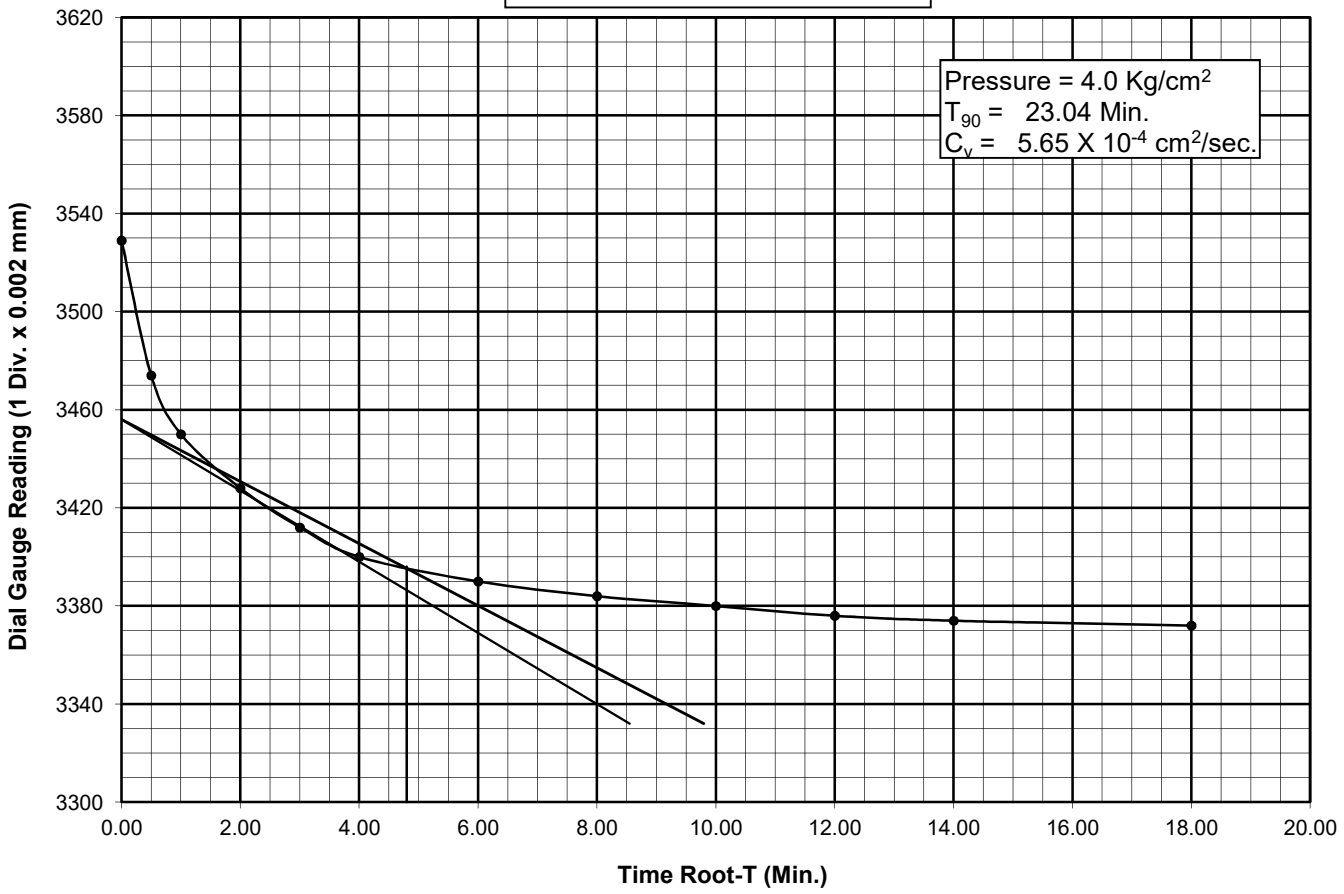


Figure No. -

BORE HOLE NO. = BH-A1
CHAINAGE = 9+726
SAMPLE NO. = UDS-07
DEPTH = 20.50 M



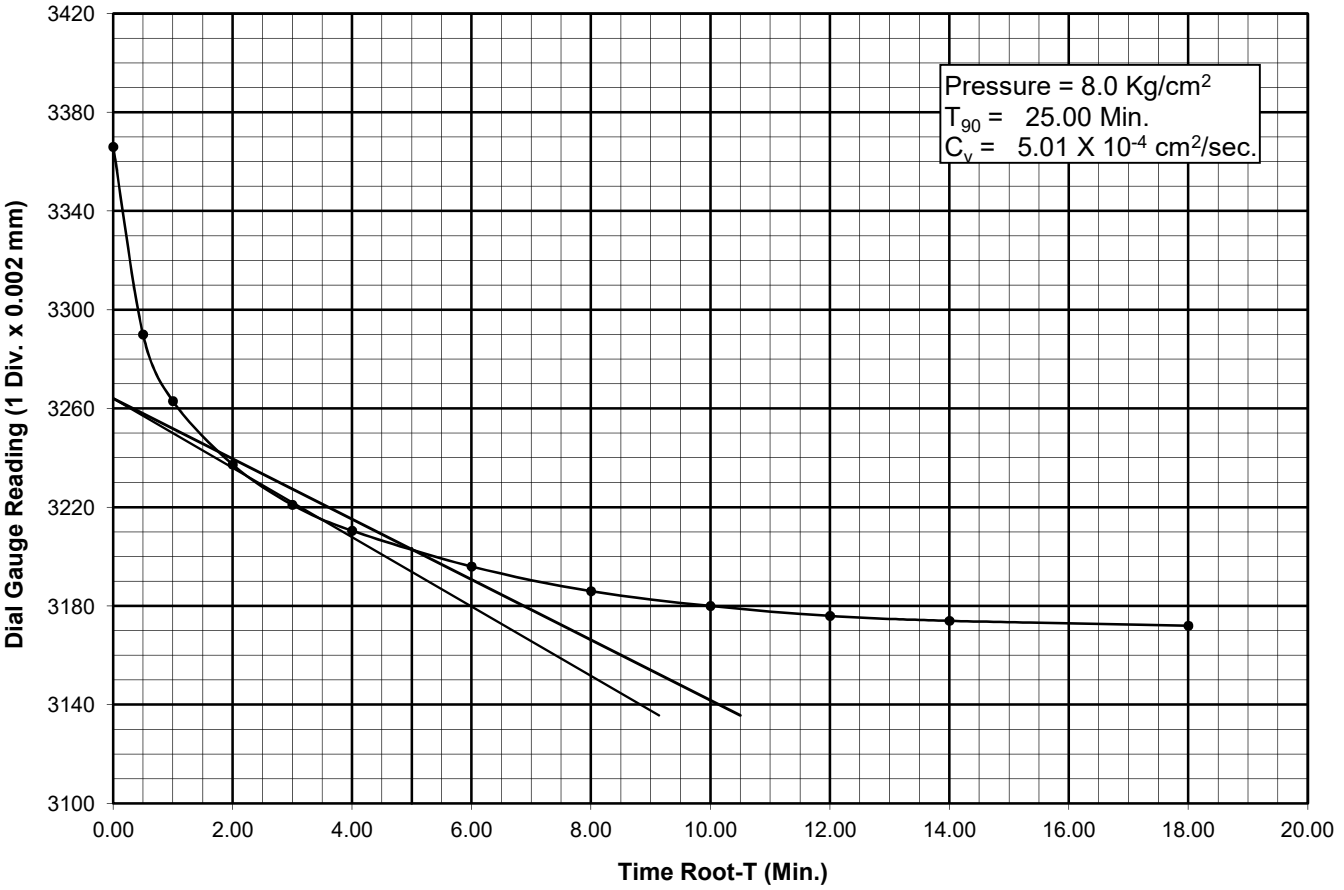
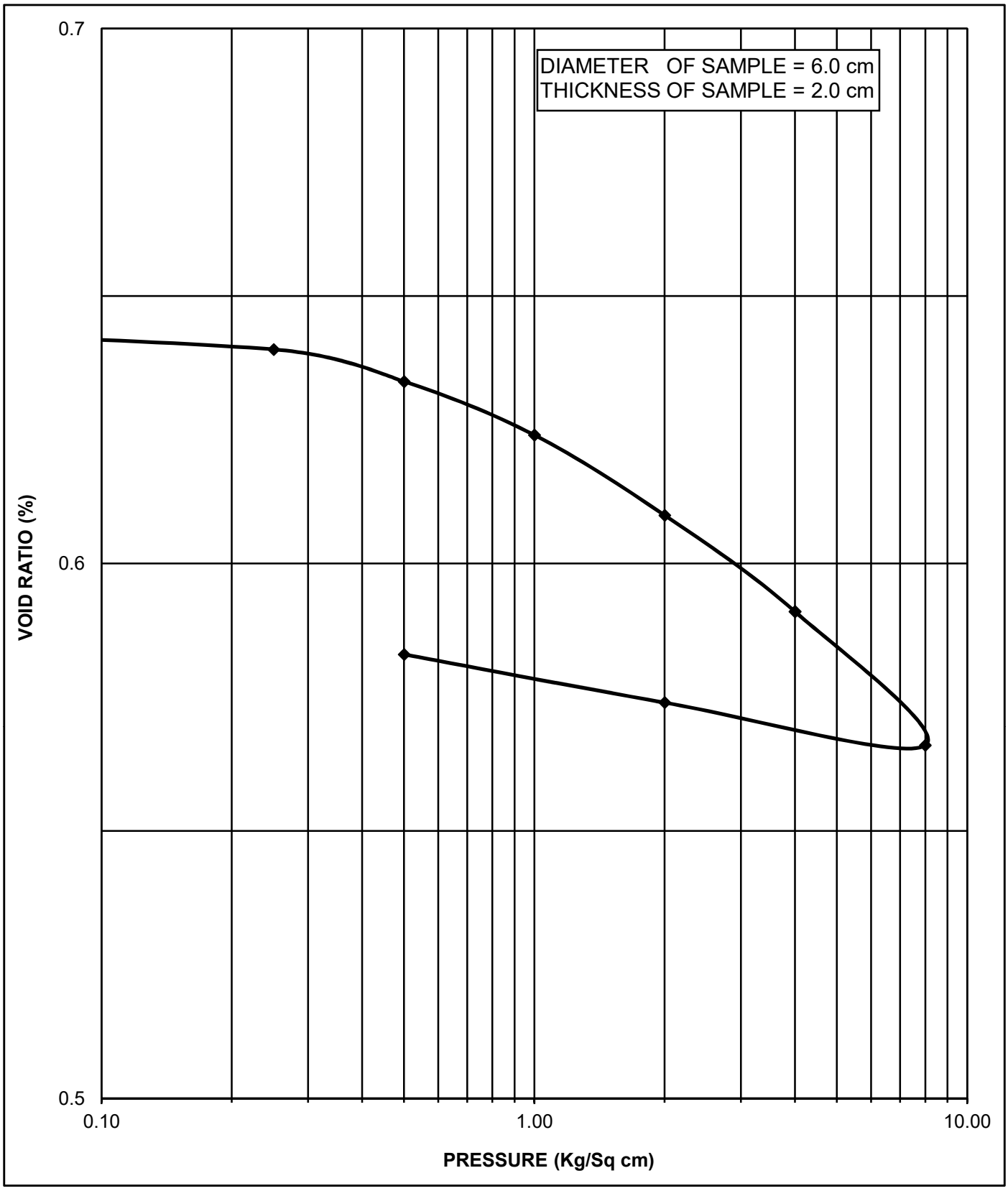


