Geotechnical Investigation for Proposed Residential Project at Sector - 146, GH-01B, Noida, Uttar Pradesh

EXECUTIVE SUMMARY

Godrej Properties Limited are in process of constructing a Residential Project at Sector - 146, Noida, Uttar Pradesh.

The proposed structures consists of a basement, ground floor and thirty five upper floors.

The Geotechnical investigation programme has been undertaken at the site, as per the scope of investigations, as stipulated by the client. The scope of work consisted of conducting boreholes in soil strata down to down to 40m depth at seven locations and conducting static cone penetration test down to 25m depth or refusal strata, whichever occurs earlier at six locations.

The borehole investigations indicate that the subsoil strata consists of clayey sandy silt/ sandy clayey silt down to about 4m depth below which the subsoil strata consists of sandy soils down to the depths investigated except between 15m and 29m depths wherein occasional thin layers of clayey sandy silt have also been encountered inbetween.

The N-values (N-values 7 -33) indicate that the subsoil strata is in a loose to medium dense state down to about 13m depth below which the subsoil is in a medium dense state (N-values 21 - 84) down to the maximum investigated depth of 40m.

Ground water table had been encountered at a depth of about 6m below the existing ground level, during the period of field investigations i.e March 2022.

The assessment of the susceptibility to liquefaction of the subsoil at site indicate that the subsoil down to about 13m depth has been considered to be susceptible to liquefaction.

Considering the type of structures involved and the subsoil characteristics as determined from the geotechnical investigations, **Straight bored pile foundations** have been recommended.

The following safe pile capacities have been recommended for various diameter and effective lengths of piles.

Pile Dia (mm)	*Pile Effective Length (m)*	*Pile Vertical Load Capacity (tons)*	*Pile Uplift Capacity (tons)*	*Safe Lateral Load Capacity (tons)*	
				Free Head	*Fixed Head*
600	15	55	30	0.2	0.6
	20	85	45		
800	15	95	45	0.4	1.4
	20	140	75		
	25	180	105		
1000	15	135	60	0.8	2.6
	20	205	105		
	25	265	155		
	30	325	205		

For boundary wall at ground level, net allowable bearing pressures varying between 7 - 9 t/m^2 have been recommended for various widths of foundations for an allowable settlement of 50mm at a depth of 1.5m below the existing ground level.

Precautions :

For Straight Bored Piles, after reaching the required depth in the pile bores, 15cm thick layer of gravel should be placed and compacted at the bottom so that the slush formed at the bottom is diminished.

For Isolated/Strip footings, foundation surface must be compacted heavily. If any loose pockets are observed, the same shall be filled with brickbats/gravel and compacted. Foundations can subsequently be placed over such a prepared surface.

1.0 INTRODUCTION

1.1 Godrej Properties Limited, Group Housing Plot GH-01/A,Sector - 146, Noida, Uttar Pradesh are in process of constructing a Residential Project at Sector - 146, Noida, Uttar Pradesh.

1.2 To design the substructures for the proposed structures, adequate information regarding the subsoil conditions is required. For this purpose, a detailed soil investigation has been undertaken at the site of the proposed structures.

1.3 This report contains the details of the geotechnical investigations conducted along with the results and analysis of the investigations and the recommendations thereof.

1.4 The geotechnical investigations have been carried out as per the authorization of authorised signatory of Godrej Properties Limited, vide their work order reference no. 4300165652 dated 23rd February 2023. This authorization has been given in response to our offer no. NCD/Q/GODREJ /133/2022 dated 25th November 2023.

2.0 PROJECT DETAILS

2.1 Site Location

2.1.1 The site for the proposed project is located at Plot No. 146, Noida, Uttar Pradesh and is situated at a distance of about 50m from Sector - 146 metro station towards Sector - 146, Noida, Uttar Pradesh.

2.2 Site Layout and Topography

2.2.1 A schematic site plan showing the dimensions and the locations of the boreholes is enclosed in this report (fig. 1a).

2.2.2 Maximum level differences of about 1m had been observed within the site, during the period of field investigations and the general level of the site had been observed to be about 1m below the adjacent road level.

2.2.3 The site had been observed to be divided in two parts by a road existing in between.

2.2.4 Levelling and grading work at the site had been observed to be under progress, during the period of field investigations.

2.2.5 Vegetation in the form of grass and bushes had been observed at the site, during the period of field investigations.

2.2.6 The colour of the surface earth had been observed to be Yellowish brown.

2.3 Seismic Zone

2.3.1 The present site is located in the Seismic Zone - IV which is the zone of high seismic intensity, as per the seismic zoning map of India given in BIS code IS:1893 (Part1)-2016.

2.4 The Structure/s

2.4.1 The proposed structures consist of a basement, ground floor and about thirty five upper floors.

2.4.2 The structures are understood to be framed ones and the construction to be of Reinforced Cement Concrete.

3.0 OBJECT OF INVESTIGATIONS

3.1 For designing the foundation system of the proposed structures, the following data are required:

a) Type of foundation

b) Depth below the ground level at which the foundation system is to be laid

c) Allowable bearing pressure at the foundation level

3.2 To determine the above factors, the following information would be required:

a) The subsoil profile indicating thickness of the various soil strata, to a depth within the influence zone below the foundations

b) Engineering properties of the soil strata at various levels

c) Physical characteristics of the soil strata

d) Variation of strength of soil strata with depth

3.3 For evaluating the above parameters, field investigations and laboratory investigations on the soil samples collected during the field investigations, have been carried out.

3.4 The results from these investigations have been analysed to provide the recommendations for the design of foundations.

4.0 SCOPE OF INVESTIGATIONS

4.1 The scope of investigations as stipulated by the client consists of :

a) Conducting boreholes in soil strata down to down to 40m depth at seven locations.

b) Conducting static cone penetration tests down to 25m depth or refusal strata, whichever occurs earlier at six locations.

c) Conducting chemical analysis to determine pH value, sulphate and chloride content on soil/ water samples.

d) Conducting relevant laboratory tests on soil samples recovered.

e) Preparation and submission of a technical report in three copies containing the details of the tests carried out, their analysis and recommendations regarding the foundation system to be adopted.

4.2 The following operations were to be undertaken while progressing the boreholes:

a) Conducting standard penetration tests at 1.5/3m intervals.

b) Recovering undisturbed soil samples from various levels of the subsoil strata.

c) Recording ground water table levels, if met with.

5.0 FIELD INVESTIGATIONS

5.1 Preliminary Details

5.1.1 Field investigations had been carried out between 25th February 2023 and 23rd March 2023.

5.1.2 Schematic site plan showing the test locations is given in fig. 1a.

5.1.3 Photographs showing view of the site and work under progress are given in figs. 1b & 1c.

5.2 Boreholes

5.2.1 All the boreholes were progressed by shell and auger method. Casing pipes were used to stabilize the sides of the boreholes below the ground water table level.

5.2.2 All the boreholes (BH1 to BH6) had been progressed down to the stipulated depth of 40m below the existing ground level whereas borehole BH7 had been terminated at a depth of 36m below the existing ground level due the presence of sandstone deposition at this depth.

5.2.3 All the boreholes had been conducted from the existing ground level whereas borehole BH7 had been conducted from a level of about 2m below the level of other boreholes.

5.2.4 The diameter of the boreholes was 150/100mm

5.2.5 Standard penetration tests were conducted at 1.5/3m intervals. Disturbed soil samples recovered from split spoon samplers were retained for identification purposes.

5.2.6 Undisturbed soil samples were recovered by thin walled tubes conforming to IS : 2132. These tubes had an area ratio of less then 10%.

5.2.7 The diameter of undisturbed soil samples was 50mm and the length was 45cm.

5.2.8 The ends of sample tubes were sealed by wax to prevent loss / ingress of moisture. Disturbed soil samples were packed properly.

5.2.9 The samples thus recovered were transported to the laboratory for testing purposes.

5.2.10 Ground water table had been encountered at a depth varying between 5.5m and 5.8m below the existing ground level except for the borehole BH7 wherein ground water table had been encountered at a depth of 3.6m below the existing ground level, during the period of field investigations i.e. February 2023 and March 2023 .

5.3 Static Cone Penetration Tests

5.3.1 Static cone penetration tests are similar to dynamic cone penetration tests with the main exception of the driving system (i.e. cone assembly is pushed into the ground and not driven) and some changes in the cone assembly (i.e. friction resistance is also measured).

5.3.2 The cone assembly basically consists of a steel cone with 60 degrees apex angle and a base diameter of 35.7mm giving a cross sectional area of about 10cm^2 and an independent cylindrical friction jacket of a slightly larger diameter than that of the cone and length 10cm giving a surface area of about 115cm^2.

5.3.3 This cone is pushed into the ground via sounding rods while the friction jacket is pushed via the mantle tubes. The sounding rods move inside the mantle tubes. The sounding rods and the mantle tubes are alternately pushed into the ground thus causing a continuous penetration of the cone assembly into the ground.

5.3.4 The cone and the friction jacket are alternately pushed into the ground using a mechanical/hydraulic machine of required capacity thus causing a continuous penetration of the cone assembly into the ground. The frame of the entire set up is anchored firmly into the ground suitably. Necessary reaction is facilitated by loading sand bags.

5.3.5 The cone resistance and sleeve friction are obtained from recorded loads required for pushing only the cone and the cone together with friction jacket. Such readings have been recorded from load cells at intervals of 10cm.

6.0 LABORATORY INVESTIGATIONS

6.1 Tests on soil samples from boreholes

6.1.1 The soil samples brought to the laboratory were subjected to various tests to determine the following properties :

a) Type of soil and its gradation

b) Consistency limits

c) Natural Bulk Density & Water Content

d) Strength parameters like cohesion, angle of shearing resistance

6.1.2 In order to determine the above properties, the following tests have been conducted :

a) Sieve analysis on coarse grained soil fraction

b) Hydrometer analysis on fine grained soil fraction

c) Atterberg limits namely Liquid Limit and Plastic Limits

d) Natural Density and Water Content

e) Triaxial compression tests

6.2 Chemical Analysis

6.2.1 The chemical analysis had been conducted on water sample collected from boreholes to determine the pH-value and the presence of salts harmful to reinforced cement concrete construction namely Chloride and Sulphate contents.

7.0 RESULTS & ANALYSIS

7.1 Presentation of Results

7.1.1 The results of the borehole investigations have been presented in the form of soil profile tables.

7.1.2 The soil profile tables indicate the following:

a) Standard penetration test values at various depths

b) Soil description identifying the type of soil

c) Grain size analysis indicating composition of subsoil

d) Atterberg limits

e) Natural density and water content

f) Triaxial test results

7.2 Soil Profile

7.2.1 A perusal of the data presented in the soil profile tables indicates that the subsoil mainly consists of the following three strata in the seven boreholes:

a) Stratum - I : Clayey sandy silt with occasional gravel/ sandy clayey silt

b) Stratum - II : Sand with traces of silt and occasional gravel/ sand with silt

c) Stratum - III : Silty sand with occasional clay and gravel

7.2.2 The thickness of the three strata in the seven boreholes are as follows :

BH. No.	Strata (depth in m : from : to)		
	Stratum - I	**Stratum - II**	**Stratum - III**
1	3 - 4.5 18.5 29	1.5 - 3 4.5 - 18.5 29 - 40	0 - 1.5
2	0 - 2.4 18.5 - 22 25.5 - 28.5	2.4 - 18.5 22 - 25.5 28.5 - 40	N.E.

BH. No.	Strata (depth in m : from : to)		
	Stratum - I	Stratum - II	Stratum - III
3	0 - 3.5 18.4 - 21.5 25.5 - 28	3.5 - 18.4 21.5 - 25.5 28 - 40	N.E.
4	0 - 2 11 - 11.2 19.4 - 22 25.5 - 28 37.9 - 38.3	2 - 11 11.2 - 19.4 22 - 25.5 28 - 37.9 38.3 - 40	N.E.
5	0 - 1.5 18.6 - 22 26.2 - 29 38 - 39.8	1.8 - 18.6 22 - 26.2 29 - 38 39.8 - 40	N.E.
6	0 - 2.4 14.8 - 17.4	2.4 - 14.8 17.4 - 18.5 23 - 40	18.5 - 23
7	0 - 0.9 17 - 20 23 - 26.2	0.9 - 17 26.2 - 36	20 - 23

N.E. : not encountered

7.2.3 The above results show that :

a) Stratum - I consisting predominantly of silty soils with varying percentages of clay and sand, has been encountered down to a maximum depth of about 4.5m below the existing ground level and also in occasional thin layers between 14.8m and 29m depths below the existing ground level.

b) Stratum - II consisting predominantly of sandy soils is predominant beyond a depth of about 2m down to the depths investigated except for occasional layers of Stratum - II & Stratum - III in between in some boreholes.

c) Stratum - III consisting predominantly of sandy soils with significant percentages of silt and occasional clay, has been encountered down to a depth of about 1.5m below the existing ground level in borehole BH1 and also between 18.5m and 23m depths in boreholes BH6 and BH7.

7.3 Soil Composition

7.3.1 The grain size distributions of the soil samples in the seven boreholes have been presented in the form of grain size analysis curves in figs. 6a to 6q.

7.3.2 The variations in the grain size distributions in each of the three strata in the seven boreholes are as follows:

a) Stratum - I : Clayey sandy silt with occasional gravel/ sandy clayey silt

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	0 - 23	19 - 37	40 - 69	2 - 14
2	0 - 8	17 - 43	48 - 60	9 - 17
3	0 - 17	12 - 34	51 - 67	6 - 18
4	0 - 3	22 - 28	53 - 64	12 - 19
5	0 - 19	18 - 33	42 - 48	12 - 20
6	0 - 3	6 - 45	50 - 62	3 - 36
7	0 - 13	11 - 25	47 - 70	15 - 19

b) Stratum - II : Sand with traces of silt and occasional gravel/ sand with silt

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	0 - 7	82 - 98	2 - 18	0
2	0 - 5	86 - 98	2 - 15	0
3	0 - 12	79 - 98	2 - 19	0
4	0 - 11	87 - 96	2 - 15	0
5	0 - 6	76 - 98	2 - 20	0

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
6	0 - 23	74 - 97	2 - 15	0
7	0 - 16	82 - 98	2 - 14	0

c) Stratum - III : Silty sand with occasional clay and gravel

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	0	41	40	19
6	9	44	38	9
7	0	71	29	0

This stratum has been encountered only in these boreholes.

7.3.3 The above results indicate that :

a) Stratum - I consists of about 40% to 70% of silt, 6% to 45% of sand and 2% to 36% of clay with occasional gravel.

b) Stratum - II consists of an average of about 90% of sand and 10% of silt with occasional gravel.

c) Stratum - III consists of about 41% to 71% of sand and 29% to 40% of silt with occasional clay and gravel.

7.4 Natural Density and Water Content

7.4.1 The natural bulk densities, water contents and dry densities in the seven boreholes vary as follows:

BH. No.	Bulk Density (g/cm^3)	Water Content (%)	Dry Density (g/cm^3)
1	1.78 - 2.12	10.8 - 27.5	1.44 - 1.75
2	1.66 - 2.12	3.9 - 24.0	1.56 - 1.81
3	1.66 - 2.10	3.9 - 22.9	1.55 - 1.82
4	1.65 - 2.10	3.4 - 24.2	1.54 - 1.74

BH. No.	Bulk Density (g/cm^3)	Water Content (%)	Dry Density (g/cm^3)
5	1.66 - 2.29	3.1 - 25.5	1.56 - 1.82
6	1.63 - 2.13	2.4 - 20.2	1.59 - 1.82
7	1.67 - 2.10	4.2 - 21.3	1.59 - 1.75

7.4.2 The dry densities of the soil have also been presented in the form of plots of dry density vs depth for the seven boreholes conducted, in figs. 3a &3b

7.4.3 The above results indicate that the subsoil is in a loose to medium dense state down to about 13m depth below which the subsoil is in a medium dense state down to the depths investigated.

7.4.4 As undisturbed soil samples could not be recovered in the sandy soil stratum below the water table level, the results for the densities and water contents of the subsoil at these depths are not available.

7.5 Atterberg Limits

7.5.1 The Atterberg limits indicate that the subsoil is predominantly non-plastic down to the depths investigated except down to a maximum depth of about 4.5m below the existing ground level and also between 14.8m and 29m depths below the existing ground level wherein layers of low plastic soils have also been encountered.

7.6 Standard Penetration Test Values (N-values)

7.6.1 The observed Standard Penetration Test values (N-values) vary between 8 and 85 as indicated in the soil profile tables and as also shown in the figs. 4a & 4b wherein the observed N-values have been plotted with respect to depths.

7.6.2 The above results indicate that the subsoil is in a loose to medium dense state down to about 13m depth below which the subsoil is in a medium dense state down to the depths investigated.

7.7 Triaxial Test Results

7.7.1 The results of triaxial tests are indicated in the respective soil profile tables. These results have been considered in providing the recommendations.

7.8 Compiled Soil Profile

7.8.1 An overview of the results and their analysis has been presented in the form of a compiled soil profile (fig. 2).

7.8.2 The above figure shows the various strata encountered and their thicknesses in each of the boreholes and also gives the soil composition and the observed N - values at various depths.

7.9 Chemical Analysis

7.9.1 The results of the chemical analysis conducted on water samples collected from the boreholes, for determining the presence of any harmful salts which can have adverse effects on concrete construction, are as follows :

Borehole no.	pH value	Chloride Content (ppm)	Sulphate Content (ppm)
BH2	7	946	412
BH3	7	652	330
BH4	7	844	371

IS LIMITS	
pH value	*Not less than 6*
Chloride content (ppm)	*Maximum 500 ppm*

IS LIMITS	
Sulphate content (ppm)	*Maximum 400 ppm*

7.9.2 The above results of chemical analysis on water samples have exceeded the IS limits. Hence, the water encountered in the boreholes should not be used for concrete construction work.

7.10 Static Cone Penetration Tests

7.10.1 The results of the Static Cone Penetration Tests (SCPT1to SCPT4, SCPT6 and SCPT7) have been presented in the form of plots of cone resistance vs depth, frictional resistance vs depth and friction ratio vs depth for four tests conducted in figs. 5a to 5f.

7.10.2 The results of this test are to be viewed in terms of the following typical empirical assessments of the significance of the various measured test parameters :

a) High cone resistance typically indicates the presence of a sandy soil and/or soil of high stiffness/shear strength and vice versa.

b) High friction ratio typically indicates the presence of significant percentages of fines (i.e. silt and clay) in the soil.

7.10.3 When the results of the present tests are viewed in terms of the above, the results are observed to be more or less in consonance with the results of the borehole investigations.

7.10.4 The cone resistance has been observed to be generally in the range of 5 to 100 kg/cm^2 down to about 15m depth indicating that the subsoil is predominantly in a loose to medium dense state, beyond which the cone resistance has been observed to be increasing upto 300 kg/cm^2 at the termination depth of the tests indicating that the subsoil is in a medium dense state down to the termination depth of the tests.

8.0 ANALYSIS OF SUSCEPTIBILITY TO LIQUEFACTION

8.1 Based on N-values

8.1.1 Analysis of the susceptibility to liquefaction of the subsoil at the site has been carried out in the form of a comparison of the shear stress induced/developed in event of an earthquake with the in-situ shear resistance of the subsoil at various depths in the different boreholes.

8.1.2 This method has been found to be very reliable and is used as one of the main criteria in almost all countries. The shear stress induced/developed at different depths during an earthquake depends upon the overburden pressure and the soil characteristics while the shear resistance is calculated based on the N-values and other soil properties for a maximum repeated strain of 2%.