Figure No. -



BORE HOLE NO. = BH-A1

CHAINAGE = 17+625

SAMPLE NO. = UDS- 07

DEPTH = 19.00 M

TYPY OF SOIL = CL

INITIAL WATER CONTENT = 21.46 %

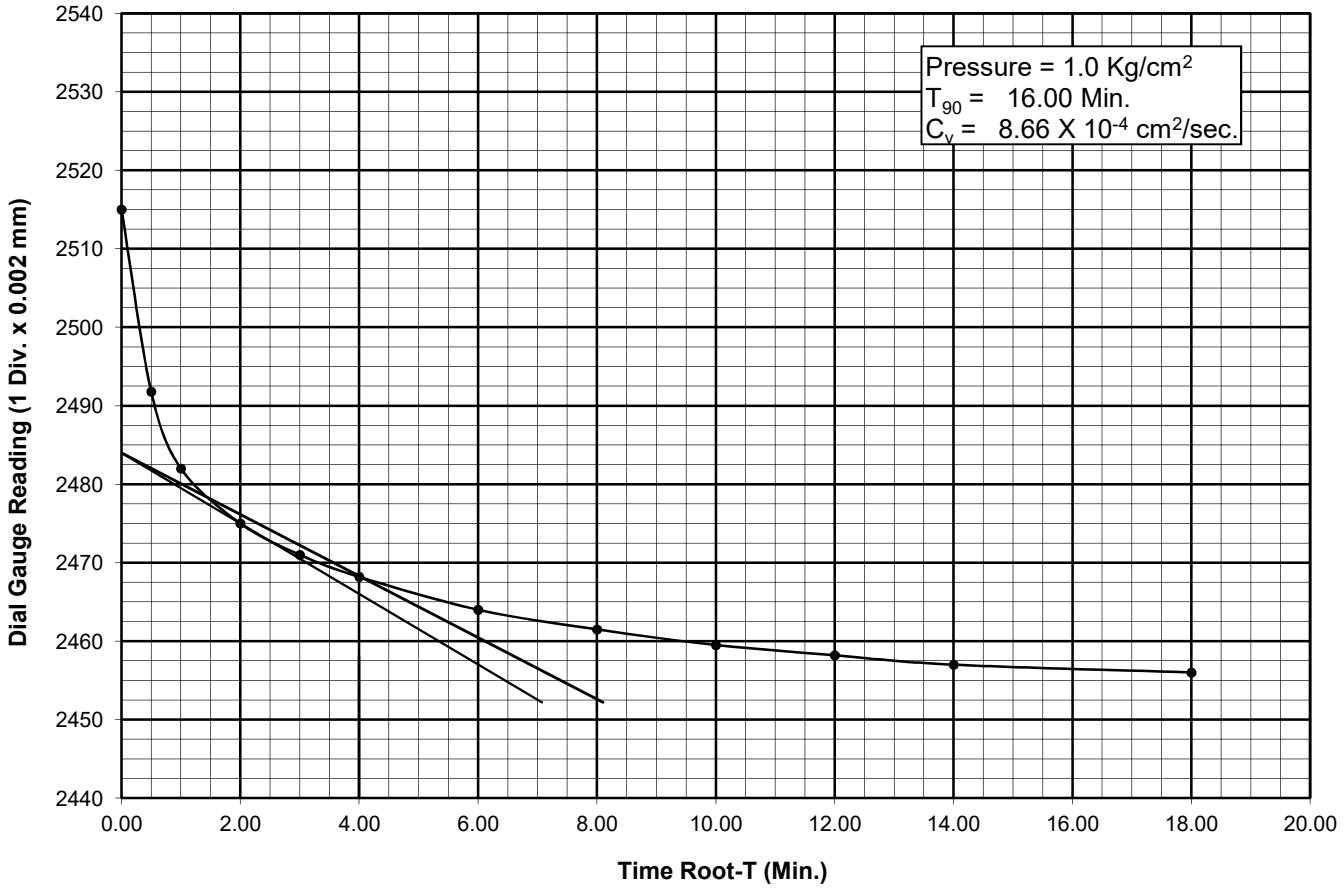
DRY DENSITY = 1.68 gm/cm^3

VOID RATIO (e_o) = 0.595

COMPRESIVE INDEX (C_c) = 0.083

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-A1
CHAINAGE = 17+625
SAMPLE NO. = UDS-07
DEPTH = 19.00 M



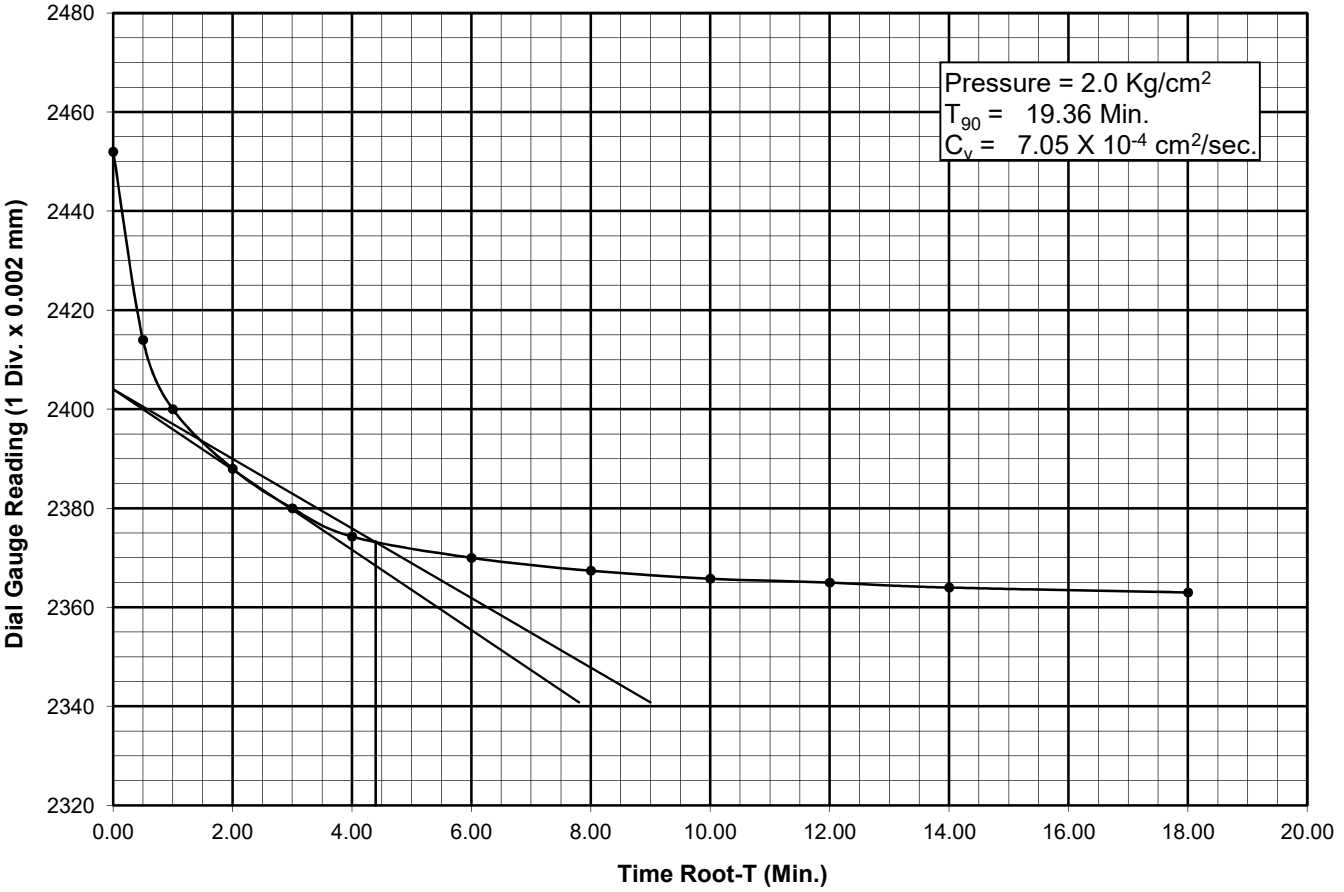
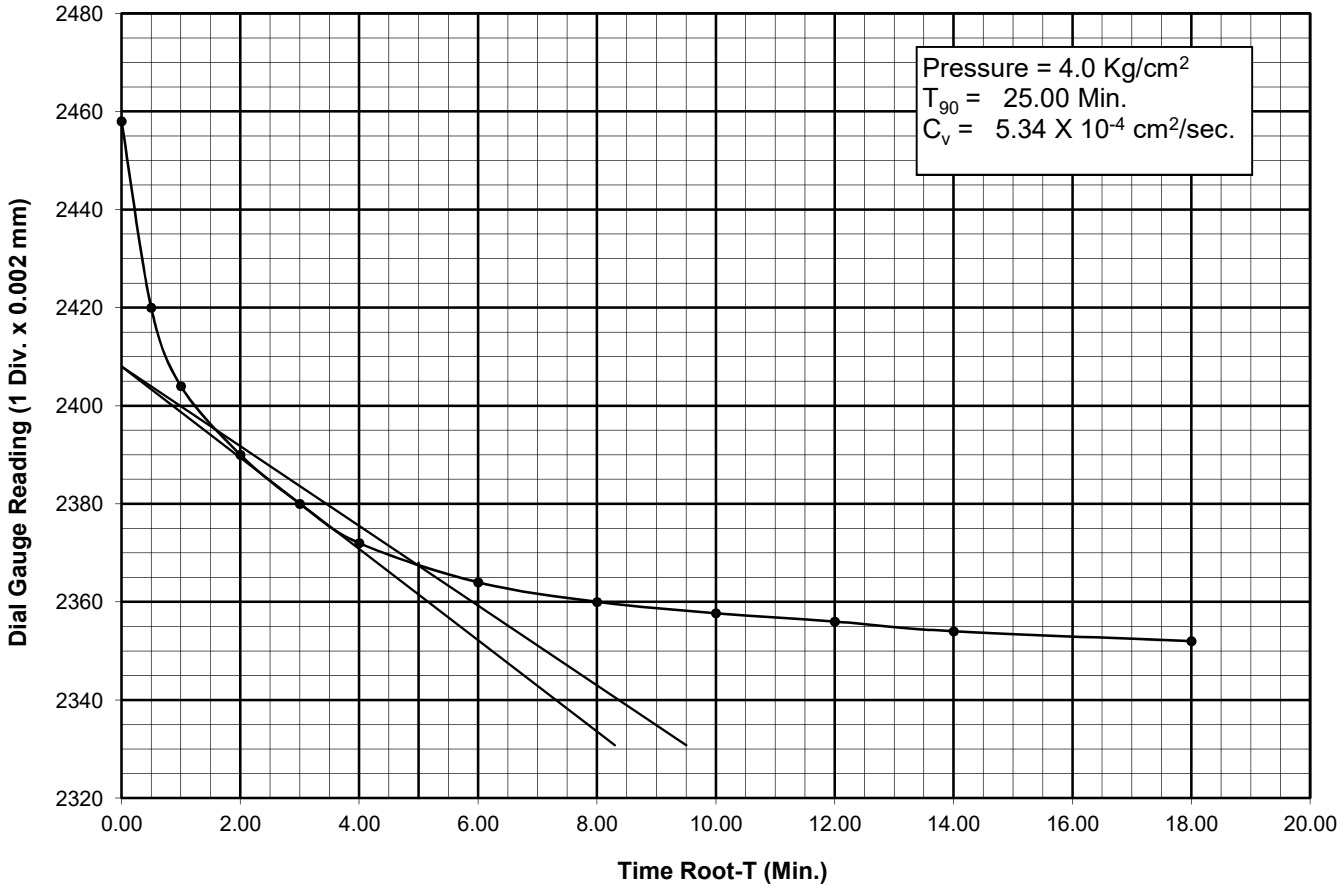