8.1.3 The shear stress induced/developed and the shear resistance offered by the soil are evaluated in terms of the Cyclic Stress Ratio (CSR) and the Cyclic Resistance Ratio (CRR) respectively. The CSR is the ratio of the shear stress developed to the effective overburden pressure at various depths while the CRR is the ratio of the shear resistance of the soil to the effective overburden pressure at various depths. The analysis of variation of the CSR and the CRR with depth based on the results of the borehole conducted have been given in tables C1 to C6 of this report.

8.1.4 The soil will liquefy in the depth zones where the CSR exceeds the CRR i.e. where the shear stress developed exceeds the shear resistance or in other words, where the factor of safety defined as the ratio of the CRR to CSR, is less than 1.

8.1.5 The results of the above analyses have indicated that the subsoil down to about 13m depth, is susceptible to liquefaction.

8.2 Comments on Liquefaction Analysis

8.2.1 Considering the above detailed analyses and also that the site is located in Seismic Zone - IV of seismic zoning map of India, the subsoil down to 13m depth can be considered to be susceptible to liquefaction. Hence, shallow foundations are not feasible. The proposed structures shall have to be supported over pile foundations.

9.0 DESIGN CRITERIA

9.1 Design Parameters

9.1.1 The parameters required for the design of the foundation system for the proposed structures are:

a) Type of foundation to be adopted

b) Depth at which the foundations have to be laid

c) Allowable bearing pressure on the soil/rock at the foundation level

9.1.2 On the basis of the analysis of the results of the investigations, the required design parameters have been arrived at as given in the following sections.

9.2 Type of Foundation

9.2.1 The type of foundation depends upon the following :

a) Subsoil/rock conditions

b) Type of structure

c) Configuration of loading points

d) Loading intensity on each column at the foundation level

9.2.2 The proposed structures are Residential buildings consisting of a basement, ground floor and about thirty five upper floors. Considering this, heavy loads can be anticipated on the foundations.

9.2.3 The results of the investigations have shown that the subsoil below the likely founding is in a loose to medium dense state down to about 13m depth below which the subsoil is medium dense state down to the depths investigated.

9.2.4 As mentioned in the earlier sections, the subsoil strata down to about 13m depth has been considered to be susceptible to liquefaction.

9.2.5 In view of the above, the proposed structures can be supported over ***Straight Bored Pile foundations.***

9.2.6 However, boundary walls can be supported over ***Isolated / strip footing***.

9.3 Depth of Pile Foundation

9.3.1 The minimum depth of pile foundations depends upon the following factors :

a) Top filled-up strata / loose soil, if any

b) Adequate depth of soil strata below the founding level of the pile foundations of requisite strength to mobilize the safe end bearing capacity

c) Adequate depth of soil strata above the founding level of the pile foundations of requisite strength to mobilize the safe friction capacity.

9.3.2 Taking the above into consideration, the pile foundations for the proposed structures shall be made to rest at a depth greater than 21m below the existing ground level. Accordingly, Considering the cut-of level of the piles as 2m below the basement floor level i.e. 6m below the existing ground level and effective length of piles of 15m, 20m, 25m and 30m, the founding levels of the piles will be about 21m, 26m, 31m and 36m respectively, below the existing ground level.

9.3.3 The soil encountered at the founding levels of the pile foundations will either be ***Yellowish brown clayey sandy silt or grey sandy soil.***

9.4 Pile Capacities

9.4.1 Load carrying capacities of bored pile foundation have been analysed and given for piles having various diameters and effective lengths.

9.4.2 The parameters considered for the analysis of the pile capacities are given below :

S. No.	Parameter	Value/s
1	Effective length (m)	15, 20, 25 & 30
2	Cohesion (kg/cm^2)	0.06
3	Angle of shearing resistance	30^o
4	Submerged density (g/cm^3)	1
5	SPT Value at pile tip	20 & 25
6	Factor of safety	2.5

9.4.3 Considering the above parameters, the following safe pile capacities have been recommended for various diameters for 15m, 20m, 25m and 30m effective lengths of piles.

Pile Dia (mm)	*Pile Effective Length (m)*	*Pile Vertical Load Capacity (tons)*	*Pile Uplift Capacity (tons)*	*Safe Lateral Load Capacity (tons)*	
				Free Head	*Fixed Head*
600	15	55	30	0.2	0.6
	20	85	45		
800	15	95	45	0.4	1.4
	20	140	75		
	25	180	105		
1000	15	135	60	0.8	2.6
	20	205	105		
	25	265	155		
	30	325	205		

9.4.4 The typical calculations of safe pile capacity and safe uplift pile capacity have been given in Appendix - A.

9.4.5 The typical calculations of safe lateral capacity of the pile have been given in Appendix-B.

9.4.6 The group action of piles depends upon the number of piles in the group and their arrangement. Therefore, the efficiency factor for each pile group can be considered and checked as per the relevant BIS codes.

9.5 Special Note

9.5.1 After reaching the required depth in the pile bore, 15cm thick layer of gravel should be placed and compacted at the bottom so that the slush formed at the bottom is diminished.

9.6 Depth of Isolated/ Strip Footings for Boundary Wall

9.6.1 The minimum depth of shallow foundations depends upon the following factors :

a) Top filled-up strata / loose soil, if any

b) Adequate depth of soil above founding level, to ensure mobilization of full safe bearing capacity

c) Adequate depth of soil strata below founding level of requisite strength to mobilize the safe bearing capacity

9.6.2 The results of the investigations have indicated that the subsoil is in a loose to medium dense state down to about 13m depth below which the subsoil is in a medium dense state down to the depth investigated.

9.6.3 Considering the above, the foundations for the boundary wall can be placed at a depth of ***1.5m below the existing ground level***.

9.6.4 The soil available at the founding level will either be ***Yellowish brown clayey sand silt or grey sandy soil.***

9.7 Allowable Bearing Pressure for Boundary Wall

9.7.1 Allowable bearing pressure depends upon the allowable settlement. Allowable settlements of 50mm has been considered to evaluate the allowable bearing pressures for ***Isolated/Strip Footings***.

9.7.2 Allowable bearing pressure has been evaluated by :

a) Shear failure criterion using average soil data

b) Settlement criterion taking SPT values

9.7.3 On the basis of the above analysis, the following recommendations regarding the net allowable bearing pressure are being made :

Net allowable bearing pressure (A.B.P.) for various widths of Isolated/Strip footings for an allowable settlement of 50mm

Width of foundation (m)	*1.5*	*3*	*>4.5*
Net Allowable Bearing Pressure (t/m^2)	*4*	*5*	*6*

9.8 Note

9.8.1 As mentioned in the earlier sections, the subsoil strata down to about 13m depth has been considered to be susceptible to liquefaction. Hence, shallow foundations are not feasible. However, the above allowable bearing pressures have been given considering that in the event of an earthquake, there is a possibility that the foundations may under go differential settlements which may cause distress to the boundary wall and develop cracks. In such a case repair/ reconstruction of the boundary wall may have to be taken up accordingly.

10.0 RECOMMENDATIONS

10.1 Type of Foundations

a) *Straight Bored Pile foundations*

b) *Isolated/ Strip Footings (for Boundary wall)*

10.2 Depth of Foundations

a) For Pile Foundations

*Considering the **cut-of level** of the piles as **2m** below the basement floor level i.e. 6m below the existing ground level and for effective lengths of pile of **15m, 20m, 25m and 30m**, the piles shall rest at a depth of about **21m, 26m, 31m and 36m** respectively below the existing ground level.*

b) For Isolated/ Strip Footings (for Boundary Wall)

1.5m below the existing ground level

10.3 Safe Pile capacities

Pile Dia (mm)	*Pile Effective Length (m)*	*Pile Vertical Load Capacity (tons)*	*Pile Uplift Capacity (tons)*	*Safe Lateral Load Capacity (tons)*	
				Free Head	*Fixed Head*
600	15	55	30	0.2	0.6
	20	85	45		
800	15	95	45	0.4	1.4
	20	140	75		
	25	180	105		
1000	15	135	60	0.8	2.6
	20	205	105		
	25	265	155		
	30	325	205		

10.4 Allowable Bearing pressure

10.4.1.1 *For boundary wall, Net allowable bearing pressure (A.B.P.) for various widths of Isolated/Strip Footings for an allowable settlement of 50mm*

Width of foundation (m)	***1.5***	***3***	***>4.5***
Net Allowable Bearing Pressure (t/m^2)	***7***	***8***	***9***

10.4.2 *The above allowable bearing pressures have been given considering that in the event of an earthquake, there is a possibility that the foundations may under go differential settlements which may cause distress to the boundary wall and develop cracks. In such a case repair/ reconstruction of the boundary wall may have to be taken up accordingly.*

10.5 Special Notes

10.5.1 As the subsoil down to about 13m depth below the existing ground level has been considered to be susceptible to liquefaction, the frictional component down to 7m depth below the cutoff level (i.e. 6m below the existing ground) level has been neglected for evaluating the pile capacities.

10.5.2 The above recommended safe pile capacities have been arrived at on the basis of provisions given in the BIS code IS:2911 (Part1/Sec2) - 2010 and can therefore, be used for design purposes. These pile capacities should be confirmed / validated by carrying out initial pile load test/s as per the provisions given in BIS code IS:2911 (Part-4) - 2013, prior to finalizing the working loads on the pile foundations.

10.5.3 For straight bored pile foundations, after reaching the required depth in the pile bore, 15cm thick layer of gravel should be placed and compacted at the bottom so that the slush formed at the bottom is diminished.

10.5.4 Foundation surface must be compacted heavily. If any loose pockets are observed, the same shall be filled with brickbats/gravel and compacted. Foundations can subsequently be placed over such a prepared surface.

10.6 Appendices

10.6.1 An appendix sheet showing the typical analysis of vertical pile capacity and uplift pile capacity calculations have been given in Appendix - A of this report.

10.6.2 An appendix sheet showing the typical analysis of lateral pile capacities calculations have been given in Appendix - B of this report.

10.6.3 An appendix sheet showing the typical procedure for Liquefaction Analysis has been given in Appendix - C of this report.

10.6.4 A list of IS Codes referred for providing the recommendations and that which might be required to implement the same is also enclosed in this report in Appendix - D.

10.7 NOTE

The recommendations given in this report have been arrived at on the basis of design parameters which have been judiciously adopted by giving due consideration to the results of field and laboratory investigations as well as NAGADI's experience of over four decades in working in various types of soil and rock conditions all over India.

10.8 LIMITATIONS

This geotechnical investigations have been carried out at locations in the site chosen by the clients so as to represent the entire site. The recommendations provided in this report are hence valid only for these test locations. However, if there is any change in subsoil conditions and properties at places between or beyond chosen test locations, fresh investigations will have to be carried out at such locations.

Dr. N. Santosh Rao

Technical Director

*For **Nagadi Consultants Pvt. Ltd***

Appendix -A

(refer para no. 10.6.1)

CALCULATIONS FOR PILE CAPACITY

A.1 Methodology

A.1.1 A typical calculation for the pile capacity has been given hereunder for a pile of diameter 'D' = 800mm and for a length of pile 'L' = 25m.

A.1.2 The pile is designed primarily as an end bearing cum friction pile.

A.1.3 The end bearing capacity has been determined based on observed N-values while the friction capacity has been determined as per the relevant provisions of the BIS code IS:2911(part1/sec4).

A.1.4 For determining the end bearing capacity, the N- value at the level of the pile tip has been taken as 25.

A.1.5 For determining the friction capacity, the average angle of shearing resistance ϕ has been taken as 30°.

A.2 DETERMINATION OF PILE CAPACITY

A.2.1 Pile end bearing capacity based on N-values

A.2.1.1 The ultimate end bearing capacity of the Bored pile foundation is determined as given below:

$$Q_{bu} = 10 \cdot N \cdot A_p$$

where N = N-value at the level of the pile tip

$A_p = \dfrac{\pi \cdot D^2}{4}$ = cross - sectional area of pile toe = 5026 cm^2

D = diameter of pile shaft = 600 mm

A.2.1.2 Therefore, the ultimate end bearing capacity of the bored pile foundation is :

Q_{bu} = 125.66 tons

A.2.2 Pile friction capacity based on IS:2911 (Part 1/Sec 4)

A.2.2.1 The ultimate friction capacity of the pile is :

$$Q_{fu} = \pi \cdot D \cdot (L - L_1) \cdot \alpha \cdot c + \sum_{1}^{n} K \cdot P_{Di} \cdot \tan\delta \cdot A_{si}$$

where c = cohesion of the soil along the pile shaft = 0.06 kg/cm^2

α = adhesion factor = 1

K = coefficient of earth pressure = 1

P_{Di} = effective overburden pressure at for the ith layer = $\gamma.d_i$

γ = submerged unit weight of soil below water table = 1 g/cm^3

d_i = depth of the ith layer from ground level

A_{si} = surface area of the pile stem in the ith layer

δ = angle of wall friction between pile and soil

= ϕ = angle of shearing resistance of the soil = 30^o

A.2.2.2 For calculation purposes, the submerged unit weight of the soil has been taken as the effective unit weight of the soil. The submerged unit weight considered is 1 g/cm^3.

A.2.2.3 As per the IS provisions, the effective overburden pressure P_{Di} is limited to a value equivalent to a depth of overburden equal to 15 times the diameter of the pile.

A.2.2.4 The skin friction capacity 'Q_{fu}' is determined as :

$$Q_{fu} = \pi \cdot d \cdot (L - L_1) \cdot \alpha \cdot c + K \cdot \tan\delta \cdot \left[\begin{array}{l} \frac{1}{2} \cdot (\gamma \cdot 15 \cdot D) \cdot (15 \cdot D) \cdot (\pi \cdot D) + \\ (\gamma \cdot 15 \cdot D) \cdot (L - 15 \cdot D) \cdot (\pi \cdot D) - \\ \frac{1}{2} \cdot (\gamma \cdot L_1) \cdot (L_1) \cdot (\pi \cdot D) \end{array} \right]$$

For $L_1 > 15$ *times the pile diameter D*

$$Q_{fu} = \pi \cdot D \cdot (L - L_1) \cdot \alpha \cdot c + K \cdot \tan\delta \cdot \left[(\gamma \cdot 15 \cdot D) \cdot (L - L_1) \cdot (\pi \cdot D) \right]$$

A.2.2.5 The skin friction capacity 'Q_{fu}' of the Bored pile foundation is :

Q_{fu} = 322.4 tons

A.3 SAFE PILE CAPACITY

A.3.1 The safe pile capacity is determined by applying appropriate factors of safety to the ultimate values determined above. A factor of safety of 2.5 has been adopted for determination of the safe pile capacity.

A.3.2 Therefore, the safe pile capacity of Bored pile foundation is :

$$Q_s = \frac{Q_{bu} + Q_{fu}}{2.5}$$

Hence,

Q_s = 179.2 tons say 180 tons

A.4 SAFE UPLIFT CAPACITY

The safe uplift capacity of the pile is determined by applying appropriate factors of safety to the ultimate friction capacity of the pile as determined above. A factor of safety of 3 has been adopted for determination of the safe uplift pile capacity.

Hence,

$$Safe.Uplift.Capacity = \frac{Q_{fu}}{3}$$

Q_{su} = 107.3 tons say 105 tons

Appendix -B

(refer para no. 10.6.2)

TYPICAL CALCULATION OF LATERAL PILE LOAD CAPACITY

(As per IS : 2911 (Part1/Sec2) - 2010)

B.1 Methodology

B.1.1 A typical calculation for the lateral pile load capacity has been given hereunder for a pile of diameter 'D' = 800mm.

B.1.2 For determining the lateral pile load capacity, the depth of fixity of the piles or in other words, the equivalent cantilever length of the pile, has to be first determined. The depth of fixity is determined based on the modulus of horizontal subgrade reaction η_h value which in turn is considered based on the relative density/ soil consistency of the soil as observed in the boreholes conducted, as per table 3 of Annex - C of the BIS code IS:2911(part1/sec2).

B.1.3 Considering that the soil in is on an average in a loose to medium dense state, the modulus of horizontal subgrade reaction can be taken as $\eta_h = 2.8 \times 10^3$ kN/m^2 or 0.28 kg/cm^3 applicable for submerged conditions (as ground water table is at a shallow depth), as per table 1 of Annex - C of the BIS code IS:2911(part1/sec2).

B.1.4 Considering the subsoil to be susceptible to liquefaction down to about 13m depth below the existing ground level, in the event of earthquake the restraint provided by the soil against lateral load on the pile will almost nil within this depth. Hence the pile length of about 7m below cut off level (i.e. 6m below the existing ground level) will behave like cantilever (i.e. e =7m).

B.2 Stiffness Factor and Depth of Fixity

B.2.1 The stiffness factor T is calculated as per C - 2.3.1 of Annex - C of the BIS code IS:2911(part1/sec2) , as given below:

$$Stiffness.\ factor = T = 5\sqrt{\frac{EI}{\eta_h}}$$

Stiffness factor = T = 2.88 m

B.2.2 The equivalent cantilever length or in other words the depth of fixity ($\mathbf{L_e}$) of the pile works out to be based on stiffness factor (T) and the plot given in fig.4 in C - 3 of Annex - C of the BIS code IS:2911(part1/sec2)

$\mathbf{L_e = 1.9 \times T = 1.9 \times 2.88 = 5.46m}$ (for free head condition)

$\mathbf{L_e = 2.2 \times T = 2.2 \times 2.88 = 6.33m}$ (for fixed head condition)

B.2.3 The lateral pile load capacity is then determined as the horizontal force required for causing the allowable horizontal deflection of the pile head when considering the pile as a cantilever.

B.2.4 For calculation purposes, the concrete of pile has been considered to be of M30 grade.

B.2.5 For the determination of the lateral pile load capacity, the allowable horizontal deflection of the pile head has been considered as 5mm based on the provisions of clause 7.4 of BIS code IS:2911 (Part4) - 1985.

B.3 Determination of Lateral Pile Load Capacity

B.3.1 The horizontal deflection of the pile head, is determined by the following equations :

$$y = \frac{Q_L \cdot (e + z_f)^3}{3 \cdot E \cdot I}$$ (for free head condition)

$$y = \frac{Q_L \cdot (e + z_f)^3}{12 \cdot E \cdot I}$$ (for fixed head condition)

where,

e = cantilever length above ground/ bed to the point of load application

z = depth to point of fixity

B.3.2 The flexural rigidity 'E·I' of the pile section has to be then determined by taking into account the flexural rigidity provided by the reinforcement. For this purpose, the moment of inertia 'I' is determined by taking into account the area of reinforcement along with the appropriate value of modular ratio 'm'.

B.3.3 The elastic modulus of concrete is determined as :

$$E = 5000 \cdot \sqrt{f_{ck}}$$

Where f_{ck} = characteristic strength of concrete = 30N/mm^2

Hence, E = 27,386 N/mm^2 or 273,860 kg/cm^2

B.3.4 The moment of inertia of the pile section is determined as :

$$I = \frac{\pi \cdot d^4}{64}$$

Hence, I = 20106192980 mm^4 = 2010619.298 cm^4

B.3.2 Considering an allowable horizontal deflection of the pile head of 5mm, the lateral pile load capacity works out to be :

Q_L = 0.4 tons (for free head condition)

Q_L = 1.4 tons (for fixed head condition)

Appendix - C

(refer para no. 10.6.3)

STANDARD PROCEDURE FOR LIQUEFACTION ANALYSIS

(Reference : Annex F of IS 1893 Part 1- 2016)

D.1 EVALUATION OF CYCLIC STRESS RATIO (CSR)

$$CSR = (\tau_{av} / \sigma'_{vo}) = 0.65(a_{\max} / g).(\sigma_{vo} / \sigma'_{vo}).r_d \qquad \textit{(i)}$$

where, $r_d = (1.0 - 0.00765z), for, (z \le 9.15m)$

$r_d = (1.174 - 0.0267z), for, (9.15m < z \le 23m)$

D.2 EVALUATION OF LIQUEFACTION RESISTANCE (CRR)

$$CRR_{7.5} = f(N_1)_{60} \qquad \textit{(ii)}$$

$$\textit{i.e. } CRR_{7.5} = \frac{1}{34 - (N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10.(N_1)_{60} + 45]^2} - \frac{1}{200}$$

D.2.1. Influence of Fine Content

$(N_1)_{60cs} = \alpha + \beta(N_1)_{60}$

where, $\alpha = 0, for, (FC \le 5\%)$

$\alpha = \exp[1.76 - (190 / FC^2)], for, (5\% < FC < 35\%)$

$\alpha = 5, for, (FC \ge 35\%)$

$\beta = 1, for, (FC \le 5\%)$

$\beta = [0.99 + (FC^{1.5} / 1{,}000)], for, (5\% < FC < 35\%)$

$\beta = 1.2, for, (FC \ge 35\%)$

D.2.1. Other Corrections

$$(N_1)_{60} = N_m C_N C_E C_B C_R C_S$$

D.3 *NOTATIONS*

Notation	Description
CSR	Cyclic Stress Ratio
CRR	Cyclic Resistance Ratio
σ_{vo}	Total Vertical Overburden Stresses
σ'_{vo}	Effective vertical overburden stresses
τ_{av}	Average horizontal shear stress acting on soil layer during shaking generated by given earthquake
a_{max}	Peak horizontal acceleration at ground surface
g	Acceleration of gravity
r_d	Stress reduction coefficient to account for flexibility in soil profile
z	Depth below ground surface (m)
$CRR_{7.5}$	Cyclic resistance ratio for M_w = 7.5 earthquakes
$(N_1)_{60}$	Corrected standard penetration resistance
$(N_1)_{60cs}$	$(N_1)_{60}$ adjusted to equivalent clean-sand value
N_m	Measured standard penetration resistance
C_N	Correction factor for overburden pressure applied to SPT
C_E	Correction factor for hammer energy
C_B	Correction factor for borehole diameter
C_R	Correction factor for drilling rod length
C_S	Correction factor for split spoon sampler without liners
α, β	Coefficients, that are functions of fines content, used to correct $(N_1)_{60}$ to $(N_1)_{60cs}$

Appendix - D

(refer para no. 10.6.4)

LIST OF IS CODES

Field Investigation

1. IS : 1892 - 2021 : Code of practice for sub surface investigations for foundations (First revision)
2. IS : 2131 - 1981 : Method of Standard Penetration Tests for soils (First revision)
3. IS : 2132 - 1986 : Code of practice for thin walled tube sampling of soils (Second revision)
4. IS: 4968 (Part III) - 1976: Method for subsurface sounding for soils - Static Cone Penetration test (First Revision; First Reprint June 1983)

Laboratory Tests

1. IS : 2720 - 1983 (Part 1) : Methods of test for soils: Preparation of dry soil samples for various tests (Second revision)
2. IS : 2720 - 1980 (Part 2) : Method of test for soils: Determination of water content (Second revision) Amendment 1
3. IS : 2720 - 1980 (Part 3/sec 1) : Method of Test for Soils : Determination of Specific Gravity : Fine Grained Soils. (First Revision)
4. IS : 2720 - 1980 (Part 3/Sec 2) : Method of test for soils : Determination of Specific Gravity : Fine, Medium & Coarse grained soils. (First revision).

5.	IS : 2720 - 1985 (Part 4) :	Method of test for soils : Grain size analysis (Second revision)
6.	IS : 2720 (Part 8) -1983:	Determination of water content - dry density relation using heavy compaction. (First revision)
7.	IS : 2720 - 1985 (Part 5) :	Method of test for soils : Determination of liquid and plastic limit (Second revision)
8.	IS 2720-1981 Part 12:	Method of tests for soils : Determination of shear strength parameters using triaxial apparatus.
9.	IS : 2720 - 1987 (Part16)	Method of Tests for Soils: Laboratory Determination of California Bering Ratio (Second revision) (Reaffirmed - 2002)
10.	IS : 2720 - 1986 (Part17)	Method of Tests for Soils: Laboratory Determination of Permeability (Reaffirmed - 2002)
11.	IS : 2720 -1987 (Part 26):	Methods of tests for soils: Determination of pH value (Second revision).
12.	IS :2720 - 1977 (Part 27):	Methods of tests for soils: Determination of total soluble sulphate (First revision).

Foundation Construction

1.	IS : 2911 - 1979 (P1/Sec 1):	Code of practice for design and construction of pile foundations : concrete piles - Driven cast insitu (First revision) Amendment 2

Analysis of Susceptibility to Liquefaction for Borehole BH1

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	11	1.70	1	1	0.75	1	14	59	5.00	1.200	22	**0.242**	***1.55***
2.4	0.24	1.000	0.998	**0.156**	8	1.50	1	1	0.8	1	10	18	3.23	1.066	14	**0.150**	***0.96***
3.9	0.24	1.175	0.997	**0.183**	16	1.18	1	1	0.85	1	16	73	5.00	1.200	24	**0.273**	***1.50***
5.4	0.24	1.334	0.996	**0.207**	11	1.00	1	1	0.95	1	10	11	1.21	1.026	11	**0.122**	***0.59***
6.9	0.24	1.442	0.995	**0.224**	12	0.92	1	1	0.95	1	10	4	0.00	1.000	10	**0.113**	***0.51***
8.4	0.24	1.519	0.994	**0.236**	15	0.87	1	1	0.95	1	12	2	0.00	1.000	12	**0.131**	***0.56***
9.9	0.24	1.578	0.910	**0.224**	17	0.82	1	1	1	1	14	2	0.00	1.000	14	**0.150**	***0.67***
11.4	0.24	1.624	0.870	**0.220**	26	0.78	1	1	1	1	20	2	0.00	1.000	20	**0.215**	***0.98***
12.9	0.24	1.661	0.830	**0.215**	30	0.75	1	1	1	1	22	2	0.00	1.000	22	**0.242**	***1.13***
14.4	0.24	1.691	0.790	**0.208**	39	0.72	1	1	1	1	28	2	0.00	1.000	28	**0.370**	***1.77***
15.9	0.24	1.717	0.749	**0.201**	38	0.69	1	1	1	1	26	2	0.00	1.000	26	**0.313**	***1.56***
17.4	0.24	1.738	0.709	**0.192**	42	0.67	1	1	1	1	28	2	0.00	1.000	28	**0.370**	***1.92***
20	0.24	1.769	0.640	**0.177**	51	0.63	1	1	1	1	32	52	5.00	1.200	43	**0.500**	***2.83***

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Job No. : G(D)4535

Sheet No. : C1

Analysis of Susceptibility to Liquefaction for Borehole BH2

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.000	0.999	**0.156**	9	1.70	1	1	0.8	1	12	57	5.00	1.200	19	**0.203**	***1.30***
3	0.24	1.037	0.998	**0.161**	12	1.34	1	1	0.85	1	14	3	0.00	1.000	14	**0.150**	***0.93***
4.5	0.24	1.247	0.997	**0.194**	6	1.10	1	1	0.95	1	6	2	0.00	1.000	6	**0.080**	***0.41***
6	0.24	1.382	0.995	**0.215**	9	0.96	1	1	0.95	1	8	7	0.12	1.009	8	**0.096**	***0.45***
7.5	0.24	1.476	0.994	**0.229**	18	0.90	1	1	0.95	1	15	4	0.00	1.000	15	**0.160**	***0.70***
9	0.24	1.545	0.993	**0.239**	15	0.85	1	1	1	1	13	2	0.00	1.000	13	**0.141**	***0.59***
10.5	0.24	1.598	0.894	**0.223**	18	0.81	1	1	1	1	14	3	0.00	1.000	14	**0.150**	***0.67***
12	0.24	1.640	0.854	**0.218**	20	0.77	1	1	1	1	15	3	0.00	1.000	15	**0.160**	***0.73***
13.5	0.24	1.674	0.814	**0.212**	21	0.74	1	1	1	1	15	2	0.00	1.000	15	**0.160**	***0.75***
15	0.24	1.702	0.774	**0.205**	27	0.71	1	1	1	1	19	2	0.00	1.000	19	**0.203**	***0.99***
16.5	0.24	1.726	0.733	**0.197**	33	0.68	1	1	1	1	23	3	0.00	1.000	23	**0.257**	***1.30***
18	0.24	1.746	0.693	**0.189**	36	0.66	1	1	1	1	24	2	0.00	1.000	24	**0.273**	***1.45***

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Job No. : G(D)4535

Sheet No. : C2

Analysis of Susceptibility to Liquefaction for Borehole BH3

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	11	1.70	1	1	0.75	1	14	77	5.00	1.200	22	**0.242**	***1.55***
2.4	0.24	1.000	0.998	**0.156**	10	1.50	1	1	0.8	1	12	64	5.00	1.200	19	**0.203**	***1.31***
3.9	0.24	1.213	0.997	**0.189**	10	1.18	1	1	0.85	1	10	4	0.00	1.000	10	**0.113**	***0.60***
5.4	0.24	1.368	0.996	**0.213**	12	1.00	1	1	0.95	1	11	3	0.00	1.000	11	**0.122**	***0.57***
6.9	0.24	1.472	0.995	**0.228**	15	0.93	1	1	0.95	1	13	3	0.00	1.000	13	**0.141**	***0.62***
8.4	0.24	1.547	0.994	**0.240**	18	0.87	1	1	0.95	1	15	3	0.00	1.000	15	**0.160**	***0.67***
9.9	0.24	1.603	0.910	**0.227**	22	0.83	1	1	1	1	18	3	0.00	1.000	18	**0.192**	***0.84***
11.4	0.24	1.647	0.870	**0.223**	25	0.79	1	1	1	1	20	2	0.00	1.000	20	**0.215**	***0.96***
12.9	0.24	1.682	0.830	**0.218**	23	0.75	1	1	1	1	17	3	0.00	1.000	17	**0.181**	***0.83***
14.4	0.24	1.710	0.790	**0.211**	34	0.72	1	1	1	1	25	2	0.00	1.000	25	**0.292**	***1.39***
15.9	0.24	1.734	0.749	**0.203**	42	0.70	1	1	1	1	29	3	0.00	1.000	29	**0.410**	***2.02***
17.4	0.24	1.755	0.709	**0.194**	54	0.67	1	1	1	1	36	2	0.00	1.000	36	**0.500**	***2.57***
20	0.24	1.783	0.640	**0.178**	27	0.64	1	1	1	1	17	57	5.00	1.200	25	**0.292**	***1.64***

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Job No. : G(D)4535

Sheet No. : C3

Analysis of Susceptibility to Liquefaction for Borehole BH4

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.000	0.999	**0.156**	19	1.70	1	1	0.8	1	26	72	5.00	1.200	36	**0.500**	***3.21***
3	0.24	1.077	0.998	**0.168**	12	1.34	1	1	0.85	1	14	12	1.55	1.032	16	**0.170**	***1.02***
4.5	0.24	1.283	0.997	**0.199**	8	1.10	1	1	0.95	1	8	4	0.00	1.000	8	**0.096**	***0.48***
6	0.24	1.414	0.995	**0.220**	9	0.96	1	1	0.95	1	8	2	0.00	1.000	8	**0.096**	***0.44***
7.5	0.24	1.505	0.994	**0.233**	11	0.90	1	1	0.95	1	9	2	0.00	1.000	9	**0.104**	***0.45***
9	0.24	1.571	0.993	**0.243**	14	0.85	1	1	1	1	12	2	0.00	1.000	12	**0.131**	***0.54***
10.5	0.24	1.622	0.894	**0.226**	15	0.81	1	1	1	1	12	4	0.00	1.000	12	**0.131**	***0.58***
12	0.24	1.662	0.854	**0.221**	16	0.77	1	1	1	1	12	3	0.00	1.000	12	**0.131**	***0.59***
13.5	0.24	1.694	0.814	**0.215**	19	0.74	1	1	1	1	14	3	0.00	1.000	14	**0.150**	***0.70***
15	0.24	1.721	0.774	**0.208**	26	0.71	1	1	1	1	18	2	0.00	1.000	18	**0.192**	***0.92***
16.5	0.24	1.743	0.733	**0.199**	33	0.69	1	1	1	1	23	2	0.00	1.000	23	**0.257**	***1.29***
18	0.24	1.762	0.693	**0.191**	42	0.66	1	1	1	1	28	3	0.00	1.000	28	**0.370**	***1.94***

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Job No. : G(D)4535

Sheet No. : C4

Analysis of Susceptibility to Liquefaction for Borehole BH5

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	21	1.70	1	1	0.75	1	27	67	5.00	1.200	37	**0.500**	***3.21***
2.4	0.24	1.000	0.998	**0.156**	13	1.50	1	1	0.8	1	16	14	2.20	1.042	19	**0.203**	***1.31***
3.9	0.24	1.232	0.997	**0.192**	10	1.18	1	1	0.85	1	10	4	0.00	1.000	10	**0.113**	***0.59***
5.4	0.24	1.385	0.996	**0.215**	8	1.00	1	1	0.95	1	8	3	0.00	1.000	8	**0.096**	***0.45***
6.9	0.24	1.488	0.995	**0.231**	11	0.93	1	1	0.95	1	10	2	0.00	1.000	10	**0.113**	***0.49***
8.4	0.24	1.561	0.994	**0.242**	14	0.87	1	1	0.95	1	12	2	0.00	1.000	12	**0.131**	***0.54***
9.9	0.24	1.615	0.910	**0.229**	19	0.83	1	1	1	1	16	2	0.00	1.000	16	**0.170**	***0.74***
11.4	0.24	1.658	0.870	**0.225**	25	0.79	1	1	1	1	20	2	0.00	1.000	20	**0.215**	***0.96***
12.9	0.24	1.692	0.830	**0.219**	33	0.75	1	1	1	1	25	2	0.00	1.000	25	**0.292**	***1.33***
14.4	0.24	1.720	0.790	**0.212**	41	0.72	1	1	1	1	30	2	0.00	1.000	30	**0.468**	***2.21***
15.9	0.24	1.743	0.749	**0.204**	49	0.70	1	1	1	1	34	3	0.00	1.000	34	**0.500**	***2.45***
17.4	0.24	1.763	0.709	**0.195**	64	0.67	1	1	1	1	43	3	0.00	1.000	43	**0.500**	***2.56***
20	0.24	1.791	0.640	**0.179**	40	0.64	1	1	1	1	25	54	5.00	1.200	35	**0.500**	***2.80***

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Analysis of Susceptibility to Liquefaction for Borehole BH6

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.000	0.999	**0.156**	15	1.70	1	1	0.8	1	20	74	5.00	1.200	29	**0.410**	***2.63***
3	0.24	1.098	0.998	**0.171**	14	1.34	1	1	0.85	1	16	15	2.50	1.048	19	**0.203**	***1.19***
4.5	0.24	1.302	0.997	**0.202**	11	1.10	1	1	0.95	1	11	3	0.00	1.000	11	**0.122**	***0.60***
6	0.24	1.431	0.995	**0.222**	15	0.97	1	1	0.95	1	14	2	0.00	1.000	14	**0.150**	***0.68***
7.5	0.24	1.519	0.994	**0.236**	7	0.91	1	1	0.95	1	6	3	0.00	1.000	6	**0.080**	***0.34***
9	0.24	1.584	0.993	**0.245**	13	0.86	1	1	1	1	11	2	0.00	1.000	11	**0.122**	***0.50***
10.5	0.24	1.634	0.894	**0.228**	24	0.81	1	1	1	1	19	2	0.00	1.000	19	**0.203**	***0.89***
12	0.24	1.673	0.854	**0.223**	24	0.77	1	1	1	1	19	2	0.00	1.000	19	**0.203**	***0.91***
13.5	0.24	1.704	0.814	**0.216**	27	0.74	1	1	1	1	20	3	0.00	1.000	20	**0.215**	***1.00***
15	0.24	1.730	0.774	**0.209**	21	0.71	1	1	1	1	15	91	5.00	1.200	23	**0.257**	***1.23***
16.5	0.24	1.752	0.733	**0.200**	24	0.69	1	1	1	1	16	53	5.00	1.200	24	**0.273**	***1.36***
18	0.24	1.770	0.693	**0.191**	50	0.66	1	1	1	1	33	17	3.01	1.060	38	**0.500**	***2.61***

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Job No. : G(D)4535

Sheet No. : C6

Analysis of Susceptibility to Liquefaction for Borehole BH7

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	8	1.70	1	1	0.75	1	10	14	2.20	1.042	13	**0.141**	***0.90***
2.4	0.24	1.000	0.998	**0.156**	12	1.50	1	1	0.8	1	14	3	0.00	1.000	14	**0.150**	***0.96***
3.9	0.24	1.213	0.997	**0.189**	11	1.20	1	1	0.85	1	11	3	0.00	1.000	11	**0.122**	***0.65***
5.4	0.24	1.368	0.996	**0.213**	7	1.09	1	1	0.95	1	7	2	0.00	1.000	7	**0.088**	***0.41***
6.9	0.24	1.472	0.995	**0.228**	11	1.00	1	1	0.95	1	10	3	0.00	1.000	10	**0.113**	***0.50***
8.4	0.24	1.547	0.994	**0.240**	22	0.93	1	1	0.95	1	20	2	0.00	1.000	20	**0.215**	***0.90***
9.9	0.24	1.603	0.910	**0.227**	26	0.88	1	1	1	1	23	2	0.00	1.000	23	**0.257**	***1.13***
11.4	0.24	1.647	0.870	**0.223**	30	0.83	1	1	1	1	25	2	0.00	1.000	25	**0.292**	***1.31***
12.9	0.24	1.682	0.830	**0.218**	31	0.79	1	1	1	1	25	2	0.00	1.000	25	**0.292**	***1.34***
14.4	0.24	1.710	0.790	**0.211**	38	0.76	1	1	1	1	29	2	0.00	1.000	29	**0.410**	***1.95***
15.9	0.24	1.734	0.749	**0.203**	43	0.73	1	1	1	1	31	2	0.00	1.000	31	**0.500**	***2.47***
17.4	0.24	1.755	0.709	**0.194**	20	0.70	1	1	1	1	14	62	5.00	1.200	22	**0.242**	***1.25***
20	0.24	1.783	0.640	**0.178**	36	0.66	1	1	1	1	24	29	4.64	1.146	32	**0.500**	***2.81***

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Job No. : G(D)4535

Sheet No. : C7

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.8m | Term. Depth : 40m | B.H. No.: 1

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg Limits		In-situ properties		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
11	0.9	Yellowish brown clayey silty sand	0	41	40	19	22	16					
	1.5	Change of the strata							1.83	12.3			
8	2.4	Grey sand with silt	0	82	18	0	Non	Plastic					
	3.0	Change of the strata							1.94	10.8	CD	0.11	24
16	3.9	Yellowish brown clayey sandy silt	0	27	59	14	25	18					
	4.5	Change of the strata							1.78	23.5			
11	5.4	Grey sand with traces of silt	0	89	11	0	Non	Plastic					
	6.0								2.02	20.1			
12	6.9	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	7.5								1.87	27.5			
15	8.4	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	9.0								Sample	slip			
17	9.9	Grey sand with traces of silt and gravel	7	91	2	0	Non	Plastic					