Figure No. -

BORE HOLE NO. = BH-A1
CHAINAGE = 17+625
SAMPLE NO. = UDS-07
DEPTH = 19.00 M



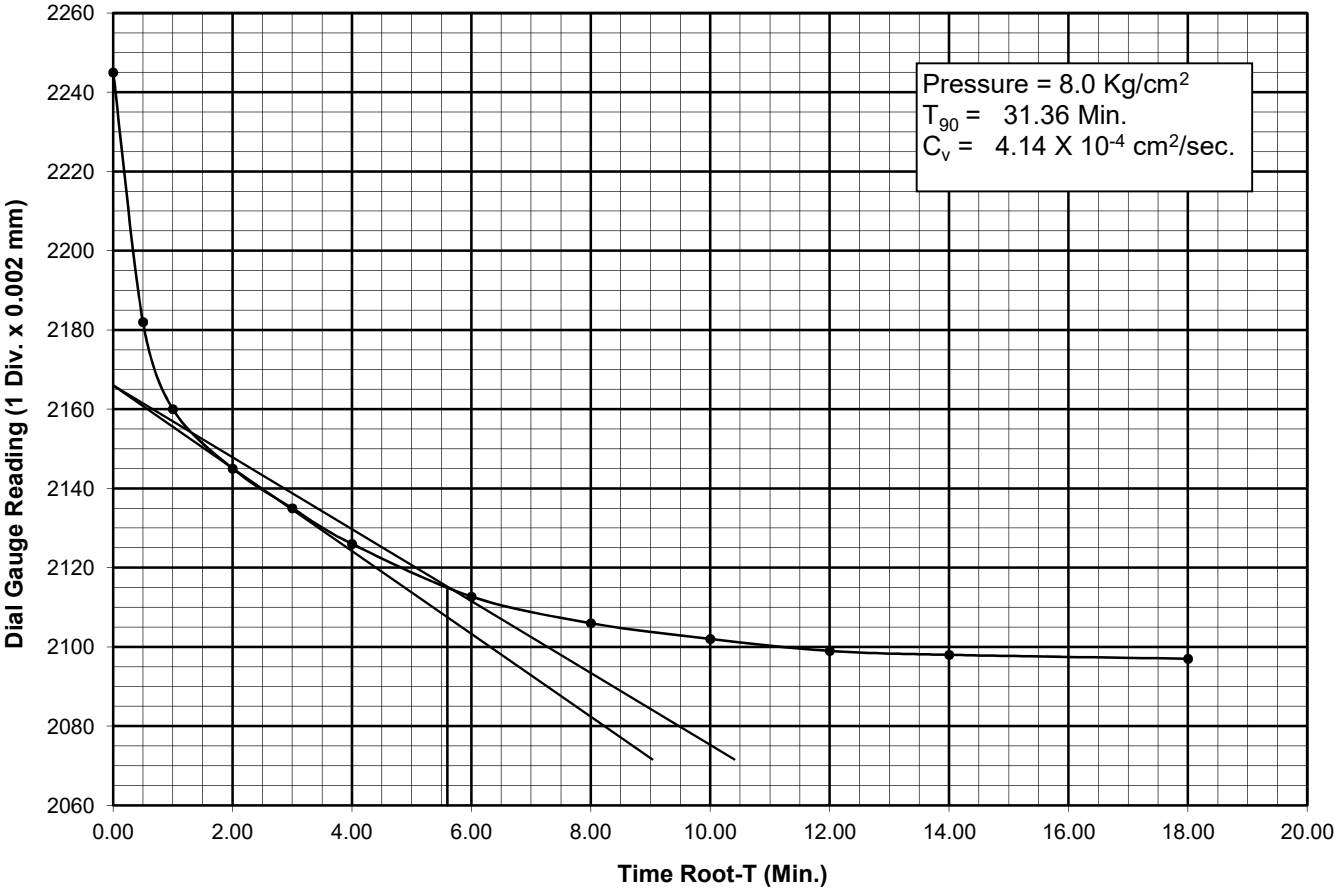
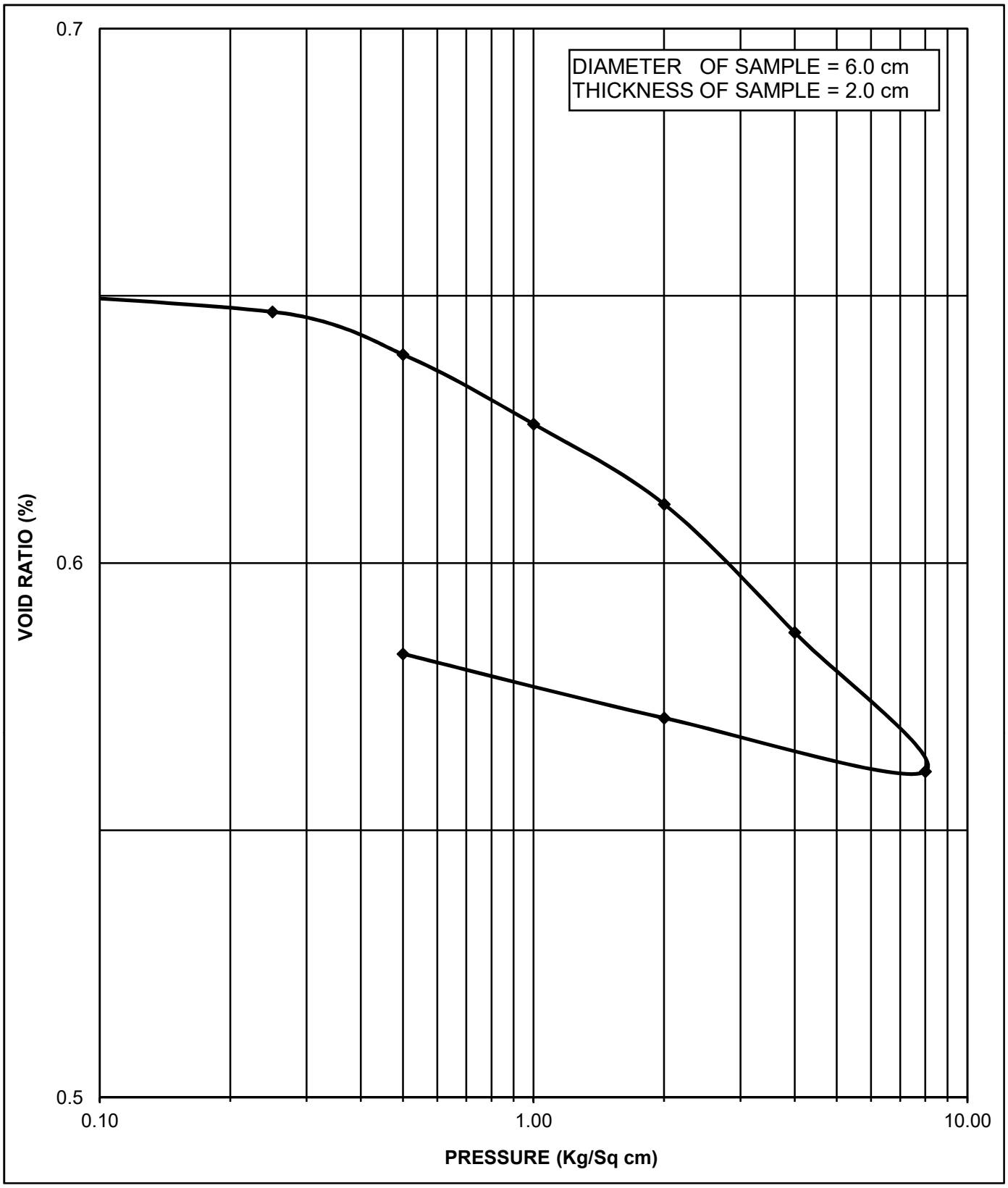


Figure No. -



BORE HOLE NO. = BH-A1

CHAINAGE = 18+750

SAMPLE NO. = UDS-8

DEPTH = 23.50 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 20.46 %

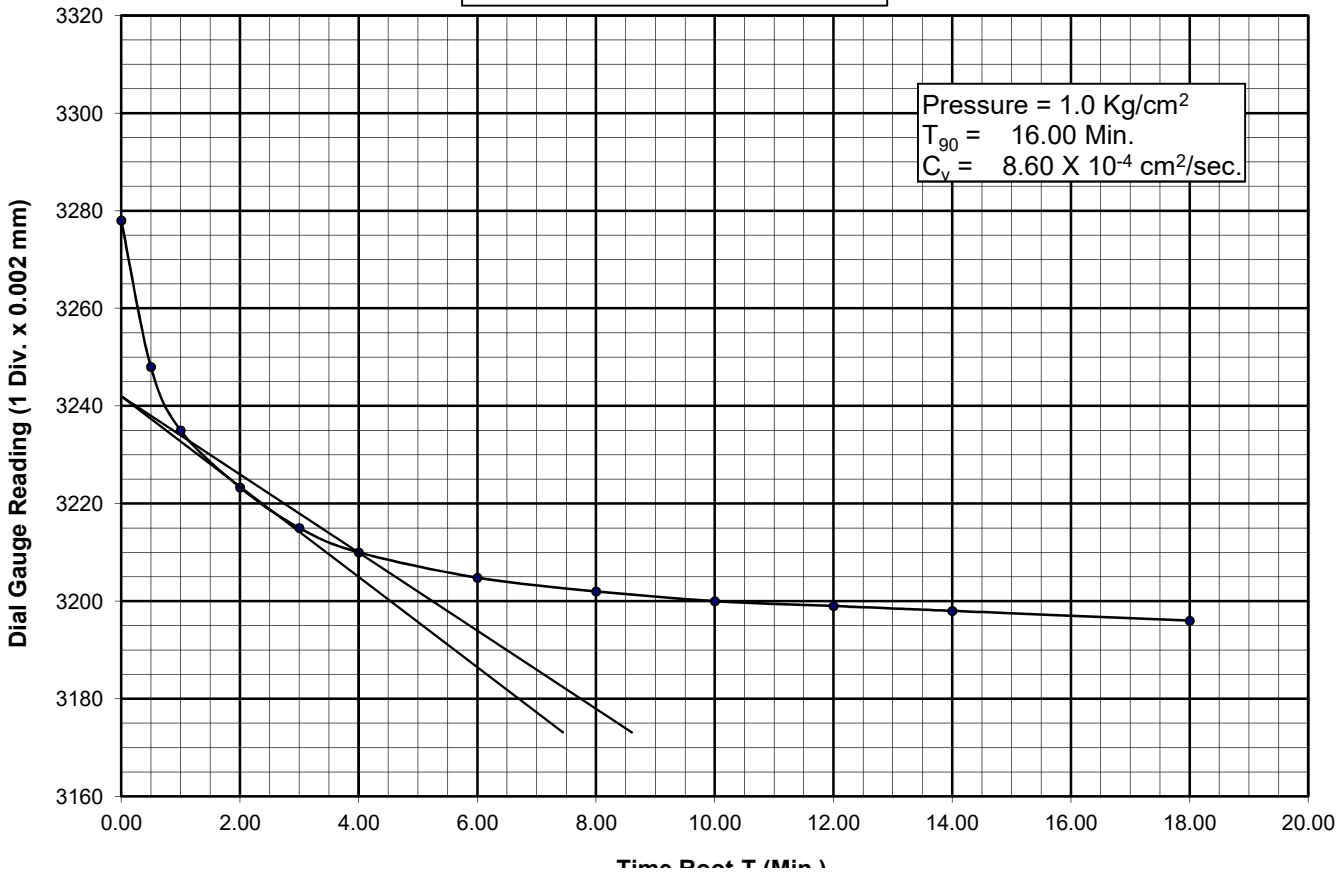
DRY DENSITY = 1.69 gm/cm^3

VOID RATIO (e_o) = 0.605

COMPRESSION INDEX (C_c) = 0.086

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-A1
CHAINAGE = 18+750
SAMPLE NO. = UDS-08
DEPTH = 23.50 M



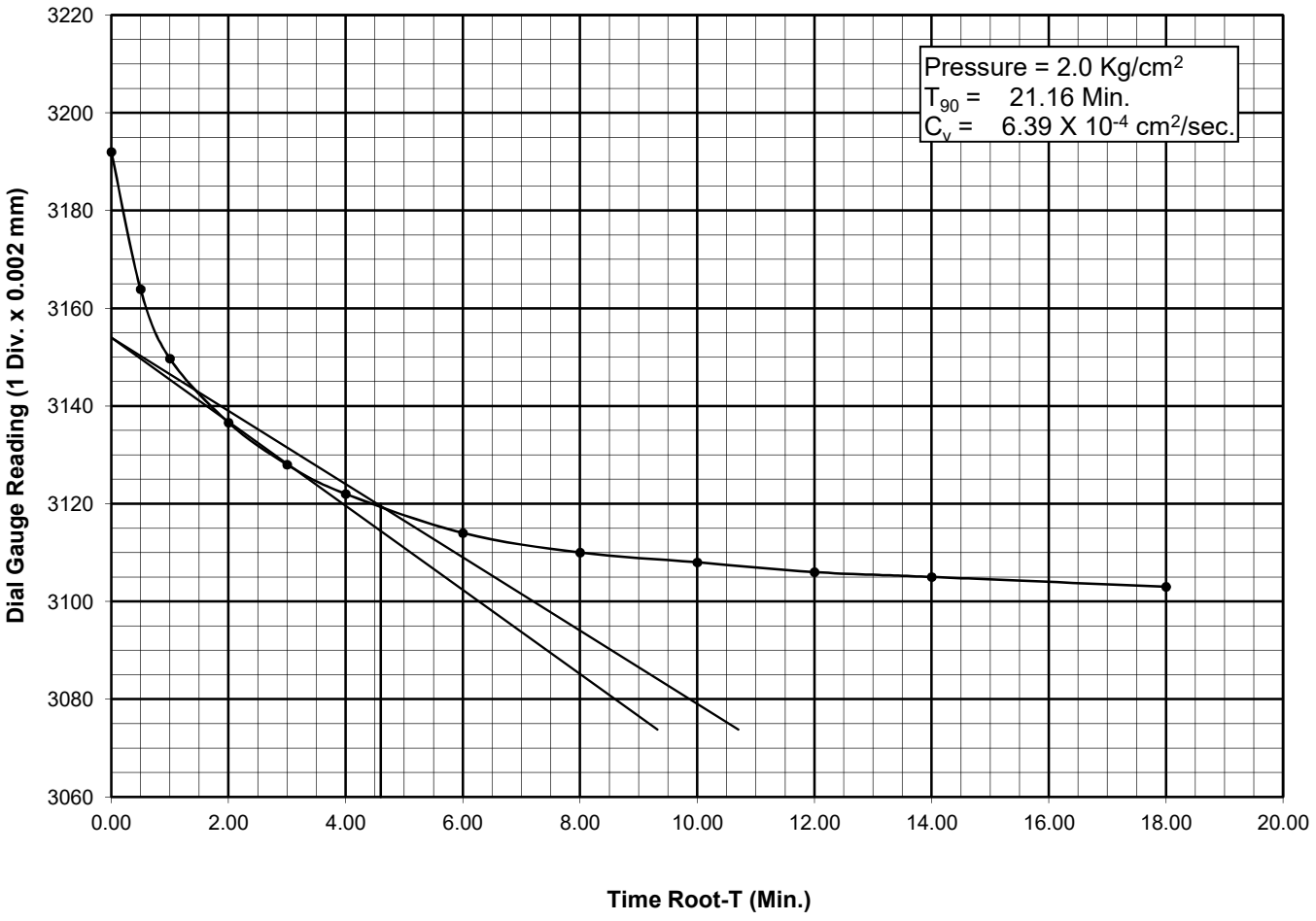
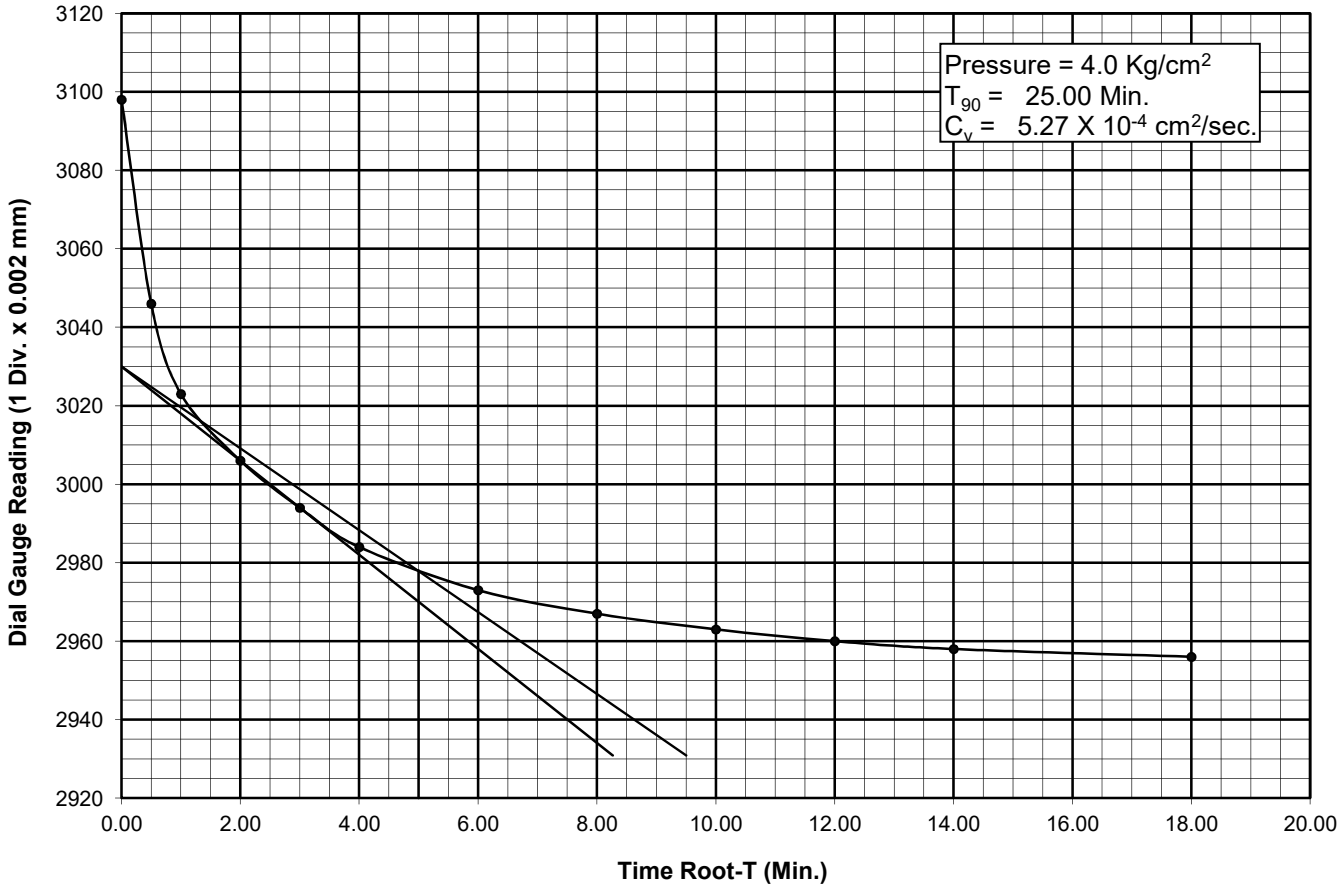