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Job No. : G(D)4535

Sheet No. : 1

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.8m | Term. Depth : 40m | B.H. No.: 1

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	10.5								Sample	slip			
26	11.4	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	12.0								Sample	slip			
30	12.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	13.5								Sample	slip			
39	14.4	Grey sand with traces of silt and gravel	10	83	2	0	Non	Plastic					
	15.0								Sample	slip			
38	15.9	Grey sand with traces of silt	6	92	2	0	Non	Plastic					
	16.5								Sample	slip			
42	17.4	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	18.0								Sample	slip			
	18.5	Change of the strata											
51	20.4	Yellowish brown clayey sandy silt with gravel	23	25	40	12	32	21					
	21.0								2.06	24.9	CD	0.10	28

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Job No. :G(D)4535

Sheet No. : 2

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.9m | Term. Depth : 40m | B.H. No.: 1

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
60	23.4	Yellowish brown clayey sandy silt with gravel	14	37	47	2	Low	Plastic					
	24.0								2.12	23.3			
74	26.4	Yellowish brown clayey sandy silt with gravel	2	19	69	10	28	19					
	27.0								2.08	21.4	CD	0.10	29
	29.0	Change of the strata											
130	29.4	Grey sand with traces of silt and gravel	2	89	9	0	Non	Plastic					
	30.0								Sample	slip			
84	32.4	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	33.0								Sample	slip			
104	35.4	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	36.0								Sample	slip			
121	38.4	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	39.0								Sample	slip			
126	40.0	Grey sand with traces of silt	0	93	7	0	Non	Plastic					

Observed 'N' Values

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Job No. : G(D)4535

Sheet No. : 3

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.8m | Term. Depth : 40m | B.H. No.: 2

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.70	9.1			
9	1.5	Yellowish brown clayey sandy silt	0	43	48	9	21	17					
	2.4	Change of the strata							1.73	10.9			
12	3.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	3.9								1.66	3.9			
9	4.5	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	5.4								1.84	17.1			
18	6.0	Grey sand with traces of silt and gravel	5	88	7	0	Non	Plastic					
	6.9								1.97	23.1	CD	0.03	25
15	7.5	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	8.4								Sample	slip			
18	9.0	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	9.9								Sample	slip			
20	10.5	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					

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Job No. G(D)4535

Sheet No. : 4

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.8m | Term. Depth : 40m | B.H. No.: 2

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	11.4								Sample	slip			
21	12.0	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	12.9								Sample	slip			
27	13.5	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	14.4								Sample	slip			
33	15.0	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	15.9								Sample	slip			
36	16.5	Grey sand with traces of silt and gravel	12	85	3	0	Non	Plastic					
	17.4								Sample	slip			
50	18.0	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	18.5	Change of the strata											
	20.4								2.12	17.3	CD	0.12	27
32	21.0	Yellowish brown clayey sandy silt with gravel	8	23	55	14	29	20					
	22.0	Change of the strata											
	23.4								Sample	slip			
61	24.0	Grey sand with silt	0	86	14	0	Non	Plastic					
	25.5	Change of the strata											

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Job No. G(D)4535

Sheet No. : 5

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.8m | Term. Depth : 40m | B.H. No.: 2

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	26.4								2.05	24.0	CD	0.11	28
69	27.0	Yellowish brown clayey sandy silt with gravel	6	17	60	17	33	22					
	28.5	Change of the strata											
	29.4								Sample	slip			
61	30.0	Grey sand with silt	0	85	15	0	Non	Plastic					
	32.4								Sample	slip			
102	33.0	Grey sand with traces of silt	0	89	11	0	Non	Plastic					
	35.4								Sample	slip			
109	36.0	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	38.4								Sample	slip			
101	39.0	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	40.0								Sample	slip			
		Observed 'N' Values											

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Job No. G(D)4535

Sheet No. : 6

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.6m | Term. Depth : 40m | B.H. No.: 3

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
11	0.9	Yellowish brown clayey sandy silt	0	23	62	15	27	19					
	1.5								1.81	16.5			
10	2.4	Yellowish brown clayey sandy silt with gravel	2	34	58	6	25	17					
	3.0								1.80	15.1	CD	0.09	24
	3.5	Change of the strata											
10	3.9	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	4.5								1.66	3.9			
12	5.4	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	6.0								1.93	18.8			
15	6.9	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	7.5								Sample	slip			
18	8.4	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	9.0								Sample	slip			
22	9.9	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	10.5								Sample	slip			

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Job No. : G(D)4535

Sheet No. : 7

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.6m | Term. Depth : 40m | B.H. No.: 3

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
25	11.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	12.0								Sample	slip			
23	12.9	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	13.5								Sample	slip			
34	14.4	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	15.0								Sample	slip			
42	15.9	Grey sand with traces of silt and gravel	11	86	3	0	Non	Plastic					
	16.5								Sample	slip			
54	17.4	Grey sand with traces of silt and gravel	12	86	2	0	Non	Plastic					
	18.0								Sample	slip			
	18.4	Change of the strata											
27	20.4	Yellowish brown clayey sandy silt with gravel	17	26	51	6	26	18					
	21.0								2.20	20.9	CD	0.09	27
	21.5	Change of the strata											
48	23.4	Grey sand with silt and gravel	2	79	19	0	Non	Plastic					
	24.0								Sample	slip			

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Job No. G(D)4535

Sheet No. : 8

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.6m | Term. Depth : 40m | B.H. No.: 3

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	25.5	Change of the strata											
35	26.4	Yellowish brown sandy clayey silt with gravel	3	12	67	18	33	22					
	27.0								2.10	22.9	CD	0.12	27
	28.0	Change of the strata											
59	29.4	Grey sand with silt	0	86	14	0	Non	Plastic					
	30.0								Sample	slip			
78	32.4	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	33.0								Sample	slip			
76	35.4	Grey sand with silt	0	88	12	0	Non	Plastic					
	36.4								Sample	slip			
79	38.4	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	39.0								Sample	slip			
65	40.0	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
		Observed 'N' Values											

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Job No. :G(D)4535

Sheet No. : 9

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.6m | Term. Depth : 40m | B.H. No.: 4

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.79	15.2			
19	1.5	Yellowish brown clayey sandy silt	0	28	53	19	30	21					
	2.0	Change of the strata											
	2.4								1.65	3.4	CD	0.02	25
12	3.0	Grey sand with silt	0	88	12	0	Non	Plastic					
	3.9								1.72	3.8			
8	4.5	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	5.4								1.85	20.4			
9	6.0	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	6.9								Sample	slip			
11	7.5	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	8.4								Sample	slip			
14	9.0	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					

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Job No. : G(D)4535

Sheet No. : 10

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.6m | Term. Depth : 40m | B.H. No.: 4

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	9.9								Sample	slip			
15	10.5	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	11.0	Yellowish brown clayey sandy silt											
	11.2	Change of the strata											
	11.4								Sample	slip			
16	12.0	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	12.5								Sample	slip			
19	12.9	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	13.5								Sample	slip			
26	14.4	Grey sand with traces of silt and gravel	11	87	2	0	Non	Plastic					
	15.0								Sample	slip			
33	15.9	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	17.4								Sample	slip			
42	18.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	19.4	Change of the strata											
	20.4								2.08	19.4	CD	0.12	27

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Job No. : G(D)4535

Sheet No. : 11

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.6m | Term. Depth : 40m | B.H. No.: 4

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
31	21.0	Yellowish brown clayey sandy silt with gravel	3	28	55	14	30	21					
	22.0	Change of the strata											
	23.4								Sample	slip			
33	24.0	Grey sand with traces of silt and gravel	4	89	7	0	Non	Plastic					
	25.5	Change of the strata											
	26.4								2.10	24.2	CD	0.11	28
45	27.0	Yellowish brown clayey sandy silt with gravel	2	22	64	12	27	19					
	28.0	Change of the strata											
	29.4								Sample	slip			
50	30.0	Grey sand with silt	0	85	15	0	Non	Plastic					
	32.4								Sample	slip			
66	33.0	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	35.4								Sample	slip			
37	36.0	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	37.9	Yellowish brown clayey sandy silt											
	38.3	Change of the strata											
	38.4								Sample	slip			
65	39.0	Grey sand with traces of silt	0	90	10	0	Non	Plastic					
	40.0												
		Observed 'N' Values											

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Sheet No. : 12

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.5m | Term. Depth : 40m | B.H. No.: 5

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
21	0.9	Yellowish brown clayey sandy silt	0	33	48	19	29	20					
	1.5								1.79	11.3	CD	0.13	27
	1.8	Change of the strata											
13	2.4	Grey sand with silt	0	86	14	0	Non	Plastic					
	3.0								1.86	18.1			
10	3.9	Grey sand with traces of silt and gravel	2	94	4	0	Non	Plastic					
	4.5								1.66	3.1			
8	5.4	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	6.0								1.95	25.2			
11	6.9	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	7.5								Sample	slip			
14	8.4	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	9.0								Sample	slip			

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Job No. G(D)4535

Sheet No. : 13

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.5m | Term. Depth : 40m | B.H. No.: 5

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
19	9.9	Grey sand with traces of silt and gravel	6	92	2	0	Non	Plastic					
	10.5								Sample	slip			
25	11.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	12.0								Sample	slip			
33	12.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	13.5								Sample	slip			
41	14.4	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	15.0								Sample	slip			
49	15.9	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	16.5								Sample	slip			
64	17.4	Grey sand with traces of silt	2	95	3	0	Non	Plastic					
	18.0								Sample	slip			
	18.6	Change of the strata											
40	20.4	Yellowish brown clayey sandy silt with gravel	19	27	42	12	27	19					
	21.0								2.13	18.7	CD	0.10	28

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Job No. :G(D)4535

Sheet No. : 14

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.5m | Term. Depth : 40m | B.H. No.: 5

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	ϕ (°)
	22.0	Change of the strata											
53	23.4 24.0	Grey sand with traces of silt and gravel	3	88	9	0	Non	Plastic	Sample	slip			
	26.2	Change of the strata											
23	26.4 27.0	Yellowish brown clayey sandy silt	0	18	66	16	32	22	2.07	23.4	CD	0.12	26
	29.0	Change of the strata											
61	29.4 30.0	Grey sand with silt and gravel	4	76	20	0	Non	Plastic	2.10	21.5			
64	32.4 33.0	Grey sand with traces of silt	0	93	7	0	Non	Plastic	Sample	slip			
68	35.4 36.0	Grey sand with traces of silt	0	96	4	0	Non	Plastic	Sample	slip			
	38.0	Change of the strata											
47	38.4 39.0	Yellowish brown sandy clayey silt with gravel	17	18	45	20	30	20	2.29	25.5			
	39.8	Change of the strata											
48	40.0	Grey sand with traces of silt	0	95	5	0	Non	Plastic					

Observed 'N' Values

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Job No. G(D)4535

Sheet No. : 15

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.5m | Term. Depth : 40m | B.H. No.: 6

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.70	6.0			
15	1.5	Yellowish brown clayey sandy silt	0	26	62	12	25	18					
	2.4	Change of the strata							1.84	15.4	CD	0.04	27
14	3.0	Grey sand with silt	0	85	15	0	Non	Plastic					
	3.9								1.63	2.4			
11	4.5	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	5.4								1.79	11.9			
15	6.0	Grey sand with traces of silt and gravel	4	94	2	0	Non	Plastic					
	6.9								Sample	slip			
7	7.5	Grey sand with traces of silt and gravel	5	92	3	0	Non	Plastic					
	8.4								Sample	slip			
13	9.0	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	9.9								Sample	slip			
24	10.5	Grey sand with traces of silt and gravel	8	90	2	0	Non	Plastic					

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Job No. : G(D)4535

Sheet No. : 16

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.5m | Term. Depth : 40m | B.H. No.: 6

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	11.4								Sample	slip			
24	12.0	Grey sand with traces of silt and gravel	8	90	2	0	Non	Plastic					
	12.9								Sample	slip			
27	13.5	Grey sand with traces of silt and gravel	23	74	3	0	Non	Plastic					
	14.4								Sample	slip			
	14.8	Change of the strata											
21	15.0	Yellowish brown sandy clayey silt with gravel	3	6	55	36	49	29					
	15.9								1.97	20.2	CD	0.15	23
24	16.5	Yellowish brown clayey sandy silt with gravel	2	45	50	3	23	16					
	17.4	Change of the strata							2.13	17.0			
50	18.0	Grey sand with silt and gravel	16	67	17	0	Non	Plastic					
	18.5	Change of the strata											
	20.4								Sample	slip			
32	21.0	Yellowish brown clayey silty sand with gravel	9	44	38	9	Low	Plastic					
	23.0	Change of the strata											
	23.4								Sample	slip			
50	24.0	Grey sand with silt	0	86	14	0	Non	Plastic					

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Sheet No. : 17

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 5.5m | Term. Depth : 40m | B.H. No.: 6

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	26.4								Sample	slip			
58	27.0	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	29.4								2.04	15.3	CD	0.05	29
61	30.0	Grey sand with silt	0	80	20	0	Non	Plastic					
	32.4								Sample	slip			
68	33.0	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	35.4								Sample	slip			
67	36.0	Grey sand with traces of silt	0	91	9	0	Non	Plastic					
	38.4								Sample	slip			
84	39.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	40.0								Sample	slip			

Observed 'N' Values

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Sheet No. : 18

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 3.6m | Term. Depth : 40m | B.H. No.: 7

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0	Yellowish brown clayey sandy silt											
8	0.9	Grey sand with silt and gravel	2	84	14	0	Non	Plastic					
	1.5								1.67	4.9			
12	2.4	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	3.0								1.68	4.2	CD	0.02	25
11	3.9	Grey sand with traces of silt and gravel	8	89	3	0	Non	Plastic					
	4.5								1.94	21.3			
7	5.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	6.0								Sample	slip			
11	6.9	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	7.5								Sample	slip			
22	8.4	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	9.0								Sample	slip			
26	9.9	Grey sand with traces of silt and gravel	5	93	2	0	Non	Plastic					
	10.5								Sample	slip			

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Job No. : G(D)4535

Sheet No. : 19

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 3.6m | Term. Depth : 40m | B.H. No.: 7

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
30	11.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	12.0								Sample	slip			
31	12.9	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	13.5								Sample	slip			
38	14.4	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	15.0								Sample	slip			
43	15.9	Grey sand with traces of silt and gravel	16	82	2	0	Non	Plastic					
	16.5								Sample	slip			
	17.0	Change of the strata											
20	17.4	Yellowish brown clayey sandy silt with gravel	13	25	47	15	37	23					
	18.0								2.07	18.2	CD	0.13	26
	20.0	Change of the strata											
36	20.4	Yellowish brown silty sand	0	71	29	0	Non	Plastic					
	21.0								2.04	20.3			
	23.0	Change of the strata											
42	23.4	Yellowish brown sandy clayey silt	0	11	70	19	35	24					
	24.0								2.10	19.9			

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Job No. G(D)4535

Sheet No. : 20

SOIL PROFILE

Project : Proposed Project at Sector - 146, Noida, Uttar Pradesh

B.H. Location : | Water Table : 3.6m | Term. Depth : 40m | B.H. No.: 7

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	26.2	Change of the strata											
65	26.4	Grey sand with silt and gravel	2	84	14	0	Non	Plastic					
	27.0								Sample	slip			
36	29.4	Grey sand with traces of silt	0	91	9	0	Non	Plastic					
	30.0								Sample	slip			
45	32.4	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	33.0								Sample	slip			
85	35.4	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
100 / 27cm	36.0	Terminated (Sandstone)											
		Observed 'N' Values											

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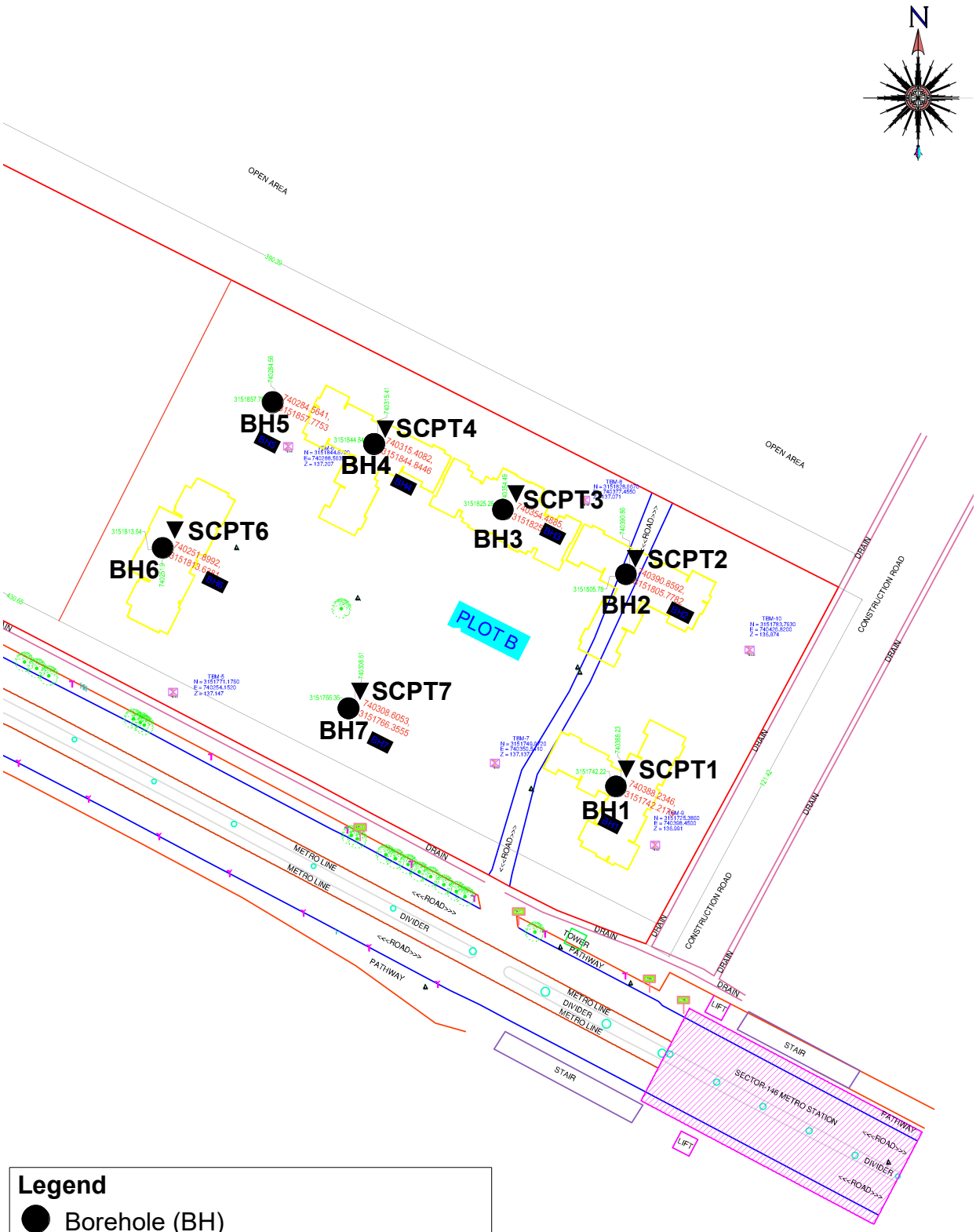
Job No. G(D)4535