Figure No. -

BORE HOLE NO. = BH-A1
CHAINAGE = 18+750
SAMPLE NO. = UDS-08
DEPTH = 23.50 M



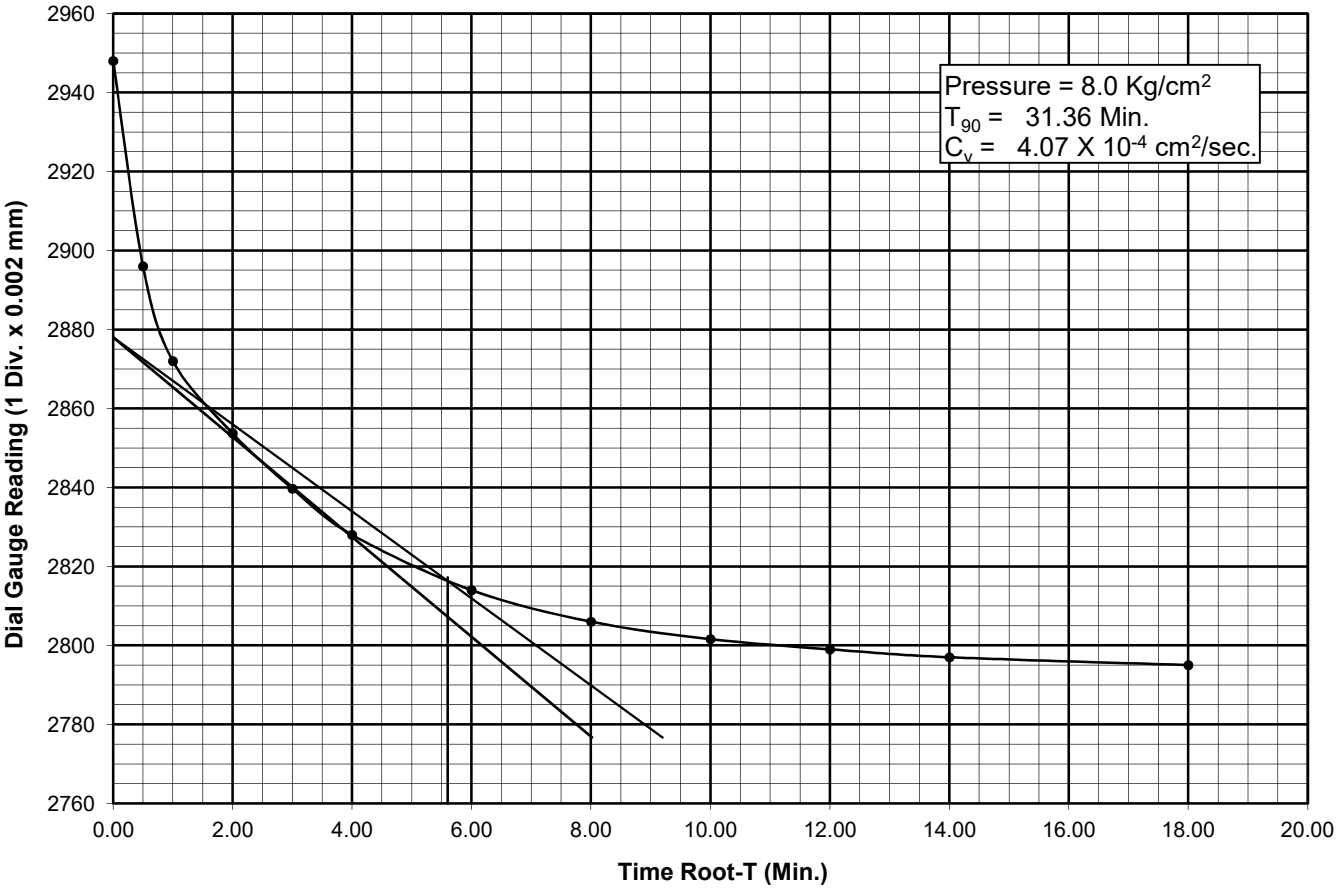
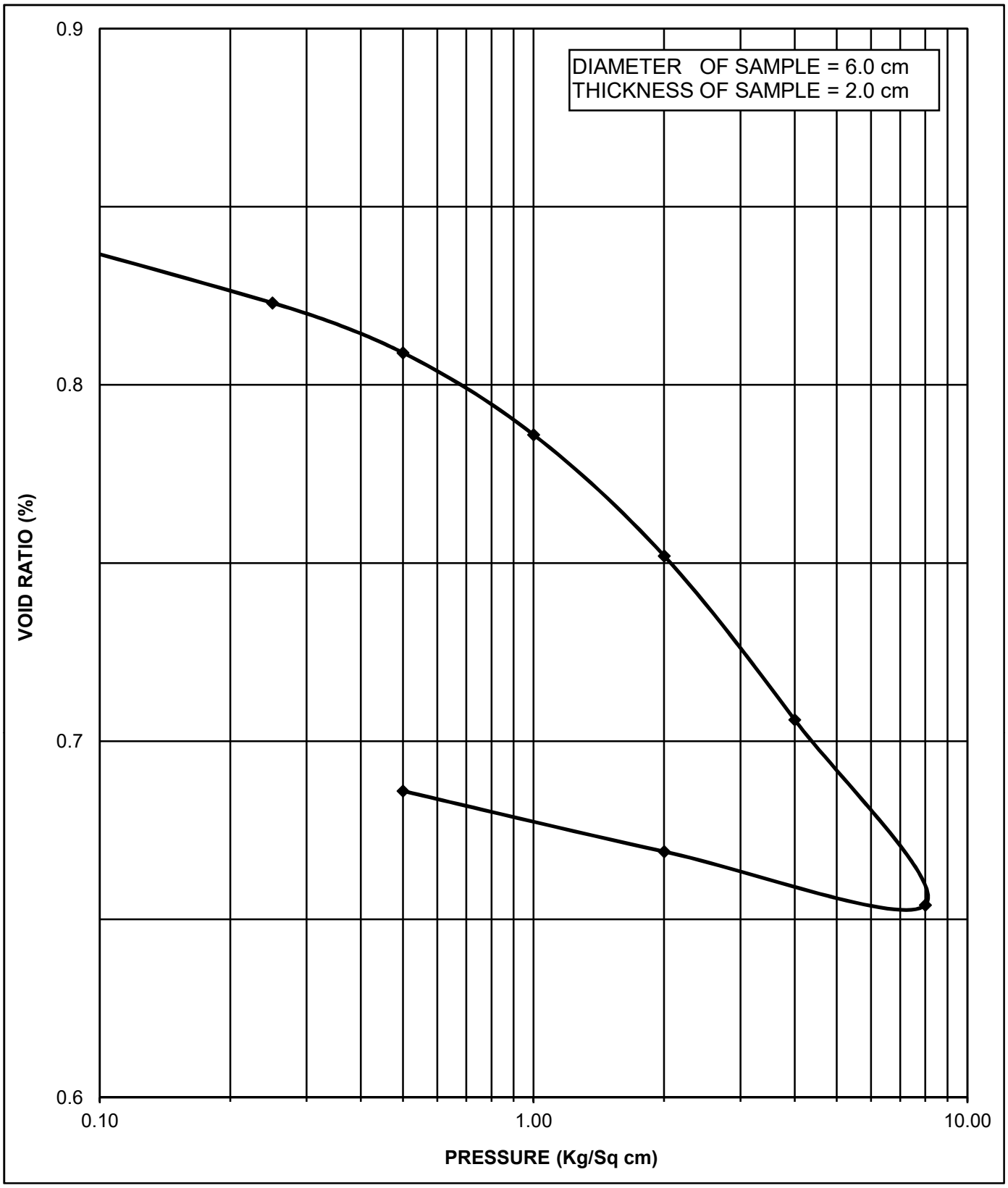


Figure No. -



BORE HOLE NO. = BH-P2

CHAINAGE = 20+300

SAMPLE NO. = UDS-01

DEPTH = 2.50 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 28.13 %

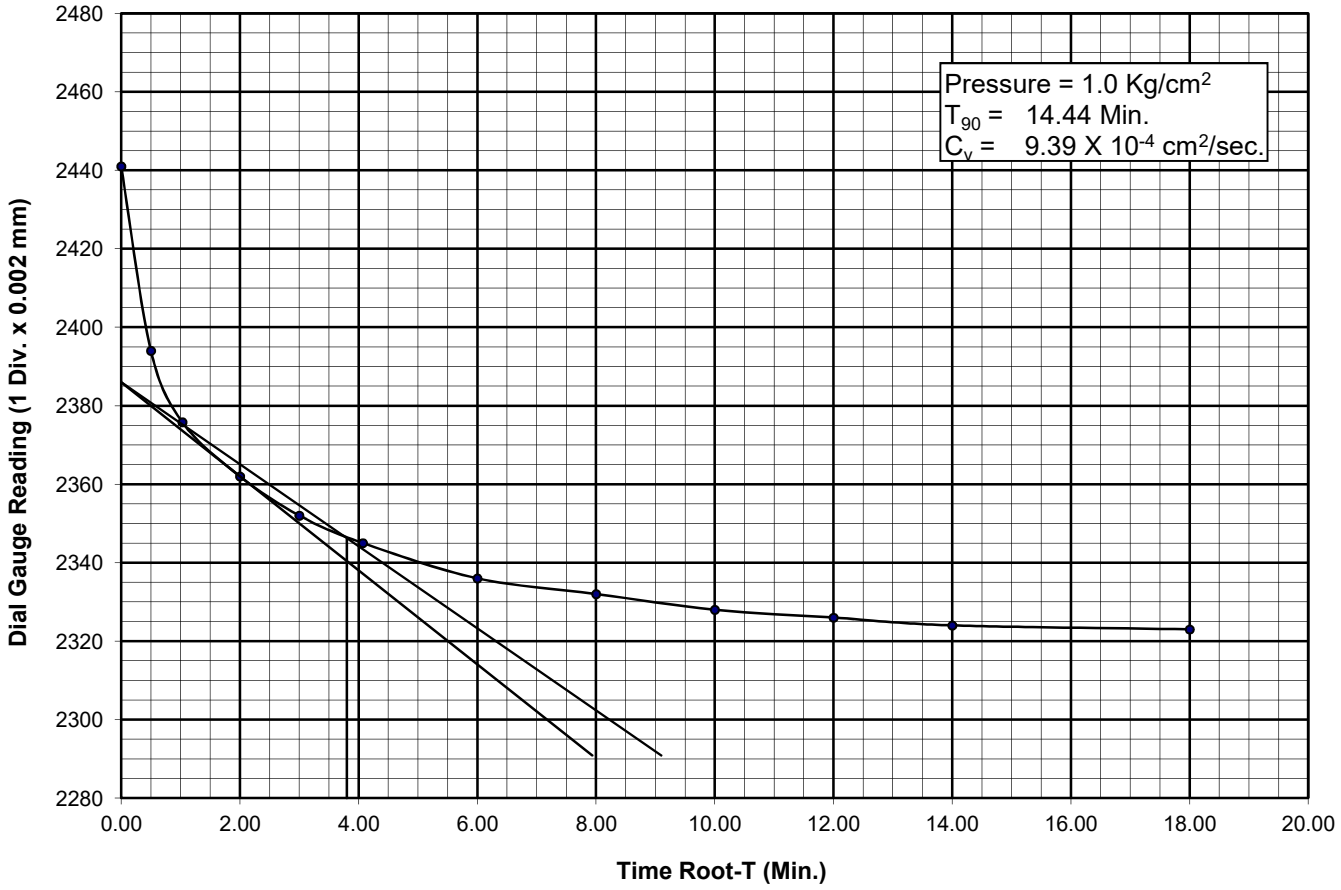
DRY DENSITY = 1.46 gm/cm^3

VOID RATIO (e_o) = 0.835

COMPRESSION INDEX (C_c) = 0.173

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-P2
CHAINAGE = 20+300
SAMPLE NO. = UDS-01
DEPTH = 2.50 M



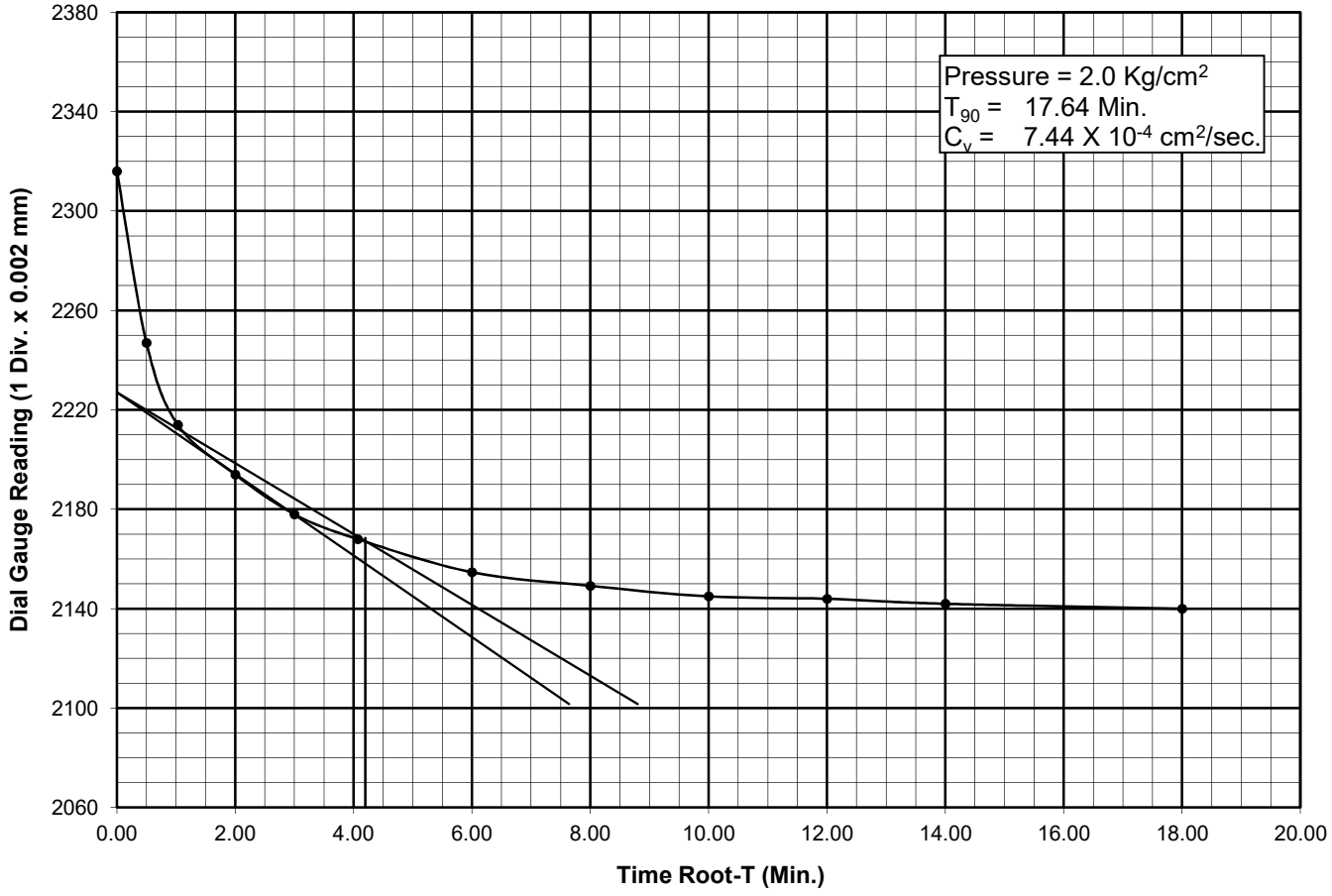
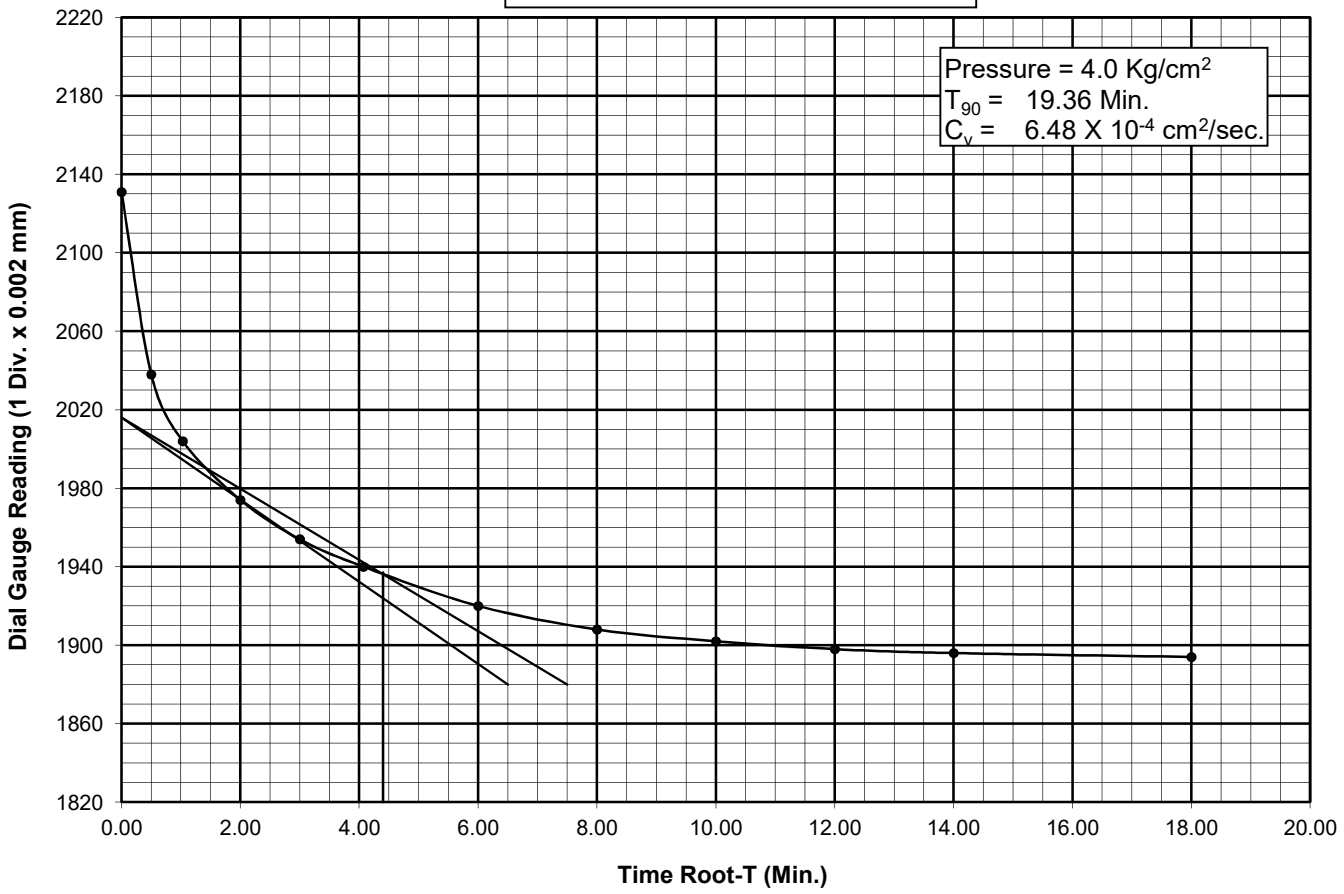


Figure No. -

BORE HOLE NO. = BH-P2
CHAINAGE = 20+300
SAMPLE NO. = UDS-01
DEPTH = 2.50 M



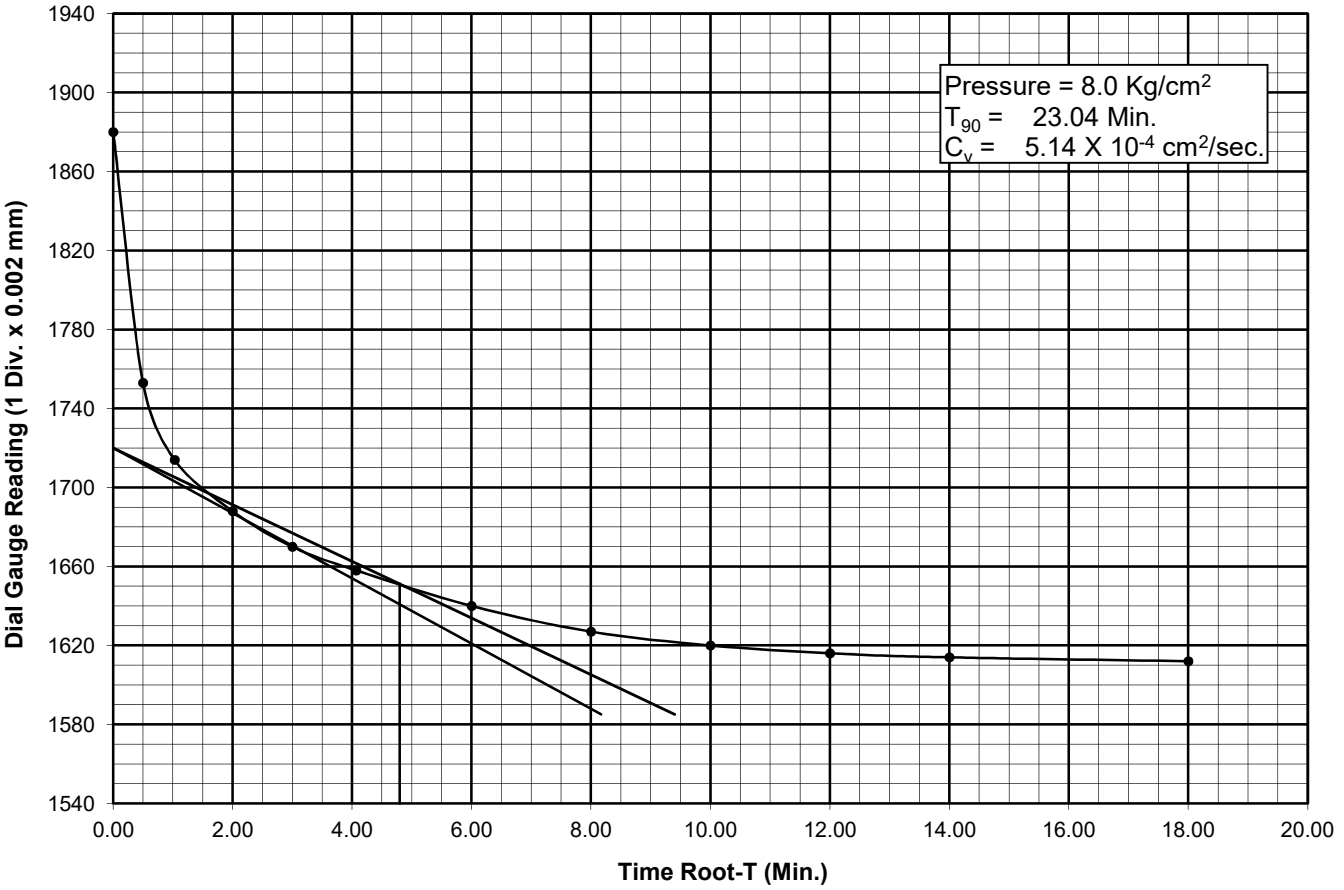


Figure No. -

APPENDIX – C
(ANALYSIS & RECOMENDATION)

Appendix No.	ITEMS
C-1	SAMPLE CALCULATION SHEET OF LIQUEFACTION ANALYSIS RESULTS
C-2	SAMPLE CALCULATIONS FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR SHALLOW 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

Liquefaction Analysis as per 2. IS code1893 Part I: 2016, IRC:75-2015 & RDSO BS-118

Chainage (Km)	(-)0+627	BH No.:-	BH-CL	Liquefiable upto=	NL		Water Table depth considered for analysis (m):-	0.00