Sheet No. : 21



Legend

- Borehole (BH)
- Static Cone Penetration Test (SCPT)

SCHEMATIC SITE PLAN

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Job No. : G(D)4535

Sheet No. : 1a

PHOTOGRAPHS SHOWING
VIEW OF THE SITE & BOREHOLES UNDER PROGRESS

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Sheet No. : 1b

PHOTOGRAPH SHOWING
STATIC CONE PENETRATION TEST UNDER PROGRESS

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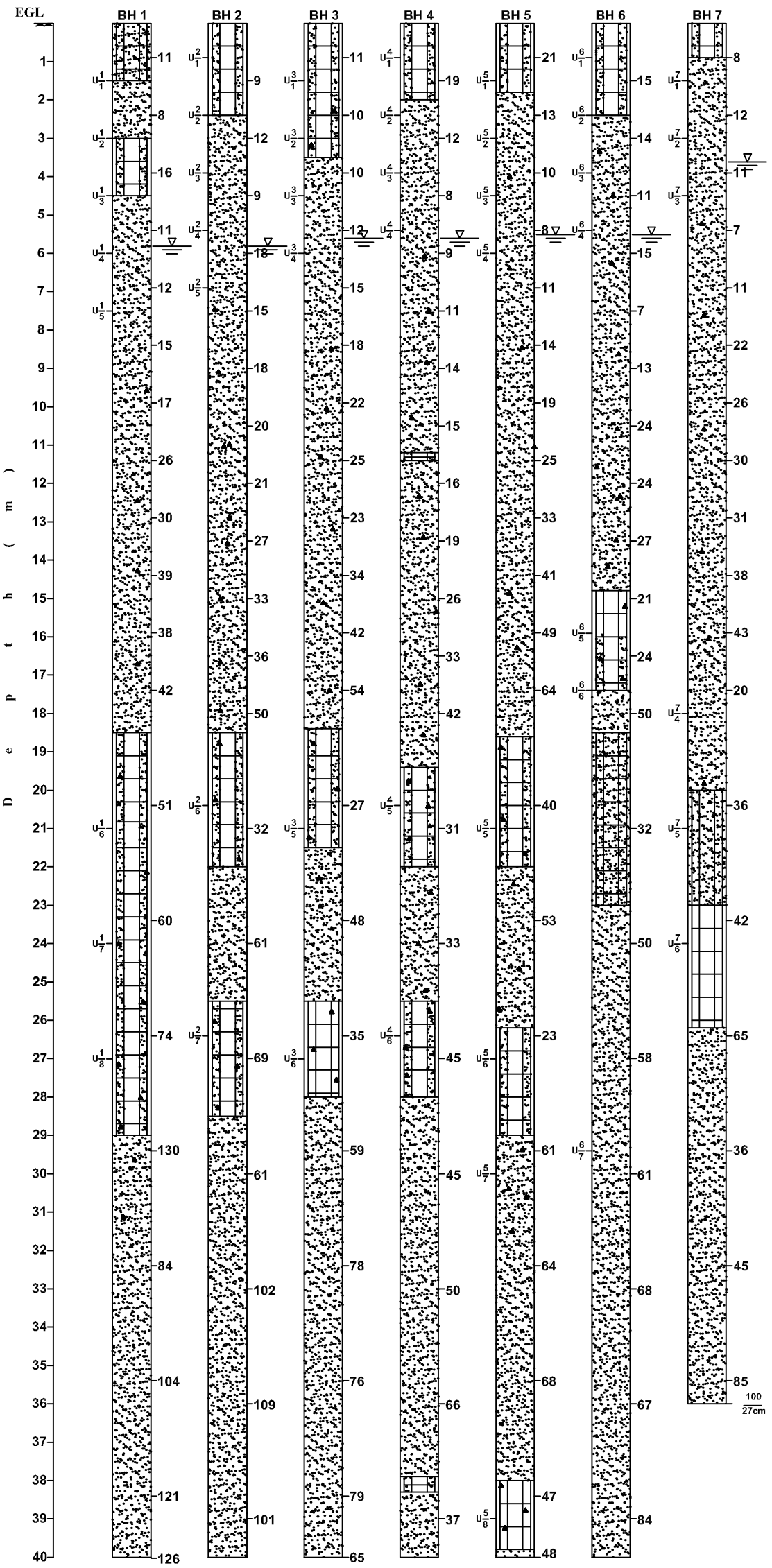
Job No. : G(D)4535

Sheet No. : 1c



LEGEND

Yellowish brown clayey sandy silt with occasional gravel / sandy clayey silt
(2-36)% (6-45)% (40-70)% (0-23)%

Grey sand with silt and occasional gravel/ sand with silt
(74-98)% (2-20)% (0-23)%

Yellowish brown silty sand with occasional clay and gravel
(29-40)% (41-71)% (0-19)% (0-10)%

61 Observed 'N' Values

U_2^1 2nd undisturbed soil sample of BH 1

Ground Water table has been encountered as on March 2023.

COMPILED SOIL PROFILE

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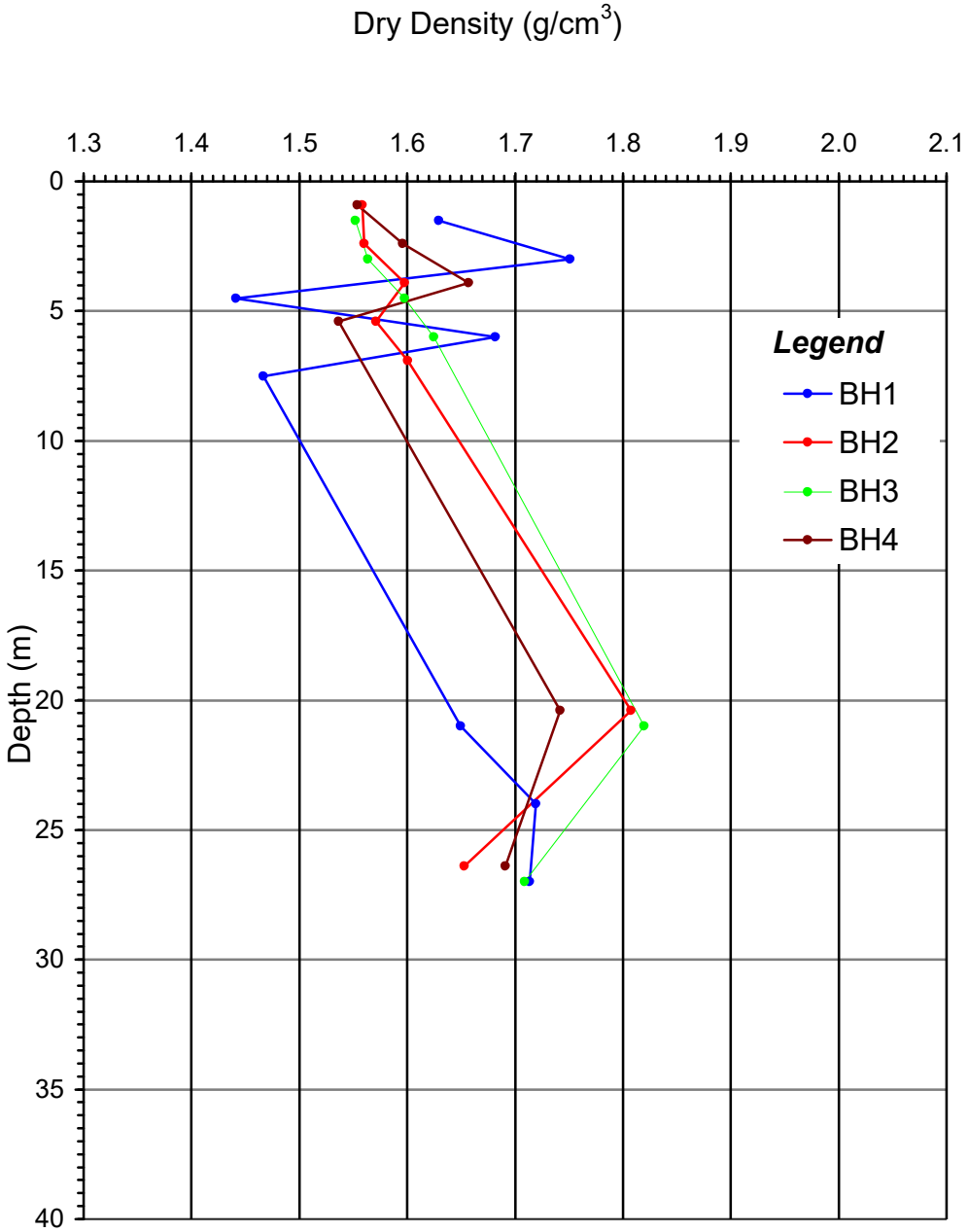
GEOTECHNICAL INVESTIGATION FOR THE PROPOSED RESIDENTIAL PROJECT AT SECTOR - 146, NOIDA, UTTAR PRADESH

Job No: G(D) 4535

Sheet No: 2



Dry Density vs Depth Curves

(Refer paragraph no. 7.4.2)

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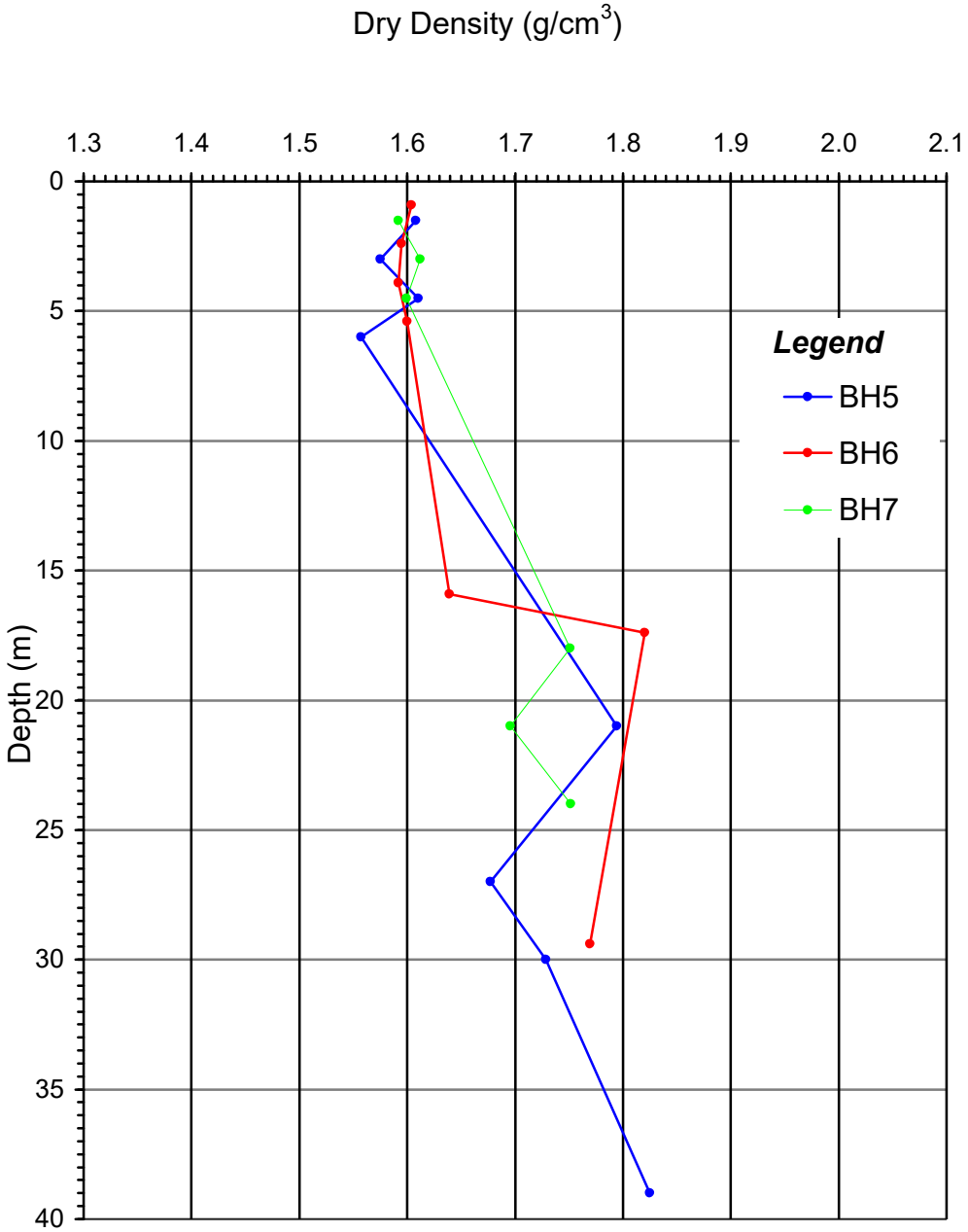
Job No. G(D)4535

Sheet No. : 3a



Dry Density vs Depth Curves

(Refer paragraph no. 7.4.2)

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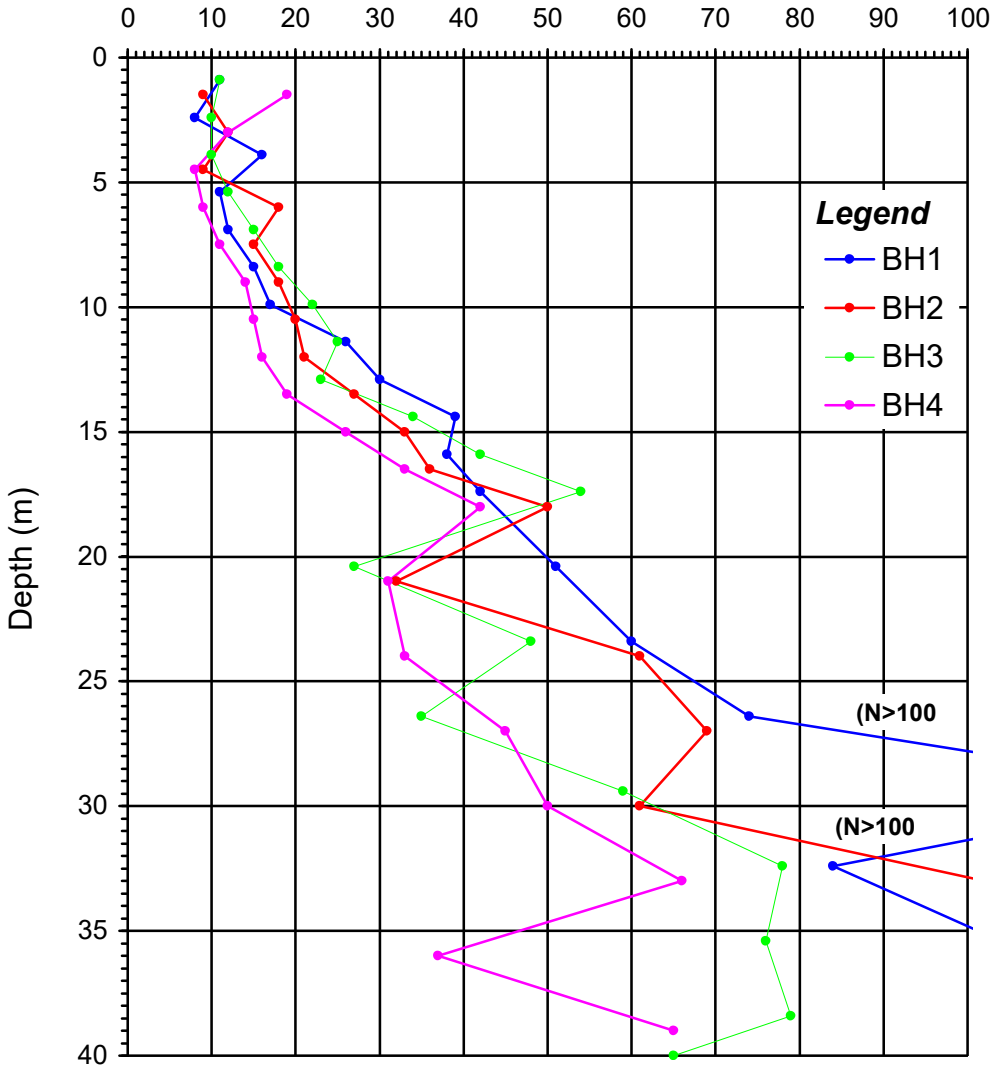
Job No. G(D)4535

Sheet No. : 3b

N - Values (Observed)



N - Values vs Depth Curves

(Refer paragraph no. 7.6.1)

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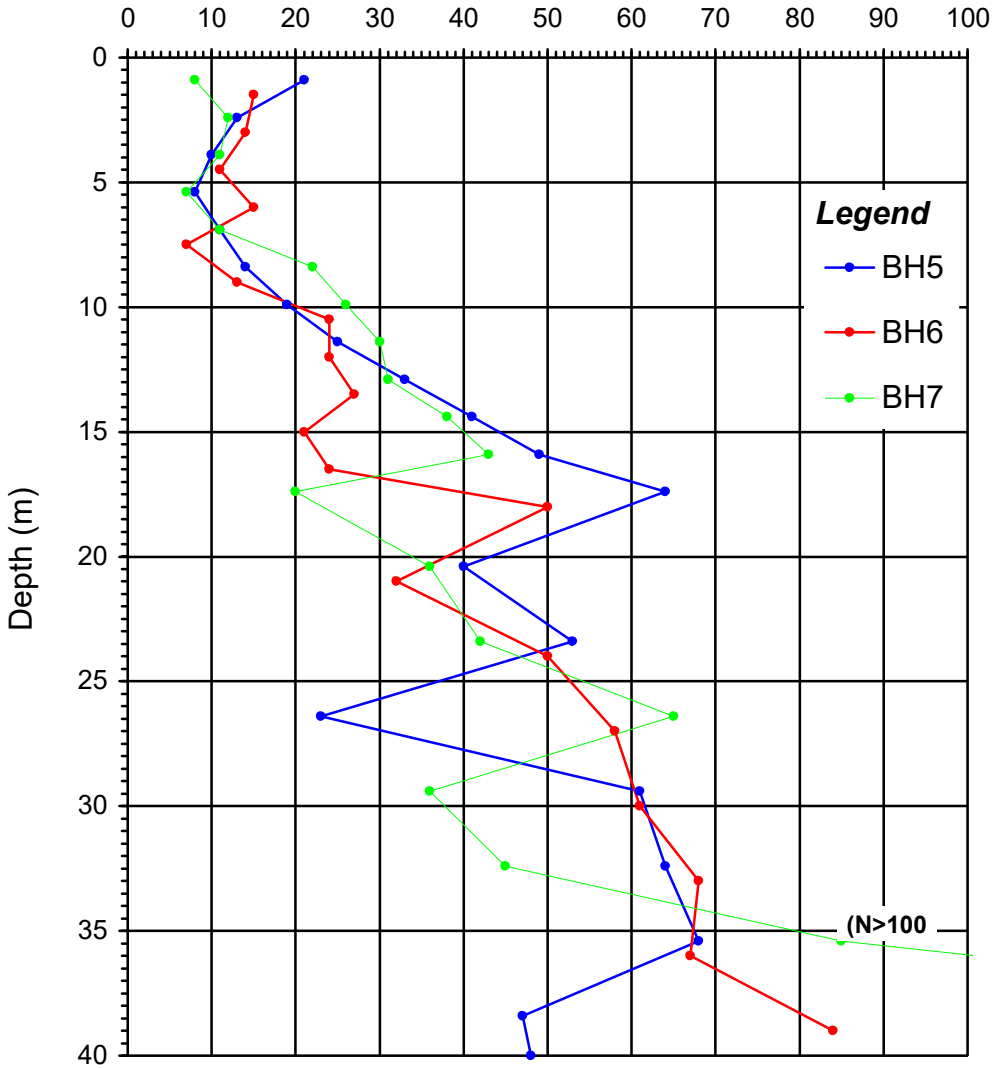
N - Values (Observed)