Depth Below G.L. (z) in m	Observed SPT Value	Saturated Density (t/m^3)	Submerged Density (t/m^3)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Moisture Content @ 100% saturation	Strata Type	Liquefaction Check for Cohesive Strata	Fine Content (%)	Stress Reduction Coefficient (rd)	Total Overburden Press (σ_o), t/m^2	Effective Overburden (σ'_o), t/m^2	Critical Stress Ratio (CSR)	C_{60}	Stress Normalization Factor(C_N)	SPT Corrected $(N1)_{60}$	α	β	$(N1)_{60CS}$	$CRR_{M=7.5}$	K_M	Kα	Kσ	CRR_{Mw}	FOS	Conclusion
1.00	20	1.99	1.99					Cohesionless		14	0.992	1.80	0.80	0.348	1.000	1.70	34.0	2.20	1.04	37.65	NA	1.19	1	1.00	NA	>1	Non Liquefiable
4.00	28	1.99	1.99					Cohesionless		14	0.969	7.77	6.77	0.174	1.000	1.20	33.7	2.20	1.04	37.33	NA	1.19	1	1.00	NA	>1	Non Liquefiable
7.00	41	2.00	1.00					Cohesionless		18	0.946	13.74	12.74	0.159	1.000	0.88	36.0	3.23	1.07	41.59	NA	1.19	1	1.00	NA	>1	Non Liquefiable
10.00	51	1.99	0.99					Cohesionless		15	0.907	19.75	15.75	0.177	1.000	0.79	40.2	2.50	1.05	44.67	NA	1.19	1	1.00	NA	>1	Non Liquefiable

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- 3+497

BH NO. :- BH-A1

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	4.00
Cohesion (c in t/m^2)	8.50
Void ratio (e), e = (G.γ_w/γ_d)-1	0.70
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.82
Depth of water table(m)	13.25
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	2.00	7.20
2	3.00	7.20
3	4.00	7.20

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	4.00	ϕ'	2.68
N_c	6.19	N'_c	5.81
N_q	1.43	N'_q	1.27
N_γ	0.34	N'_γ	0.21

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	7.20	1.30	1.20	0.80
2	7.20	1.30	1.20	0.80
3	7.20	1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	2.00	7.20	1.06	1.00	1.00
2	3.00	7.20	1.09	1.00	1.00
3	4.00	7.20	1.12	1.00	1.00

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1- \alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	2.00	7.20	1.56	1.00
2	3.00	7.20	1.42	1.00
3	4.00	7.20	1.28	1.00

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	2.00	7.20	30.44	19.07	22.13
2	3.00	7.20	31.63	19.82	23.00
3	4.00	7.20	32.82	20.57	23.86

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): 3+497						BH NO. :- BH-A1			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/kg)	Consolidation Settlement (mm)	Water Table Correction Factor	Modulus of Soil (Kg/Cm^2)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		2.00	4.00	2.00				2.00	7.20	7.200	0.716	8			0.50	57.5	0.30	80.00	19.26	19.26			
Layer 2		4.00	8.50	4.50				4.50	11.450	11.450	0.283	26	0.0051	6.54	0.50	96	0.45			6.54			
Layer 3		8.50	11.50	3.00				3.00	13.700	13.700	0.198	43				290	0.30	6.50	0.35	0.35			
Layer 4	2.00	11.50	12.80	1.30	0.72	7.20	7.20	1.30	17.350	17.350	0.123	27	0.0049	0.79	0.50	99	0.45			0.79	0.93	1.00	25.00
Layer 1		3.00	4.00	1.00				1.00	7.20	7.200	1.023	8			0.50	57.5	0.30	80.00	14.45	14.45			
Layer 2		4.00	8.50	4.50				4.50	10.450	10.450	0.486	26	0.0051	11.21	0.50	96	0.45			11.21			
Layer 3		8.50	11.50	3.00				3.00	12.700	12.700	0.329	43				290	0.30	6.50	0.62	0.62			
Layer 4	3.00	11.50	13.80	2.30	1.02	7.20	7.20	2.30	16.850	16.850	0.187	27	0.0049	2.12	0.50	99	0.45			2.12	0.88	1.00	25.00
Layer 1		4.00	8.50	4.50				4.50	9.45	9.450	1.005	26	0.0051	23.19	0.50	96	0.45			23.19			
Layer 2		8.50	11.50	3.00				3.00	11.700	11.700	0.656	43			0.50	290	0.30	6.50	1.33	1.33			
Layer 3		11.50	14.80	3.30				3.30	16.350	16.350	0.336	27	0.0049	5.47		99	0.45			5.47			
	4.00				1.73	7.20	7.20								0.50						0.83	1.00	25.00

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): 3+497						BH NO. :- BH-A1			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/kg)	Consolidation Settlement (mm)	Water Table Correction Factor	Modulus of Soil (Kg/Cm^2)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		2.00	4.00	2.00				2.00	7.20	7.200	1.433	8			0.50	57.5	0.30	80.00	38.52	38.52			
Layer 2		4.00	8.50	4.50				4.50	11.450	11.450	0.567	26	0.0051	13.07	0.50	96	0.45			13.07			
Layer 3		8.50	11.50	3.00				3.00	13.700	13.700	0.396	43				290	0.30	6.50	0.70	0.70			
Layer 4	2.00	11.50	12.80	1.30	1.43	7.20	7.20	1.30	17.350	17.350	0.247	27	0.0049	1.58	0.50	99	0.45			1.58	0.93	1.00	50.00
Layer 1		3.00	4.00	1.00				1.00	7.20	7.200	2.046	8			0.50	57.5	0.30	80.00	28.90	28.90			
Layer 2		4.00	8.50	4.50				4.50	10.450	10.450	0.971	26	0.0051	22.41	0.50	96	0.45			22.41			
Layer 3		8.50	11.50	3.00				3.00	12.700	12.700	0.658	43				290	0.30	6.50	1.24	1.24			
Layer 4	3.00	11.50	13.80	2.30	2.05	7.20	7.20	2.30	16.850	16.850	0.374	27	0.0049	4.24	0.50	99	0.45			4.24	0.88	1.00	50.00
Layer 1		4.00	8.50	4.50				4.50	9.45	9.450	2.010	26	0.0051	46.38	0.50	96	0.45			46.38			
Layer 2		8.50	11.50	3.00				3.00	11.700	11.700	1.311	43			0.50	290	0.30	6.50	2.66	2.66			
Layer 3		11.50	14.80	3.30				3.30	16.350	16.350	0.671	27	0.0049	10.94	0.50	99	0.45			10.94			
	4.00				3.46	7.20	7.20														0.83	1.00	50.00

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- 3+497

BH NO. :- BH-A1

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	12.29
Cohesion (c in t/m^2)	5.89
Void ratio (e), e = (G.γ_w/γ_d)-1	0.67
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.82
Depth of water table(m)	13.25
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	2.00	7.20
2	3.00	7.20
3	4.00	7.20

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	12.29	ϕ'	8.31
N_c	9.43	N'_c	7.65
N_q	3.06	N'_q	2.12
N_γ	1.77	N'_γ	0.91

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	7.20	1.30	1.20	0.80
2	7.20	1.30	1.20	0.80
3	7.20	1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	2.00	7.20	1.07	1.03	1.03
2	3.00	7.20	1.10	1.05	1.05
3	4.00	7.20	1.14	1.07	1.07

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1- \alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	2.00	7.20	1.56	1.00
2	3.00	7.20	1.42	1.00
3	4.00	7.20	1.28	1.00

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	2.00	7.20	38.41	20.67	27.63
2	3.00	7.20	41.42	22.29	29.80
3	4.00	7.20	44.48	23.95	32.01

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): 3+497						BH NO. :- BH-A1			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/kg)	Consolidation Settlement (mm)	Water Table Correction Factor	Modulus of Soil (Kg/Cm^2)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		2.00	5.00	3.00				3.00	7.20	7.200	1.375	25			0.50	100	0.30	11.50	15.13	15.13			
Layer 2		5.00	8.50	3.50				3.50	11.950	11.950	0.499	26	0.0051	8.96	0.50	96	0.45			8.96			
Layer 3		8.50	11.50	3.00				3.00	13.700	13.700	0.380	43			0.50	145	0.30	6.50	1.34	1.34			
Layer 4	2.00	11.50	12.80	1.30	1.37	7.20	7.20	1.30	17.350	17.350	0.237	27	0.0049	1.52	0.50	99	0.45			1.52	0.93	1.00	25.00
Layer 1		3.00	5.00	2.00				2.00	7.20	7.200	1.513	25			0.50	100	0.30	11.50	11.69	11.69			
Layer 2		5.00	8.50	3.50				3.50	10.950	10.950	0.654	26	0.0051	11.74	0.50	96	0.45			11.74			
Layer 3		8.50	11.50	3.00				3.00	12.700	12.700	0.486	43			0.50	145	0.30	6.50	1.83	1.83			
Layer 4	3.00	11.50	13.80	2.30	1.51	7.20	7.20	2.30	16.850	16.850	0.276	27	0.0049	3.14	0.50	99	0.45			3.14	0.88	1.00	25.00
Layer 1		4.00	5.00	1.00				1.00	7.20	7.200	1.651	25			0.50	100	0.30	11.50	6.71	6.71			
Layer 2		5.00	8.50	3.50				3.50	9.950	9.950	0.865	26	0.0051	15.52	0.50	96	0.45			15.52			
Layer 3		8.50	11.50	3.00				3.00	11.700	11.700	0.625	43			0.50	145	0.30	6.50	2.54	2.54			
Layer 4	4.00	11.50	14.80	3.30	1.65	7.20	7.20	3.30	16.350	16.350	0.320	27	0.0049	5.22	0.50	99	0.45			5.22	0.83	1.00	25.00

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): 3+497						BH NO. :- BH-A1			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/kg)	Consolidation Settlement (mm)	Water Table Correction Factor	Modulus of Soil (Kg/Cm^2)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		2.00	5.00	3.00				3.00	7.20	7.200	2.749	25			0.50	100	0.30	11.50	30.25	30.25			
Layer 2		5.00	8.50	3.50				3.50	11.950	11.950	0.998	26	0.0051	17.91	0.50	96	0.45			17.91			
Layer 3		8.50	11.50	3.00				3.00	13.700	13.700	0.759	43			0.50	145	0.30	6.50	2.67	2.67			
Layer 4	2.00	11.50	12.80	1.30	2.75	7.20	7.20	1.30	17.350	17.350	0.473	27	0.0049	3.04	0.50	99	0.45			3.04	0.93	1.00	50.00
Layer 1		3.00	5.00	2.00				2.00	7.20	7.200	3.025	25			0.50	100	0.30	11.50	23.38	23.38			
Layer 2		5.00	8.50	3.50				3.50	10.950	10.950	1.308	26	0.0051	23.47	0.50	96	0.45			23.47			
Layer 3		8.50	11.50	3.00				3.00	12.700	12.700	0.972	43			0.50	145	0.30	6.50	3.67	3.67			
Layer 4	3.00	11.50	13.80	2.30	3.03	7.20	7.20	2.30	16.850	16.850	0.552	27	0.0049	6.27	0.50	99	0.45			6.27	0.88	1.00	50.00
Layer 1		4.00	5.00	1.00				1.00	7.20	7.200	3.303	25			0.50	100	0.30	11.50	13.42	13.42			
Layer 2		5.00	8.50	3.50				3.50	9.950	9.950	1.730	26	0.0051	31.04	0.50	96	0.45			31.04			
Layer 3		8.50	11.50	3.00				3.00	11.700	11.700	1.251	43			0.50	145	0.30	6.50	5.08	5.08			
Layer 4	4.00	11.50	14.80	3.30	3.30	7.20	7.20	3.30	16.350	16.350	0.641	27	0.0049	10.44	0.50	99	0.45			10.44	0.83	1.00	50.00

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 18.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.67	200	0.17											
1.00		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								314.29		16.75	
1.00		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								314.29		48.71	
1.00		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								314.29		136.66	
1.00		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								314.29		130.11	
1.00		14.50	15.00	0.00	32	1.00	1.00	1.88	50	2.62								314.29		25.72	
1.00		15.00	19.00	0.00	32	1.00	1.00	1.88	400	2.67								314.29		209.49	
1.00		19.00	20.00	0.18	27	1.00	1.00	1.88	100	2.67	2.67	0.88	0.18	27	9	13.39	14.47	314.29	7857.14	48.36	298.18
																				615.80	298.18

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (615.8 + 298.18) / 2.5 Qa,uplift = 615.8 / 3 + 35.34

Qa,comp.= 365.59 T Qa,uplift = 240.61 T

Say **Qa,comp.= 365.00 T** **Qa,uplift = 240.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 20.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.67	200	0.17											
1.00		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								314.29		16.75	
1.00		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								314.29		48.71	
1.00		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								314.29		136.66	
1.00		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								314.29		130.11	
1.00		14.50	15.00	0.00	32	1.00	1.00	1.88	50	2.62								314.29		25.72	
1.00		15.00	19.00	0.00	32	1.00	1.00	1.88	400	2.67								314.29		209.49	
1.00		19.00	20.00	0.18	27	1.00	1.00	1.88	100	2.67								314.29		48.36	
1.00		20.00	22.00	0.18	27	1.00	1.00	0.88	200	2.67	2.67	0.88	0.18	27	9	13.39	14.47	314.29	7857.14	96.72	298.18
																				712.53	298.18

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (712.53 + 298.18) / 2.5 Qa,uplift = 712.53 / 3 + 39.27