N - Values vs Depth Curves

(Refer paragraph no. 7.6.1)

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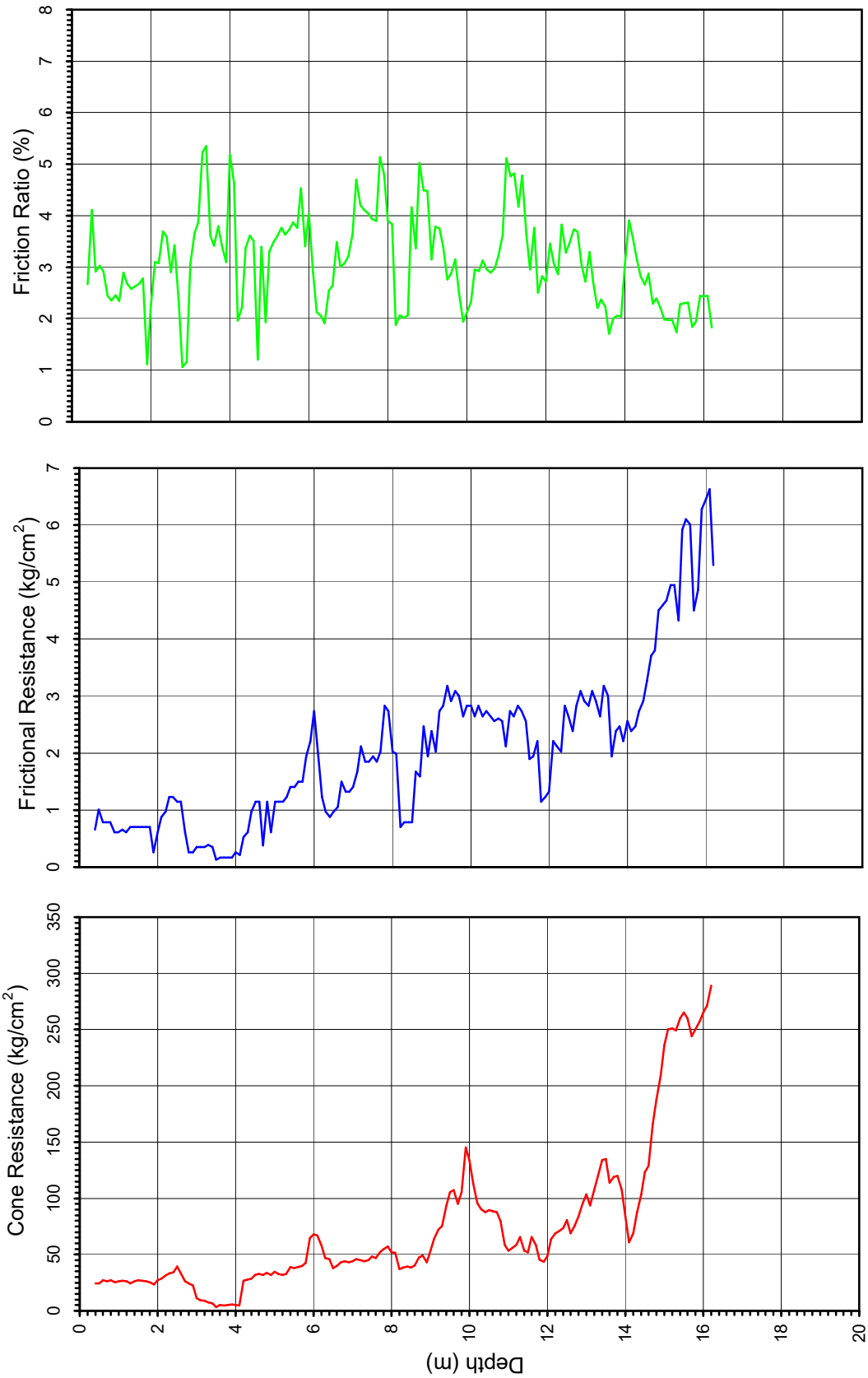
Job No. : G(D)4535

Sheet No. : 4b



Results of Static Cone Penetration Test - 1

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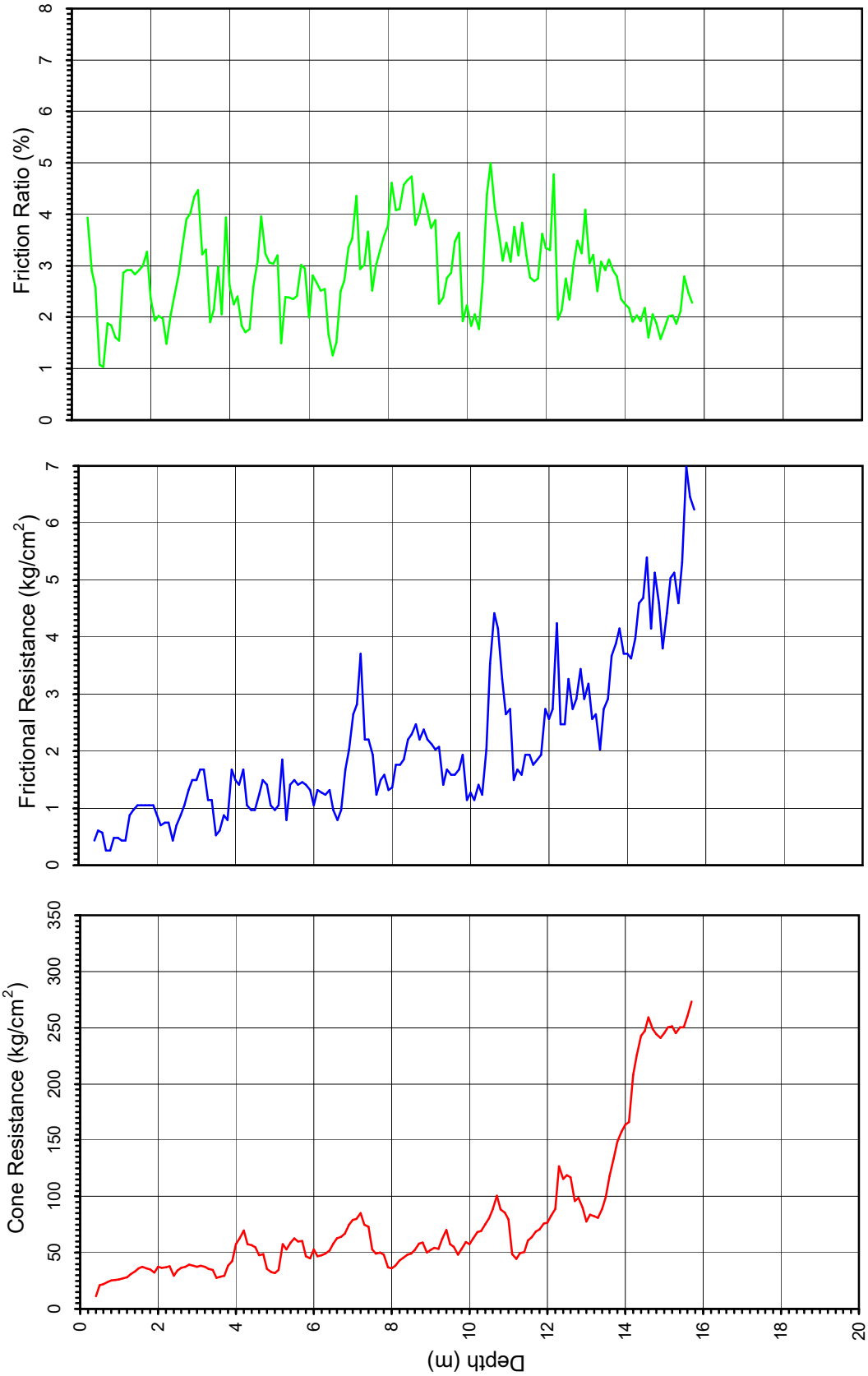
Job No. :

Sheet No. :



Results of Static Cone Penetration Test - 2

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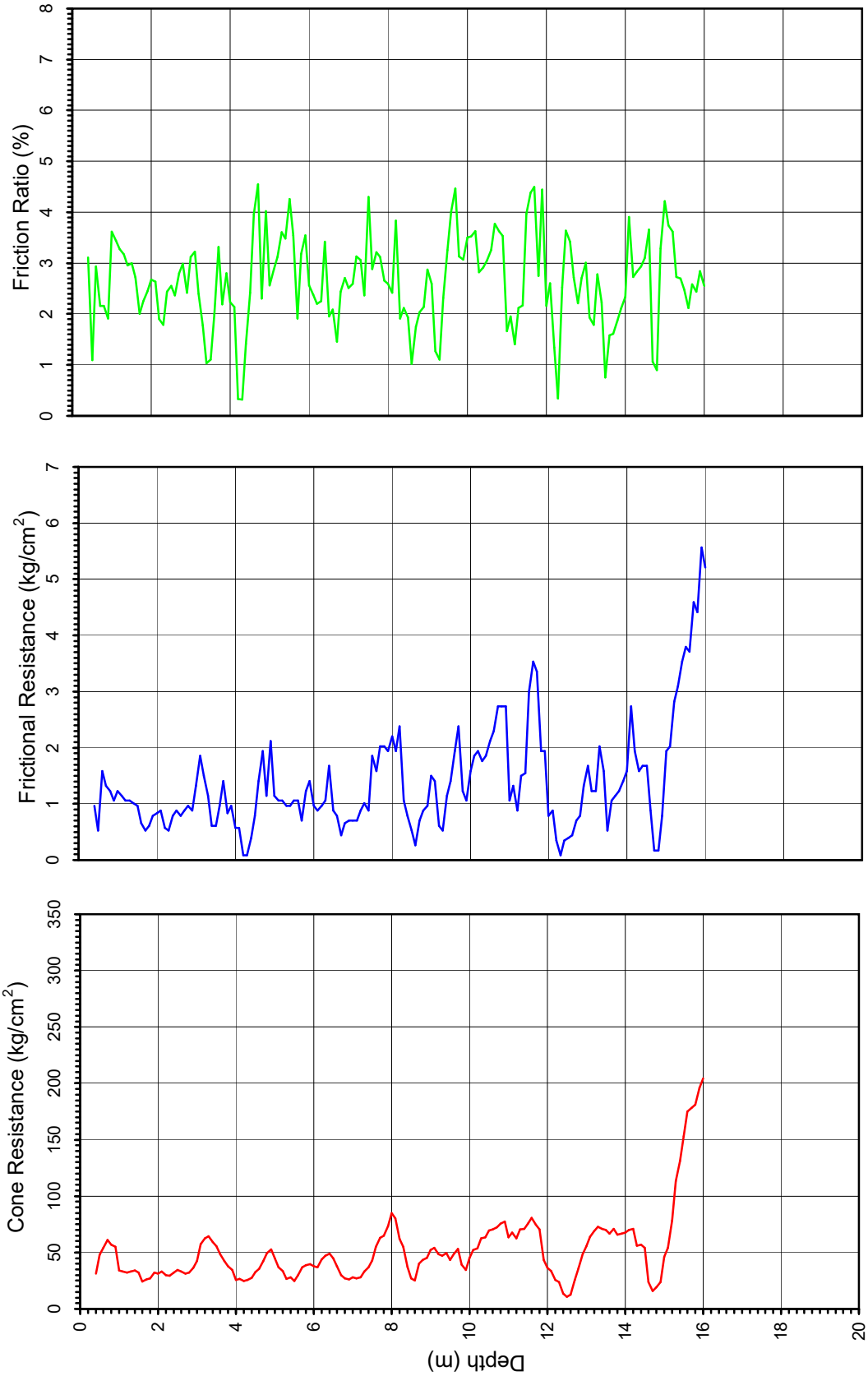
Job No. :

Sheet No. :



Results of Static Cone Penetration Test - 3

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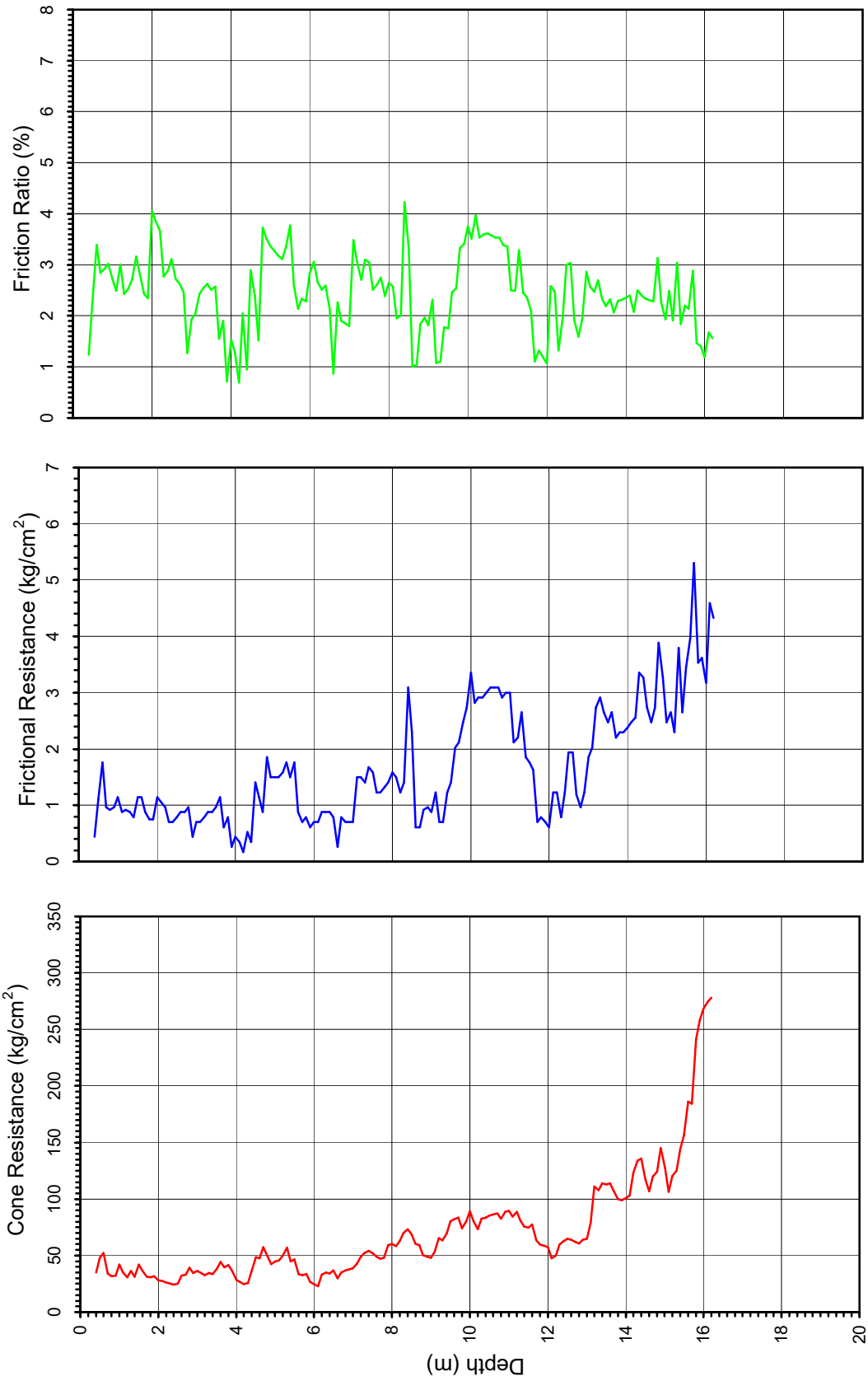
Job No. :

Sheet No. :



Results of Static Cone Penetration Test - 4

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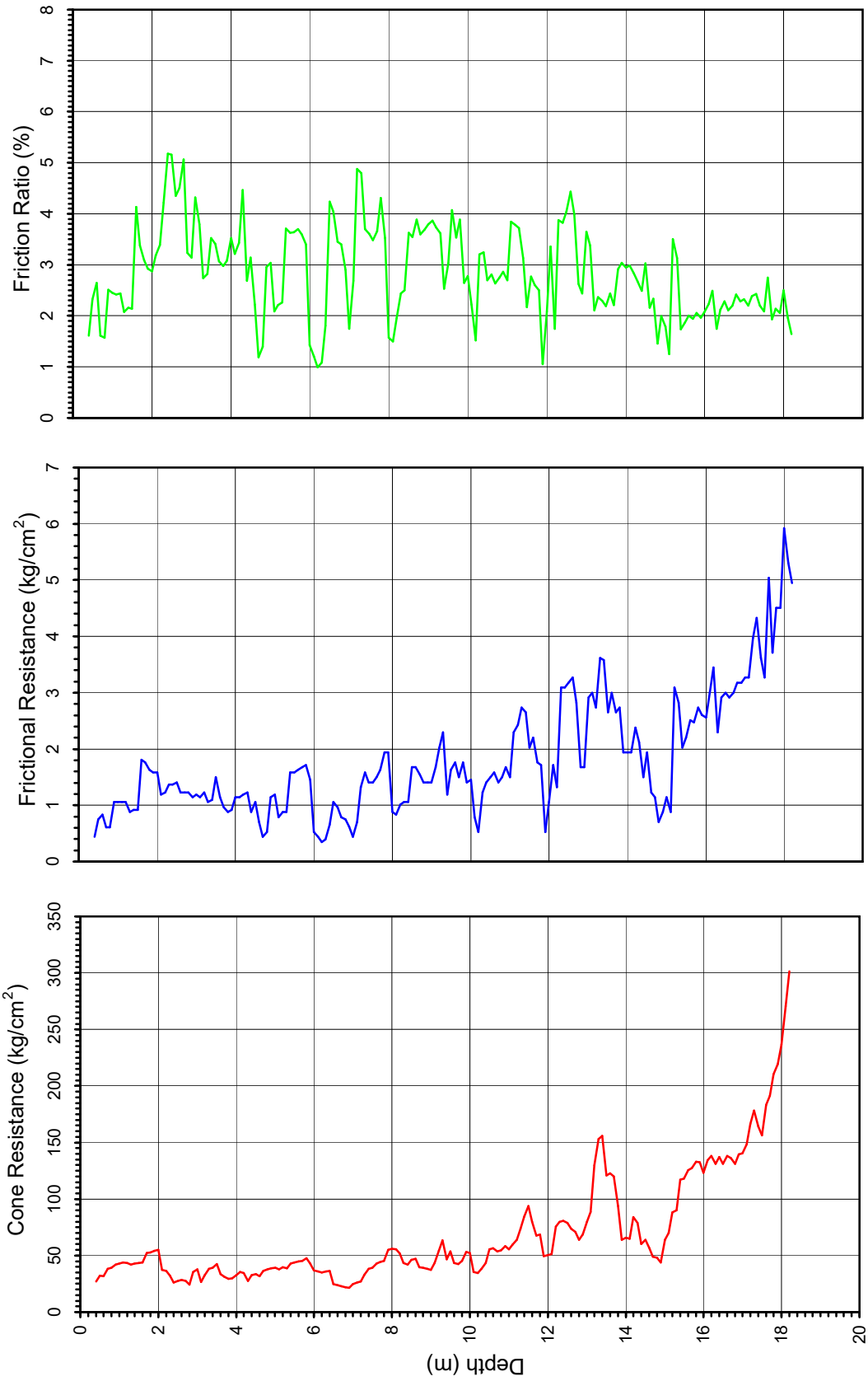
Job No. :

Sheet No. :



Results of Static Cone Penetration Test - 6

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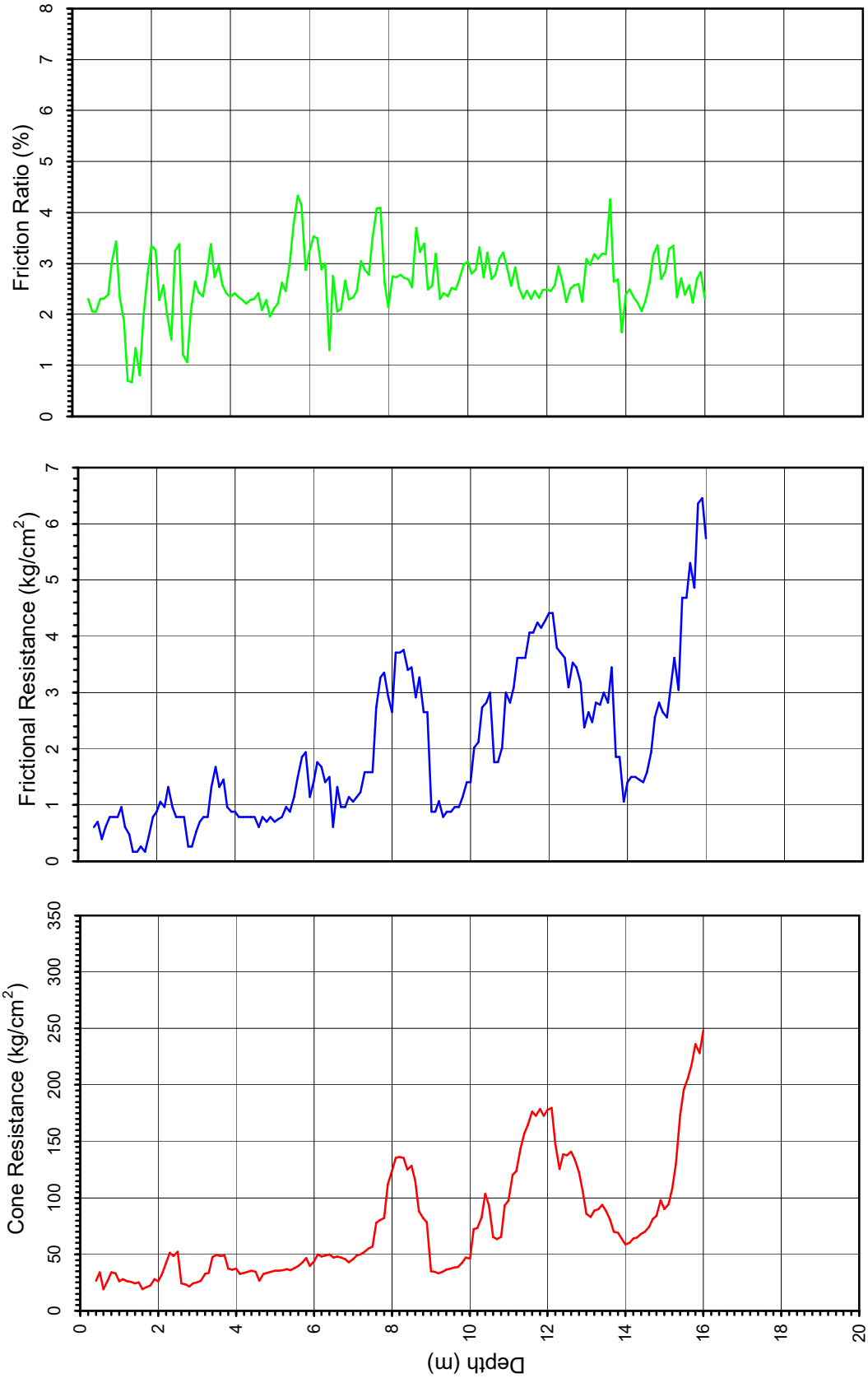
Job No. :

Sheet No. :



Results of Static Cone Penetration Test - 7

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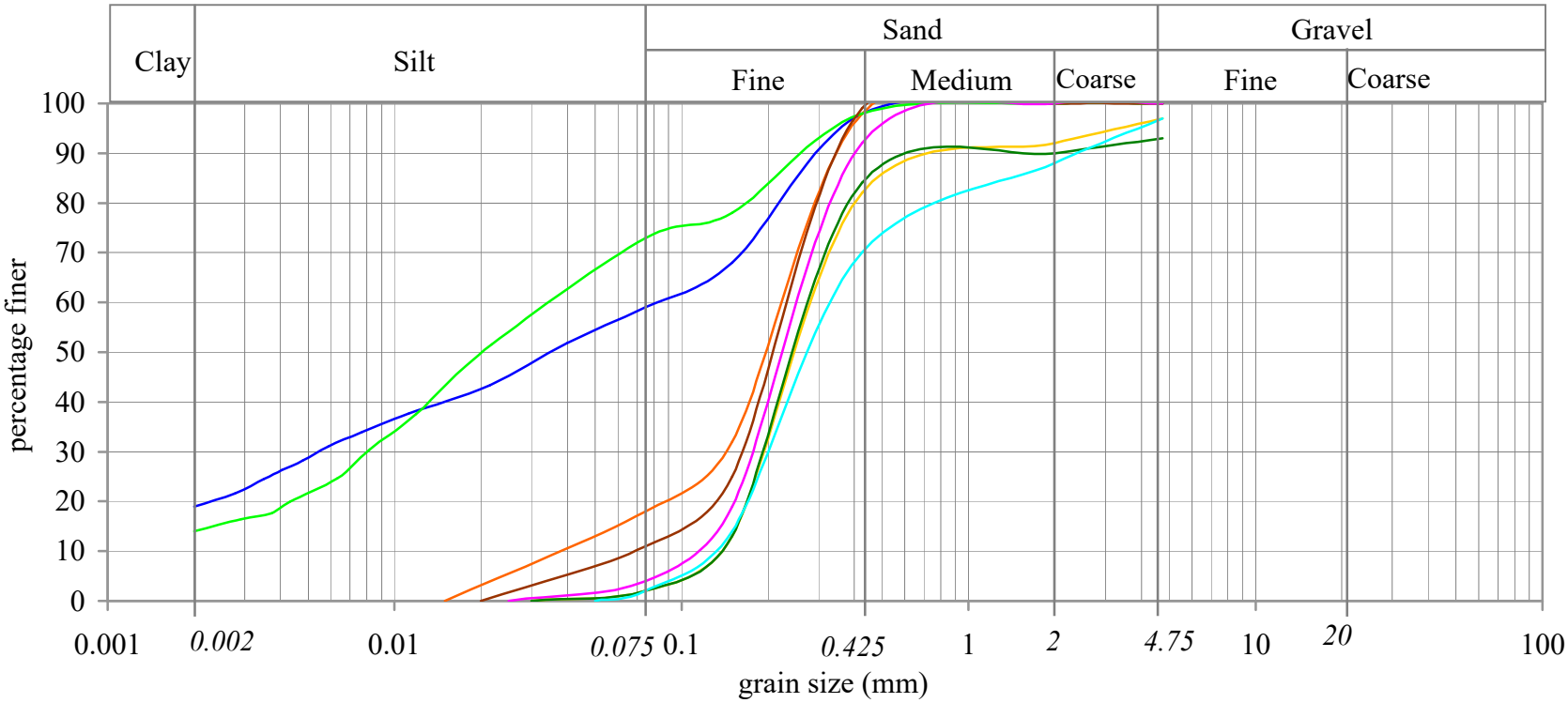
Job No. : G(D)4535

Sheet No. : 6a

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	1	0.9	Clayey silty sand	0	41	40	19	0.081	-	-
	1	2.4	Sand with silt	0	82	18	0	0.23	0.039	5.9
	1	3.9	Clayey sandy silt	0	27	59	14	0.032	-	-
	1	5.4	Sand with silt	0	89	11	0	0.24	0.068	3.5
	1	6.9	Sand with traces of silt	0	96	4	0	0.25	0.12	2.1
	1	8.4	Sand with traces of silt and gravel	3	95	2	0	0.27	0.14	1.9
	1	9.9	Sand with traces of silt and gravel	7	91	2	0	0.27	0.15	1.8
	1	11.4	Sand with traces of silt and gravel	3	95	2	0	0.32	0.14	2.3

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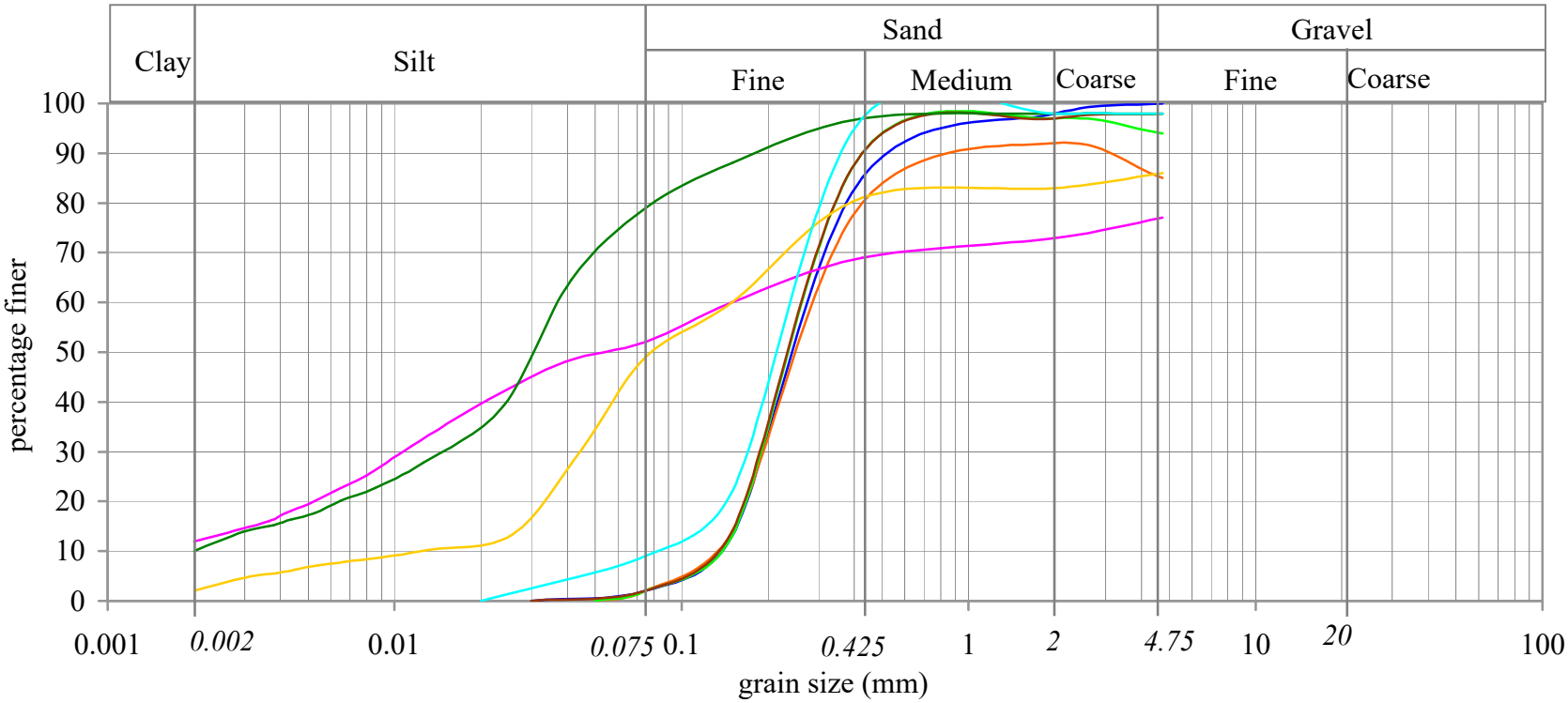
Job No. : G(D)4535

Sheet No. : 6b

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	1	12.9	Sand with traces of silt	0	98	2	0	0.26	0.15	1.7
	1	14.4	Sand with traces of silt and gravel	15	83	2	0	0.27	0.15	1.8
	1	15.9	Sand with traces of silt	6	92	2	0	0.27	0.15	1.8
	1	17.4	Sand with traces of silt and gravel	2	96	2	0	0.25	0.15	1.7
	1	20.4	Clayey sandy silt with gravel	23	25	40	12	0.17	-	-
	1	23.4	Clayey sandy silt with gravel	14	37	47	2	0.17	0.012	14.2
	1	26.4	Clayey sandy silt with gravel	2	19	69	10	0.038	0.002	19.0
	1	29.4	Sand with traces of silt and gravel	2	89	9	0	0.25	0.081	3.1

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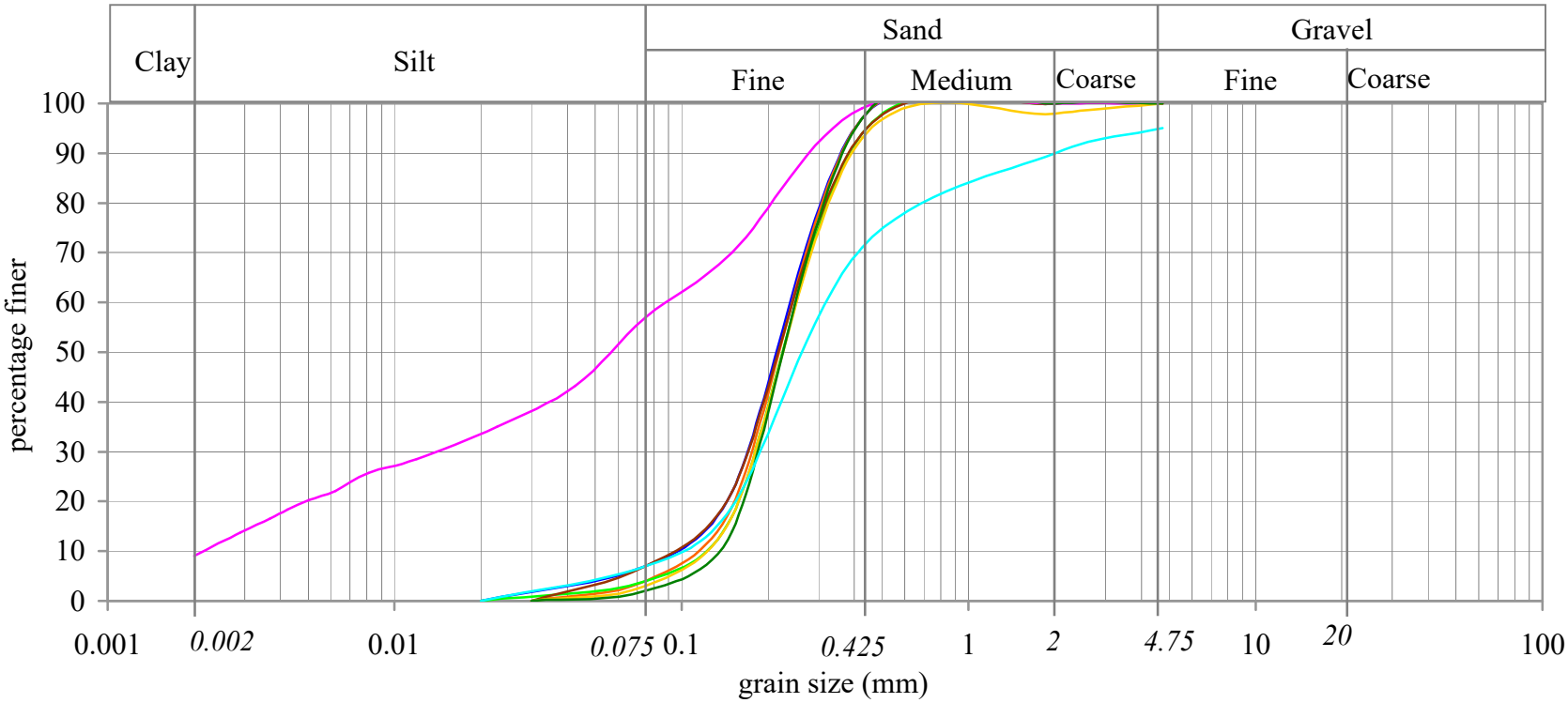
Job No. : G(D)4535

Sheet No. : 6c

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	1	32.4	Sand with traces of silt	0	93	7	0	0.25	0.091	2.7
	1	35.4	Sand with traces of silt	0	96	4	0	0.24	0.12	2.0
	1	38.4	Sand with traces of silt	0	96	4	0	0.25	0.13	1.9
	1	40	Sand with traces of silt	0	93	7	0	0.31	0.091	3.4
	2	1.5	Clayey sandy silt	0	43	48	9	0.089	0.0022	40.5
	2	3	Sand with traces of silt	0	97	3	0	0.25	0.12	2.1
	2	4.5	Sand with traces of silt	0	98	2	0	0.24	0.14	1.7
	2	6	Sand with traces of silt and gravel	5	88	7	0	0.25	0.11	2.3

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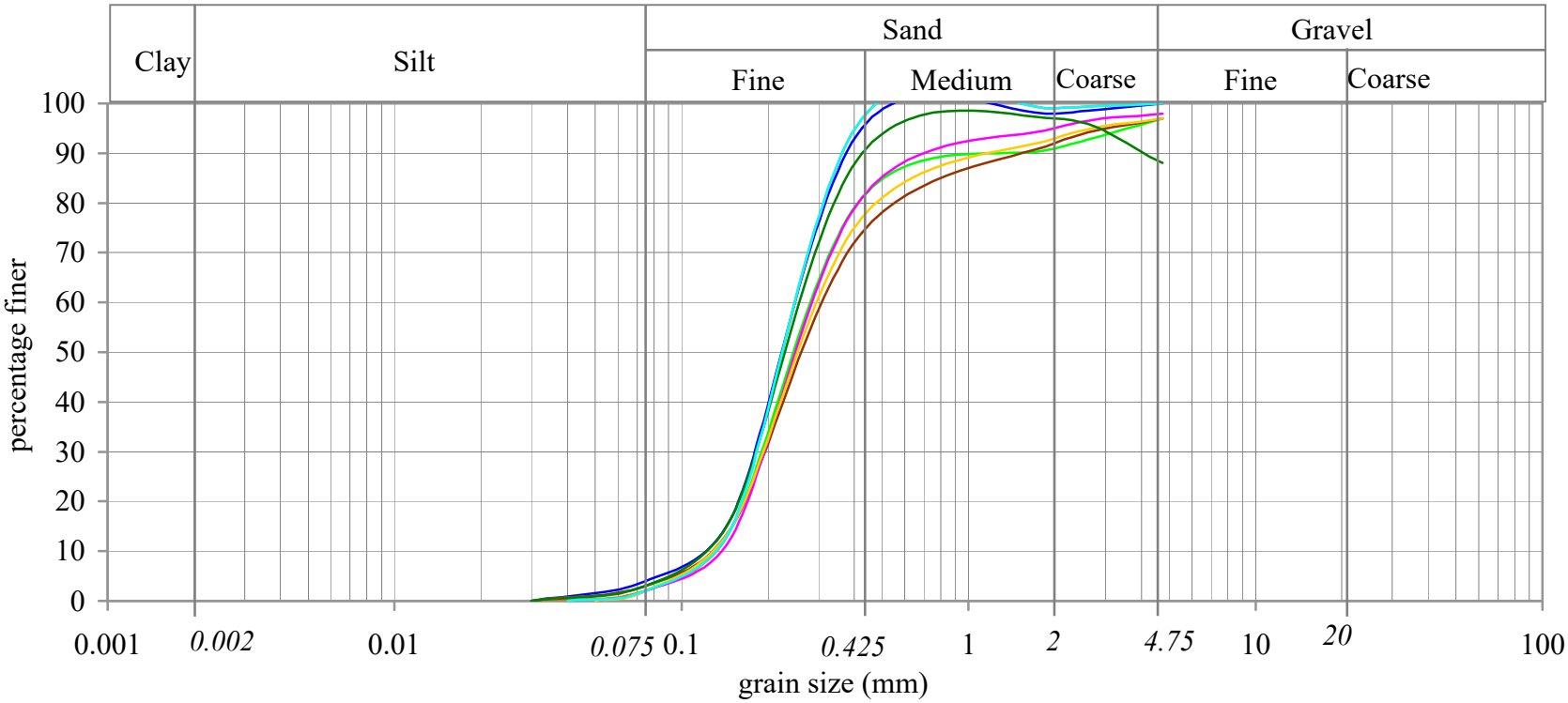
Job No. : G(D)4535