Qa,comp.= 404.28 T Qa,uplift = 276.78 T

Say **Qa,comp.= 404.00 T** **Qa,uplift = 276.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.67	200	0.17											
1.00		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								314.29		16.75	
1.00		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								314.29		48.71	
1.00		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								314.29		136.66	
1.00		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								314.29		130.11	
1.00		14.50	15.00	0.00	32	1.00	1.00	1.88	50	2.62								314.29		25.72	
1.00		15.00	19.00	0.00	32	1.00	1.00	1.88	400	2.67								314.29		209.49	
1.00		19.00	20.00	0.18	27	1.00	1.00	1.88	100	2.67								314.29		48.36	
1.00		20.00	23.50	0.18	27	1.00	1.00	0.88	350	2.67								314.29		169.26	
1.00		23.50	24.00	0.18	28	1.00	1.00	0.97	50	2.67	2.67	0.88	0.18	27	9	13.39	14.47	314.29	7857.14	25.11	298.18
																				810.18	298.18

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (810.18 + 298.18) / 2.5 Qa,uplift = 810.18 / 3 + 43.2

Qa,comp.= 443.34 T Qa,uplift = 313.26 T

Say **Qa,comp.= 443.00 T** **Qa,uplift = 313.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.67	200	0.17											
1.00		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								314.29		16.75	
1.00		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								314.29		48.71	
1.00		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								314.29		136.66	
1.00		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								314.29		130.11	
1.00		14.50	15.00	0.00	32	1.00	1.00	1.88	50	2.62								314.29		25.72	
1.00		15.00	19.00	0.00	32	1.00	1.00	1.88	400	2.67								314.29		209.49	
1.00		19.00	20.00	0.18	27	1.00	1.00	1.88	100	2.67								314.29		48.36	
1.00		20.00	23.50	0.18	27	1.00	1.00	0.88	350	2.67								314.29		169.26	
1.00		23.50	26.00	0.18	28	1.00	1.00	0.97	250	2.67	2.67	0.97	0.18	28	9	15.50	16.72	314.29	7857.14	125.55	343.60
																				910.62	343.60

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (910.62 + 343.6) / 2.5 Qa,uplift = 910.62 / 3 + 47.12

Qa,comp.= 501.69 T Qa,uplift = 350.66 T

Say **Qa,comp.= 501.00 T** **Qa,uplift = 350.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.67	200	0.17											
1.00		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								314.29		16.75	
1.00		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								314.29		48.71	
1.00		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								314.29		136.66	
1.00		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								314.29		130.11	
1.00		14.50	15.00	0.00	32	1.00	1.00	1.88	50	2.62								314.29		25.72	
1.00		15.00	19.00	0.00	32	1.00	1.00	1.88	400	2.67								314.29		209.49	
1.00		19.00	20.00	0.18	27	1.00	1.00	1.88	100	2.67								314.29		48.36	
1.00		20.00	23.50	0.18	27	1.00	1.00	0.88	350	2.67								314.29		169.26	
1.00		23.50	28.00	0.18	28	1.00	1.00	0.97	450	2.67	2.67	0.98	1.56	4	9	1.43	0.34	314.29	7857.14	225.99	140.45
																				1011.06	140.45

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1011.06 + 140.45) / 2.5 Qa,uplift = 1011.06 / 3 + 51.05

Qa,comp.= 460.60 T Qa,uplift = 388.07 T

Say **Qa,comp.= 460.00 T** **Qa,uplift = 388.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.67	200	0.17											
1.00		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								314.29		16.75	
1.00		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								314.29		48.71	
1.00		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								314.29		136.66	
1.00		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								314.29		130.11	
1.00		14.50	15.00	0.00	32	1.00	1.00	1.88	50	2.62								314.29		25.72	
1.00		15.00	19.00	0.00	32	1.00	1.00	1.88	400	2.67								314.29		209.49	
1.00		19.00	20.00	0.18	27	1.00	1.00	1.88	100	2.67								314.29		48.36	
1.00		20.00	23.50	0.18	27	1.00	1.00	0.88	350	2.67								314.29		169.26	
1.00		23.50	29.50	0.18	28	1.00	1.00	0.97	600	2.67								314.29		301.32	
1.00		29.50	30.00	1.56	4	1.00	0.29	0.98	50	2.67	2.67	0.98	1.56	4	9	1.43	0.34	314.29	7857.14	10.02	140.45
																				1096.41	140.45

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1096.41 + 140.45) / 2.5 Qa,uplift = 1096.41 / 3 + 54.98

Qa,comp.= 494.74 T Qa,uplift = 420.45 T

Say **Qa,comp.= 494.00 T** **Qa,uplift = 420.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 18.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.67	200	0.17											
1.20		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								377.14		20.10	
1.20		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								377.14		58.46	
1.20		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								377.14		163.99	
1.20		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								377.14		156.13	
1.20		14.50	18.00	0.00	32	1.00	1.00	1.88	350	2.90								377.14		239.36	
1.20		18.00	19.00	0.00	32	1.00	1.00	1.88	100	3.23								377.14		76.14	
1.20		19.00	20.00	0.18	27	1.00	1.00	1.88	100	3.23	3.23	0.88	0.18	27	9	13.39	14.47	377.14	11314.29	68.88	516.25
																				783.05	516.25

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (783.05 + 516.25) / 2.5 Qa,uplift = 783.05 / 3 + 50.89

Qa,comp.= 519.72 T Qa,uplift = 311.91 T

Say **Qa,comp.= 519.00 T** **Qa,uplift = 311.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 20.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.67	200	0.17											
1.20		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								377.14		20.10	
1.20		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								377.14		58.46	
1.20		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								377.14		163.99	
1.20		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								377.14		156.13	
1.20		14.50	18.00	0.00	32	1.00	1.00	1.88	350	2.90								377.14		239.36	
1.20		18.00	19.00	0.00	32	1.00	1.00	1.88	100	3.23								377.14		76.14	
1.20		19.00	20.00	0.18	27	1.00	1.00	1.88	100	3.23								377.14		68.88	
1.20		20.00	22.00	0.18	27	1.00	1.00	0.88	200	3.23	3.23	0.88	0.18	27	9	13.39	14.47	377.14	11314.29	137.75	516.25
																				920.80	516.25

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (920.8 + 516.25) / 2.5 Qa,uplift = 920.8 / 3 + 56.55

Qa,comp.= 574.82 T Qa,uplift = 363.48 T

Say **Qa,comp.= 574.00 T** **Qa,uplift = 363.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.67	200	0.17											
1.20		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								377.14		20.10	
1.20		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								377.14		58.46	
1.20		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								377.14		163.99	
1.20		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								377.14		156.13	
1.20		14.50	18.00	0.00	32	1.00	1.00	1.88	350	2.90								377.14		239.36	
1.20		18.00	19.00	0.00	32	1.00	1.00	1.88	100	3.23								377.14		76.14	
1.20		19.00	20.00	0.18	27	1.00	1.00	1.88	100	3.23								377.14		68.88	
1.20		20.00	23.50	0.18	27	1.00	1.00	0.88	350	3.23								377.14		241.06	
1.20		23.50	24.00	0.18	28	1.00	1.00	0.97	50	3.23	3.23	0.88	0.18	27	9	13.39	14.47	377.14	11314.29	35.79	516.25
																				1059.90	516.25

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1059.9 + 516.25) / 2.5 Qa,uplift = 1059.9 / 3 + 62.2

Qa,comp.= 630.46 T Qa,uplift = 415.50 T

Say **Qa,comp.= 630.00 T** **Qa,uplift = 415.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.67	200	0.17											
1.20		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								377.14		20.10	
1.20		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								377.14		58.46	
1.20		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								377.14		163.99	
1.20		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								377.14		156.13	
1.20		14.50	18.00	0.00	32	1.00	1.00	1.88	350	2.90								377.14		239.36	
1.20		18.00	19.00	0.00	32	1.00	1.00	1.88	100	3.23								377.14		76.14	
1.20		19.00	20.00	0.18	27	1.00	1.00	1.88	100	3.23								377.14		68.88	
1.20		20.00	23.50	0.18	27	1.00	1.00	0.88	350	3.23								377.14		241.06	
1.20		23.50	26.00	0.18	28	1.00	1.00	0.97	250	3.23	3.23	0.97	0.18	28	9	15.50	16.72	377.14	11314.29	178.95	595.48
																				1203.06	595.48

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1203.06 + 595.48) / 2.5 Qa,uplift = 1203.06 / 3 + 67.86

Qa,comp.= 719.42 T Qa,uplift = 468.88 T

Say **Qa,comp.= 719.00 T** **Qa,uplift = 468.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.67	200	0.17											
1.20		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								377.14		20.10	
1.20		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								377.14		58.46	
1.20		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								377.14		163.99	
1.20		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								377.14		156.13	
1.20		14.50	18.00	0.00	32	1.00	1.00	1.88	350	2.90								377.14		239.36	
1.20		18.00	19.00	0.00	32	1.00	1.00	1.88	100	3.23								377.14		76.14	
1.20		19.00	20.00	0.18	27	1.00	1.00	1.88	100	3.23								377.14		68.88	
1.20		20.00	23.50	0.18	27	1.00	1.00	0.88	350	3.23								377.14		241.06	
1.20		23.50	28.00	0.18	28	1.00	1.00	0.97	450	3.23	3.23	0.98	1.56	4	9	1.43	0.34	377.14	11314.29	322.10	211.42
																				1346.22	211.42

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1346.22 + 211.42) / 2.5 Qa,uplift = 1346.22 / 3 + 73.51

Qa,comp.= 623.05 T Qa,uplift = 522.25 T

Say **Qa,comp.= 623.00 T** **Qa,uplift = 522.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 1+006 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 20.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.67	200	0.17											
1.20		2.00	4.00	0.00	28	1.00	1.00	1.67	200	0.50								377.14		20.10	
1.20		4.00	7.00	0.00	29	1.00	1.00	1.76	300	0.93								377.14		58.46	
1.20		7.00	11.50	0.00	31	1.00	1.00	1.83	450	1.61								377.14		163.99	
1.20		11.50	14.50	0.00	31	1.00	1.00	1.84	300	2.30								377.14		156.13	
1.20		14.50	18.00	0.00	32	1.00	1.00	1.88	350	2.90								377.14		239.36	
1.20		18.00	19.00	0.00	32	1.00	1.00	1.88	100	3.23								377.14		76.14	
1.20		19.00	20.00	0.18	27	1.00	1.00	1.88	100	3.23								377.14		68.88	
1.20		20.00	23.50	0.18	27	1.00	1.00	0.88	350	3.23								377.14		241.06	
1.20		23.50	29.50	0.18	28	1.00	1.00	0.97	600	3.23								377.14		429.47	
1.20		29.50	30.00	1.56	4	1.00	0.29	0.98	50	3.23	3.23	0.98	1.56	4	9	1.43	0.34	377.14	11314.29	12.76	211.42
																				1466.35	211.42

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1466.35 + 211.42) / 2.5 Qa,uplift = 1466.35 / 3 + 79.17

Qa,comp.= 671.11 T Qa,uplift = 567.95 T

Say **Qa,comp.= 671.00 T** **Qa,uplift = 567.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.65	200	0.06											
1.00		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								314.29		0.00	
1.00		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								314.29		0.00	
1.00		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								314.29		13.21	
1.00		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								314.29		44.36	
1.00		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								314.29		59.37	
1.00		14.50	15.00	0.22	29	1.00	1.00	0.94	50	1.04								314.29		12.54	
1.00		15.00	18.00	0.22	29	1.00	1.00	0.94	300	1.07								314.29		76.43	
1.00		18.00	24.00	0.19	30	1.00	1.00	0.96	600	1.07	1.07	0.98	0.15	30	9	20.75	22.40	314.29	7857.14	151.84	192.88
																				357.75	192.88

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (357.75 + 192.88) / 2.5 Qa,uplift = 357.75 / 3 + 43.2

Qa,comp.= 220.25 T Qa,uplift = 162.45 T

Say **Qa,comp.= 220.00 T** **Qa,uplift = 162.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.65	200	0.06											
1.00		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								314.29		0.00	
1.00		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								314.29		0.00	
1.00		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								314.29		13.21	
1.00		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								314.29		44.36	
1.00		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								314.29		59.37	
1.00		14.50	15.00	0.22	29	1.00	1.00	0.94	50	1.04								314.29		12.54	
1.00		15.00	18.00	0.22	29	1.00	1.00	0.94	300	1.07								314.29		76.43	
1.00		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.07								314.29		177.15	
1.00		25.00	26.00	0.15	30	1.00	1.00	0.98	100	1.07	1.07	0.98	0.15	30	9	20.75	22.40	314.29	7857.14	24.05	192.88
																				407.11	192.88

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (407.11 + 192.88) / 2.5 Qa,uplift = 407.11 / 3 + 47.12

Qa,comp.= 240.00 T Qa,uplift = 182.83 T

Say **Qa,comp.= 239.00 T** **Qa,uplift = 182.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.65	200	0.06											
1.00		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								314.29		0.00	
1.00		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								314.29		0.00	
1.00		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								314.29		13.21	
1.00		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								314.29		44.36	
1.00		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								314.29		59.37	
1.00		14.50	15.00	0.22	29	1.00	1.00	0.94	50	1.04								314.29		12.54	
1.00		15.00	18.00	0.22	29	1.00	1.00	0.94	300	1.07								314.29		76.43	
1.00		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.07								314.29		177.15	
1.00		25.00	28.00	0.15	30	1.00	1.00	0.98	300	1.07	1.07	0.98	0.15	30	9	20.75	22.40	314.29	7857.14	72.15	192.88
																				455.21	192.88

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (455.21 + 192.88) / 2.5 Qa,uplift = 455.21 / 3 + 51.05

Qa,comp.= 259.24 T Qa,uplift = 202.79 T

Say **Qa,comp.= 259.00 T** **Qa,uplift = 202.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.65	200	0.06											
1.00		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								314.29		0.00	
1.00		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								314.29		0.00	
1.00		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								314.29		13.21	
1.00		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								314.29		44.36	
1.00		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								314.29		59.37	
1.00		14.50	15.00	0.22	29	1.00	1.00	0.94	50	1.04								314.29		12.54	
1.00		15.00	18.00	0.22	29	1.00	1.00	0.94	300	1.07								314.29		76.43	
1.00		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.07								314.29		177.15	
1.00		25.00	30.00	0.15	30	1.00	1.00	0.98	500	1.07	1.07	0.98	0.15	30	9	20.75	22.40	314.29	7857.14	120.25	192.88
																				503.30	192.88

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (503.3 + 192.88) / 2.5 Qa,uplift = 503.3 / 3 + 54.98

Qa,comp.= 278.47 T Qa,uplift = 222.75 T

Say **Qa,comp.= 278.00 T** **Qa,uplift = 222.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 30.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.65	200	0.06											
1.00		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								314.29		0.00	
1.00		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								314.29		0.00	
1.00		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								314.29		13.21	
1.00		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								314.29		44.36	
1.00		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								314.29		59.37	
1.00		14.50	15.00	0.22	29	1.00	1.00	0.94	50	1.04								314.29		12.54	
1.00		15.00	18.00	0.22	29	1.00	1.00	0.94	300	1.07								314.29		76.43	
1.00		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.07								314.29		177.15	
1.00		25.00	32.00	0.15	30	1.00	1.00	0.98	700	1.07	1.07	0.98	0.15	30	9	20.75	22.40	314.29	7857.14	168.35	192.88
																				551.40	192.88

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (551.4 + 192.88) / 2.5 Qa,uplift = 551.4 / 3 + 58.9

Qa,comp.= 297.71 T Qa,uplift = 242.71 T

Say **Qa,comp.= 297.00 T** **Qa,uplift = 242.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 32.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.65	200	0.06											
1.00		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								314.29		0.00	
1.00		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								314.29		0.00	
1.00		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								314.29		13.21	
1.00		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								314.29		44.36	
1.00		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								314.29		59.37	
1.00		14.50	15.00	0.22	29	1.00	1.00	0.94	50	1.04								314.29		12.54	
1.00		15.00	18.00	0.22	29	1.00	1.00	0.94	300	1.07								314.29		76.43	
1.00		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.07								314.29		177.15	
1.00		25.00	34.00	0.15	30	1.00	1.00	0.98	900	1.07	1.07	0.98	0.15	30	9	20.75	22.40	314.29	7857.14	216.44	192.88
																				599.50	192.88

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (599.5 + 192.88) / 2.5 Qa,uplift = 599.5 / 3 + 62.83

Qa,comp.= 316.95 T Qa,uplift = 262.67 T

Say **Qa,comp.= 316.00 T** **Qa,uplift = 262.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.65	200	0.06											
1.20		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								377.14		0.00	
1.20		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								377.14		0.00	
1.20		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								377.14		15.85	
1.20		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								377.14		53.24	
1.20		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								377.14		71.24	
1.20		14.50	18.00	0.22	29	1.00	1.00	0.94	350	1.18								377.14		115.56	
1.20		18.00	24.00	0.19	30	1.00	1.00	0.96	600	1.35	1.35	0.98	0.15	30	9	20.75	22.40	377.14	11314.29	218.88	346.11
																				474.78	346.11

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (474.78 + 346.11) / 2.5 Qa,uplift = 474.78 / 3 + 62.2

Qa,comp.= 328.35 T Qa,uplift = 220.46 T

Say **Qa,comp.= 328.00 T** **Qa,uplift = 220.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.65	200	0.06											
1.20		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								377.14		0.00	
1.20		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								377.14		0.00	
1.20		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								377.14		15.85	
1.20		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								377.14		53.24	
1.20		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								377.14		71.24	
1.20		14.50	18.00	0.22	29	1.00	1.00	0.94	350	1.18								377.14		115.56	
1.20		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.35								377.14		255.36	
1.20		25.00	26.00	0.15	30	1.00	1.00	0.98	100	1.35	1.35	0.98	0.15	30	9	20.75	22.40	377.14	11314.29	34.97	346.11
																				546.23	346.11

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (546.23 + 346.11) / 2.5 Qa,uplift = 546.23 / 3 + 67.86

Qa,comp.= 356.94 T Qa,uplift = 249.93 T

Say **Qa,comp.= 356.00 T** **Qa,uplift = 249.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.65	200	0.06											
1.20		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								377.14		0.00	
1.20		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								377.14		0.00	
1.20		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								377.14		15.85	
1.20		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								377.14		53.24	
1.20		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								377.14		71.24	
1.20		14.50	18.00	0.22	29	1.00	1.00	0.94	350	1.18								377.14		115.56	
1.20		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.35								377.14		255.36	
1.20		25.00	28.00	0.15	30	1.00	1.00	0.98	300	1.35	1.35	0.98	0.15	30	9	20.75	22.40	377.14	11314.29	104.91	346.11
																				616.17	346.11

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (616.17 + 346.11) / 2.5 Qa,uplift = 616.17 / 3 + 73.51

Qa,comp.= 384.91 T Qa,uplift = 278.90 T

Say **Qa,comp.= 384.00 T** **Qa,uplift = 278.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.65	200	0.06											
1.20		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								377.14		0.00	
1.20		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								377.14		0.00	
1.20		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								377.14		15.85	
1.20		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								377.14		53.24	
1.20		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								377.14		71.24	
1.20		14.50	18.00	0.22	29	1.00	1.00	0.94	350	1.18								377.14		115.56	
1.20		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.35								377.14		255.36	
1.20		25.00	30.00	0.15	30	1.00	1.00	0.98	500	1.35	1.35	0.98	0.15	30	9	20.75	22.40	377.14	11314.29	174.86	346.11
																				686.12	346.11

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (686.12 + 346.11) / 2.5 Qa,uplift = 686.12 / 3 + 79.17

Qa,comp.= 412.89 T Qa,uplift = 307.87 T

Say **Qa,comp.= 412.00 T** **Qa,uplift = 307.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 30.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.65	200	0.06											
1.20		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								377.14		0.00	
1.20		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								377.14		0.00	
1.20		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								377.14		15.85	
1.20		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								377.14		53.24	
1.20		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								377.14		71.24	
1.20		14.50	18.00	0.22	29	1.00	1.00	0.94	350	1.18								377.14		115.56	
1.20		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.35								377.14		255.36	
1.20		25.00	32.00	0.15	30	1.00	1.00	0.98	700	1.35	1.35	0.98	0.15	30	9	20.75	22.40	377.14	11314.29	244.80	346.11
																				756.06	346.11

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (756.06 + 346.11) / 2.5 Qa,uplift = 756.06 / 3 + 84.82

Qa,comp.= 440.87 T Qa,uplift = 336.84 T

Say **Qa,comp.= 440.00 T** **Qa,uplift = 336.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 32.00 m **Bore Hole No =** BH-A2 **Ch. (KM)** 7+351 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 7.00 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.65	200	0.06											
1.20		2.00	5.50	0.00	29	1.00	1.00	0.65	350	0.24								377.14		0.00	
1.20		5.50	7.00	0.00	29	1.00	1.00	0.66	150	0.41								377.14		0.00	
1.20		7.00	8.50	0.00	29	1.00	1.00	0.66	150	0.51								377.14		15.85	
1.20		8.50	11.50	0.10	29	1.00	1.00	0.75	300	0.67								377.14		53.24	
1.20		11.50	14.50	0.11	30	1.00	1.00	0.79	300	0.90								377.14		71.24	
1.20		14.50	18.00	0.22	29	1.00	1.00	0.94	350	1.18								377.14		115.56	
1.20		18.00	25.00	0.19	30	1.00	1.00	0.96	700	1.35								377.14		255.36	
1.20		25.00	34.00	0.15	30	1.00	1.00	0.98	900	1.35	1.35	0.98	0.15	30	9	20.75	22.40	377.14	11314.29	314.74	346.11
																				826.00	346.11

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (826 + 346.11) / 2.5 Qa,uplift = 826 / 3 + 90.48

Qa,comp.= 468.84 T Qa,uplift = 365.81 T

Say **Qa,comp.= 468.00 T** **Qa,uplift = 365.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

Lateral Load capacity of Pile

BH-A1

1+006

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 20.000 m **Fck = 35.0 N/mm^2** **D = 100 cm**

Pile cap bottom level -2.0 m

Max. of Liquefaction & Scour Depth -2.0 m

E = Young's Modulus of Pile (Kg/cm^2)	=	$5000\sqrt{F_{ck}}$	N/mm^2	=	295803.99	Kg/cm^2	
I = Moment of Inertia (cm^2)	=	$\pi xD^4/64$		=	4908738.5	cm^4	
K_1 = Constant for Sandy / Normally Consolidated Clay		(Kg/cm^3)		=	**0.385**		
T, Relative stiffness factor in Sand				=	**327.6**	cm	
T =		$\sqrt[5]{EI/K_1}$					

For Long Pile If $L_e > 4T$

L1 =				=	**0.000**	cm
L_1/T				=	0.00	

For Fixed Head Pile

L_f/T				=	**2.219**	From Fig. 4
Lf				=	726.95	cm
Equivalent length of cantilever	L= L1+L_F: 0.00	+	726.95089	=	**726.95**	cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\,EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection .5 cm	Q			=	22678.27	Kg
				=	**22.68**	**T**
			Say		**22.0**	**T**

Lateral Load capacity of Pile

BH-A1

1+006

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 20.000 m **Fck = 35.0 N/mm^2** **D = 120 cm**

Pile cap bottom level -2.0 m

Max. of Liquefaction & Scour Depth -2.0 m

E = Young's Modulus of Pile (Kg/cm^2)	=	$5000\sqrt{F_{ck}}$	N/mm^2	=	295803.99	Kg/cm^2	
I = Moment of Inertia (cm^2)	=	$\pi xD^4/64$		=	10178760.2	cm^4	
K_1 = Constant for Sandy / Normally Consolidated Clay		(Kg/cm^3)		=	**0.385**		
T, Relative stiffness factor in Sand				=	**379.0**	cm	
$T = \sqrt[5]{\frac{EI}{K_1}}$							

For Long Pile If $L_e > 4T$

L1 =	=	**0.000**	cm	
$\frac{L_1}{T}$	=	0.00		

For Fixed Head Pile

$\frac{L_f}{T}$	=	**2.219**	From Fig. 4	
Lf	=	841.10	cm	
Equivalent length of cantilever L= L1+L_F: 0.00 + 841.10472	=	**841.10**	cm	

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection .5 cm Q	=	30359.87	Kg	
	=	**30.36**	**T**	
	Say	**30.0**	**T**	

Lateral Load capacity of Pile

BH-A2

7+351

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 24.000 m **Fck = 35.0 N/mm^2** **D = 100 cm**

Bed level	**0.0 m**
Pile cap bottom level	**-2.0 m**
Max. of Liquefaction & Scour Depth	**-7.0 m**

E = Young's Modulus of Pile (Kg/cm^2) = $5000\sqrt{F_{ck}}$ N/mm^2 = 295803.99 Kg/cm^2

I = Moment of Inertia (cm^2) = $\pi xD^4/64$ = 4908738.5 cm^4

K_1 = Constant for Sandy / Normally Consolidated Clay (Kg/cm^3) = **0.284**

T, Relative stiffness factor in Sand $T = \sqrt[5]{\frac{EI}{K_1}}$ = **348.1** cm

For Long Pile If $L_e > 4T$

L1 = = **500.000** cm

$\frac{L_1}{T}$ = 1.44

For Fixed Head Pile

$\frac{L_f}{T}$ = **1.958** From Fig. 4

Lf = 681.75 cm

Equivalent length of cantilever L= $L1+L_F$: 500.00 + 681.75139 = **1181.75** cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Safe Lateral resistance of Pile = Lateral resistance at pile head corresponding to deflection 5mm at liquefaction level 0.8 cm

= **8.59 T**

Say 8 T

Lateral Load capacity of Pile

BH-A2

7+351

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 24.000 m Fck = 35.0 N/mm^2 D = 120 cm

Bed level	**0.0 m**
Pile cap bottom level	**-2.0 m**
Max. of Liquefaction & Scour Depth	**-7.0 m**

E = Young's Modulus of Pile (Kg/cm^2) = $5000\sqrt{F_{ck}}$ N/mm^2 = 295803.99 Kg/cm^2

I = Moment of Inertia (cm^2) = $\pi xD^4/64$ = 10178760.2 cm^4

K_1 = Constant for Sandy / Normally Consolidated Clay (Kg/cm^3) = **0.284**

T, Relative stiffness factor in Sand $T = \sqrt[5]{\frac{EI}{K_1}}$ = **402.8** cm

For Long Pile If $L_e > 4T$

L1 = = **500.000** cm

$\frac{L_1}{T}$ = 1.24

For Fixed Head Pile

$\frac{L_f}{T}$ = **1.977** From Fig. 4

Lf = 796.12 cm

Equivalent length of cantilever L= $L1+L_F$: 500.00 + 796.12422 = **1296.12** cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Safe Lateral resistance of Pile = Lateral resistance at pile head corresponding to deflection 5mm at liquefaction level 0.7 cm

= **12.41 T**

Say 12 T