Sheet No. : 6d

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	2	7.5	Sand with traces of silt	0	96	4	0	0.25	0.13	1.9
	2	9	Sand with traces of silt	0	98	2	0	0.24	0.15	1.6
	2	10.5	Sand with traces of silt and gravel	3	94	3	0	0.25	0.14	1.8
	2	12	Sand with traces of silt and gravel	3	94	3	0	0.24	0.15	1.6
	2	13.5	Sand with traces of silt and gravel	2	96	2	0	0.27	0.15	1.8
	2	15	Sand with traces of silt and gravel	3	95	2	0	0.28	0.15	1.9
	2	16.5	Sand with traces of silt and gravel	12	85	3	0	0.24	0.14	1.7
	2	18	Sand with traces of silt	0	98	2	0	0.25	0.14	1.8

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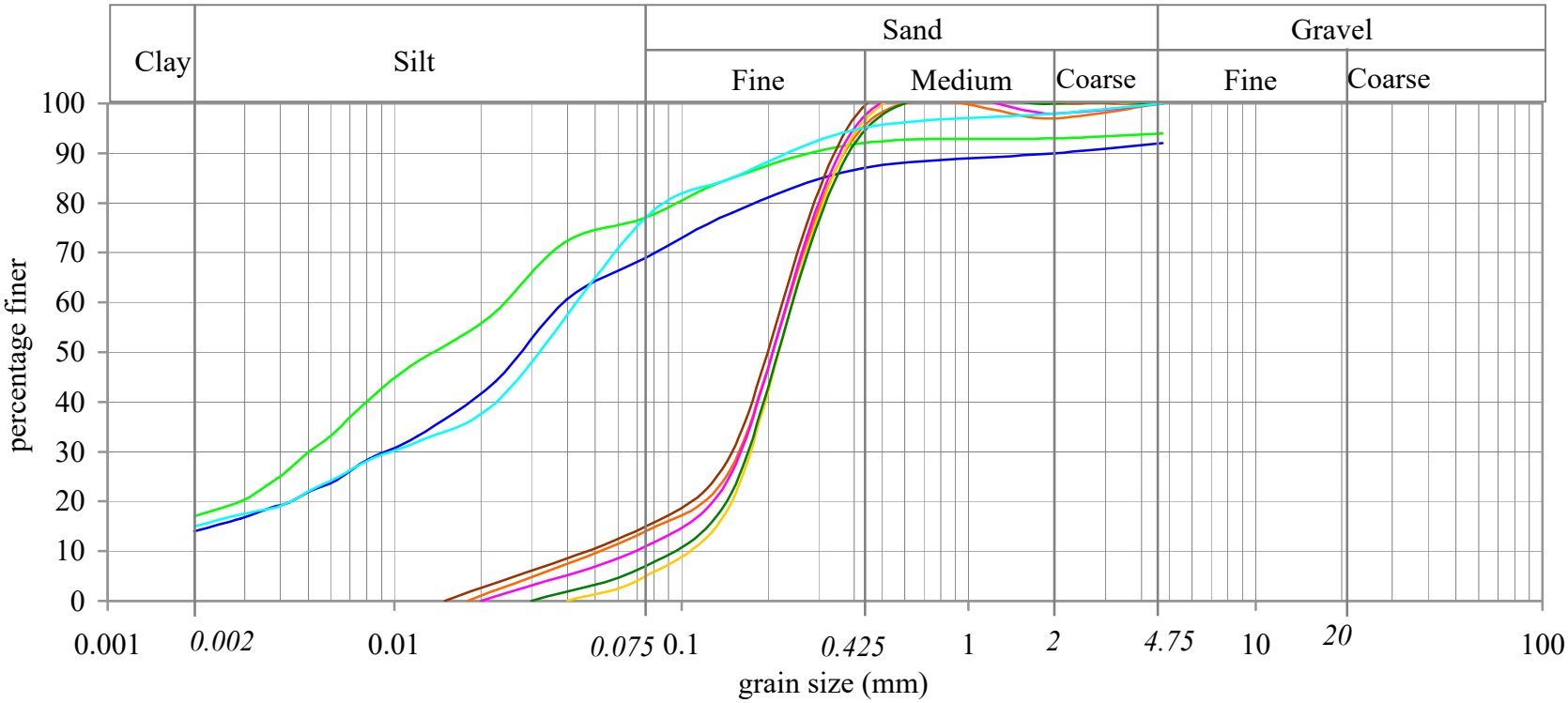
Job No. : G(D)4535

Sheet No. : 6e

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	2	21	Clayey sandy silt with gravel	8	23	55	14	0.039	-	-
	2	24	Sand with silt	0	86	14	0	0.25	0.051	4.9
	2	27	Sandy clayey silt with gravel	6	17	60	17	0.024	-	-
	2	30	Sand with silt	0	85	15	0	0.23	0.091	2.5
	2	33	Sand with silt	0	89	11	0	0.24	0.07	3.4
	2	36	Sand with traces of silt	0	95	5	0	0.25	0.11	2.3
	2	39	Sand with traces of silt	0	93	7	0	0.24	0.091	2.6
	3	0.9	Clayey sandy silt	0	23	62	15	0.041	-	-

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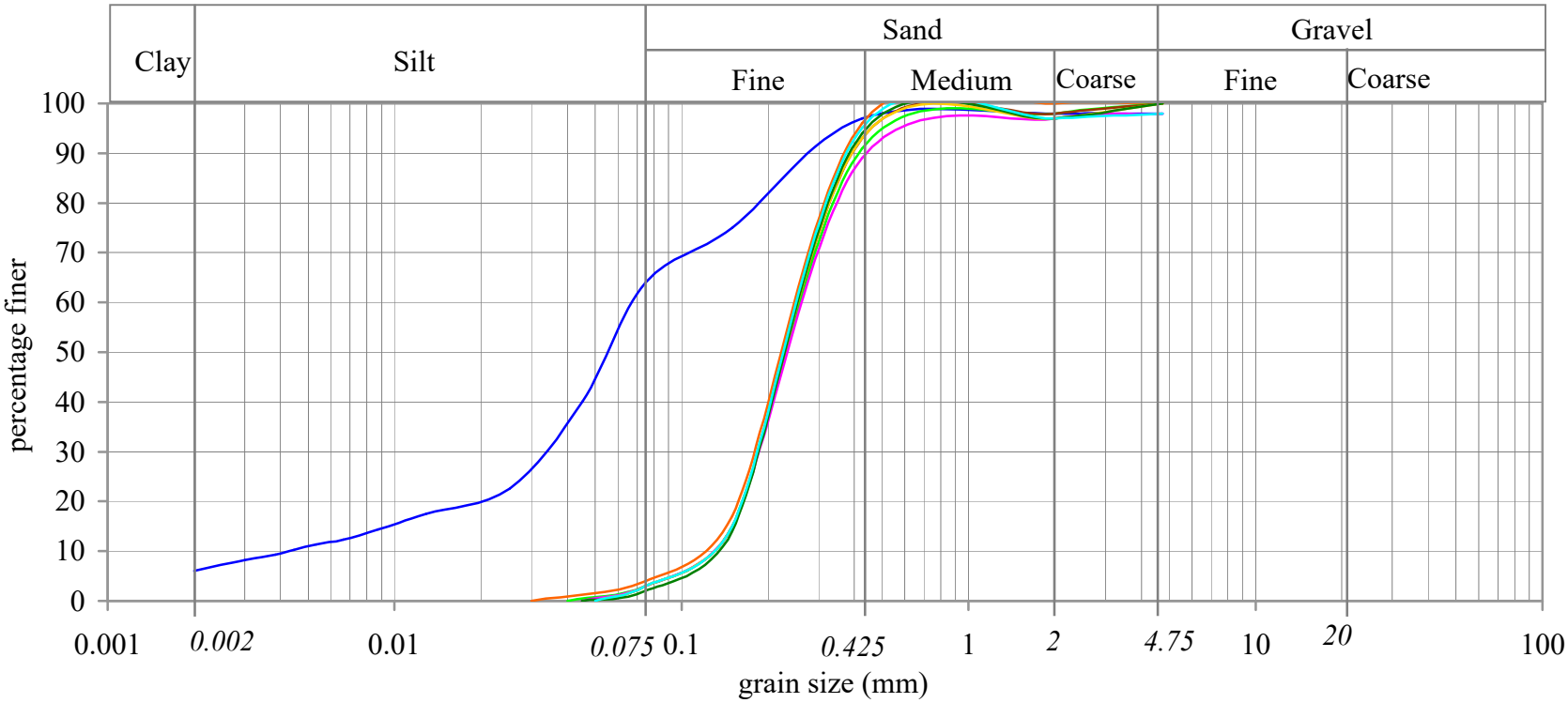
Job No. : G(D)4535

Sheet No. : 6f

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	3	2.4	Clayey sandy silt with gravel	2	34	58	6	0.069	0.0041	16.8
	3	3.9	Sand with traces of silt	0	96	4	0	0.26	0.13	2.0
	3	5.4	Sand with traces of silt	0	97	3	0	0.25	0.14	1.8
	3	6.9	Sand with traces of silt	0	97	3	0	0.24	0.15	1.6
	3	8.4	Sand with traces of silt and gravel	2	95	3	0	0.25	0.14	1.8
	3	9.9	Sand with traces of silt	0	97	3	0	0.25	0.15	1.7
	3	11.4	Sand with traces of silt	0	98	2	0	0.25	0.14	1.8
	3	12.9	Sand with traces of silt and gravel	2	95	3	0	0.24	0.15	1.6

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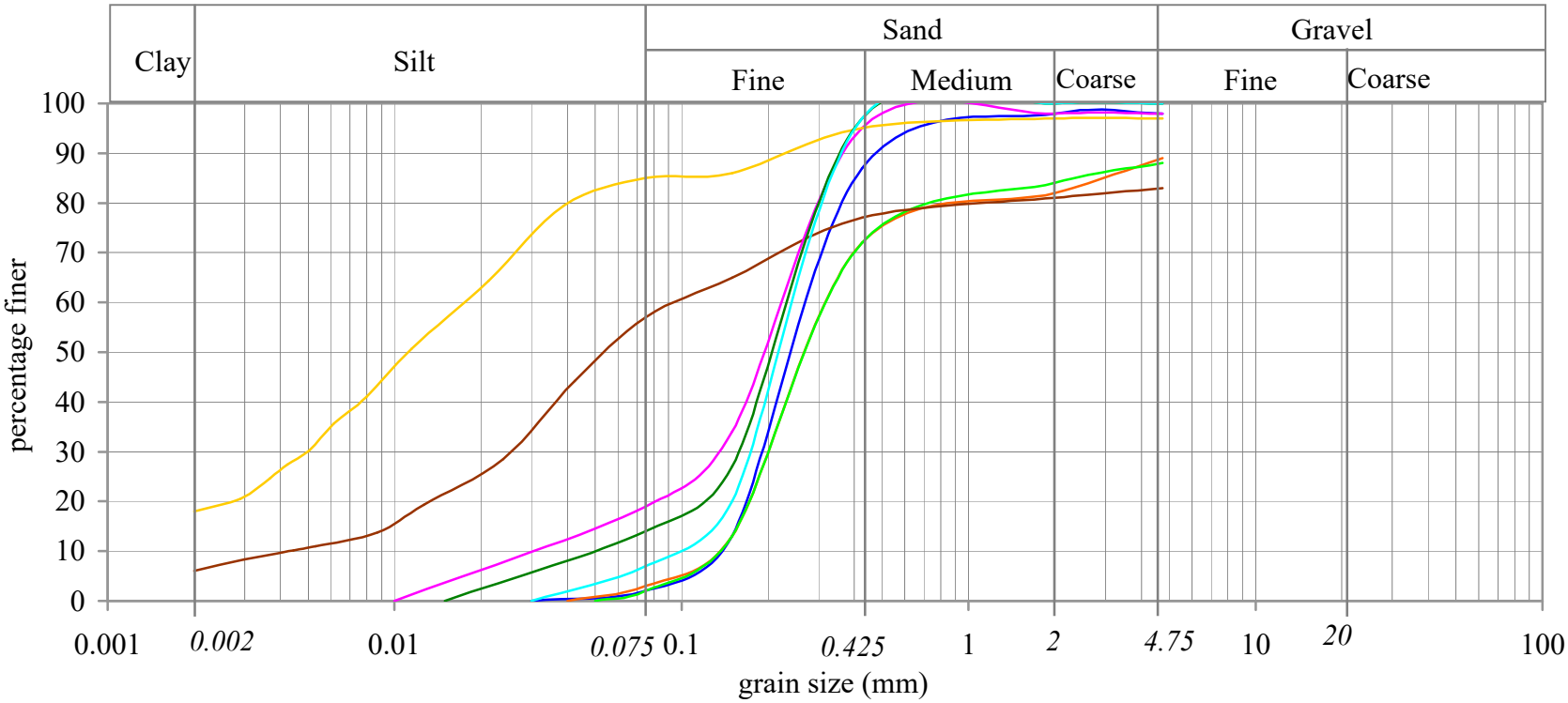
Job No. : G(D)4535

Sheet No. : 6g

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	3	14.4	Sand with traces of silt and gravel	2	96	2	0	0.27	0.15	1.8
	3	15.9	Sand with traces of silt and gravel	11	86	3	0	0.23	0.15	1.5
	3	17.4	Sand with traces of silt and gravel	12	86	2	0	0.31	0.15	2.1
	3	20.4	Clayey sandy silt with gravel	17	26	51	6	0.091	0.0039	23.3
	3	23.4	Sand with silt and gravel	2	79	19	0	0.22	0.029	7.6
	3	26.4	Sandy clayey silt with gravel	3	12	67	18	0.017	-	-
	3	29.4	Sand with silt	0	86	14	0	0.31	0.15	2.1
	3	32.4	Sand with traces of silt	0	93	7	0	0.33	0.1	3.3

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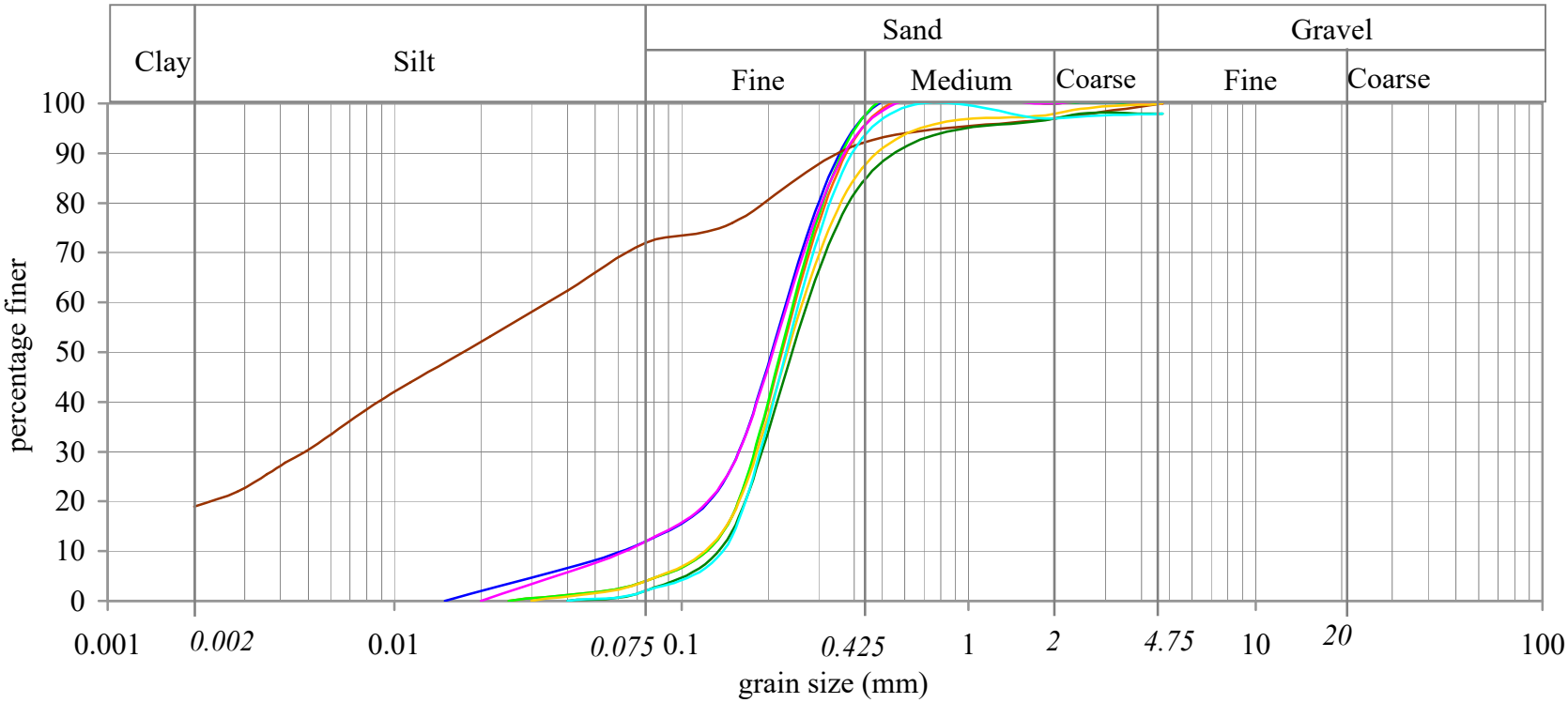
Job No. : G(D)4535

Sheet No. : 6h

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	3	35.4	Sand with silt	0	88	12	0	0.24	0.061	3.9
	3	38.4	Sand with traces of silt	0	96	4	0	0.25	0.061	4.1
	3	40	Sand with traces of silt	0	96	4	0	0.24	0.13	1.8
	4	1.5	Clayey sandy silt	0	28	53	19	0.032	-	-
	4	3	Sand with silt	0	88	12	0	0.24	0.062	3.9
	4	4.5	Sand with traces of silt	0	96	4	0	0.27	0.13	2.1
	4	6	Sand with traces of silt and gravel	2	96	2	0	0.27	0.14	1.9
	4	7.5	Sand with traces of silt and gravel	2	96	2	0	0.25	0.14	1.8

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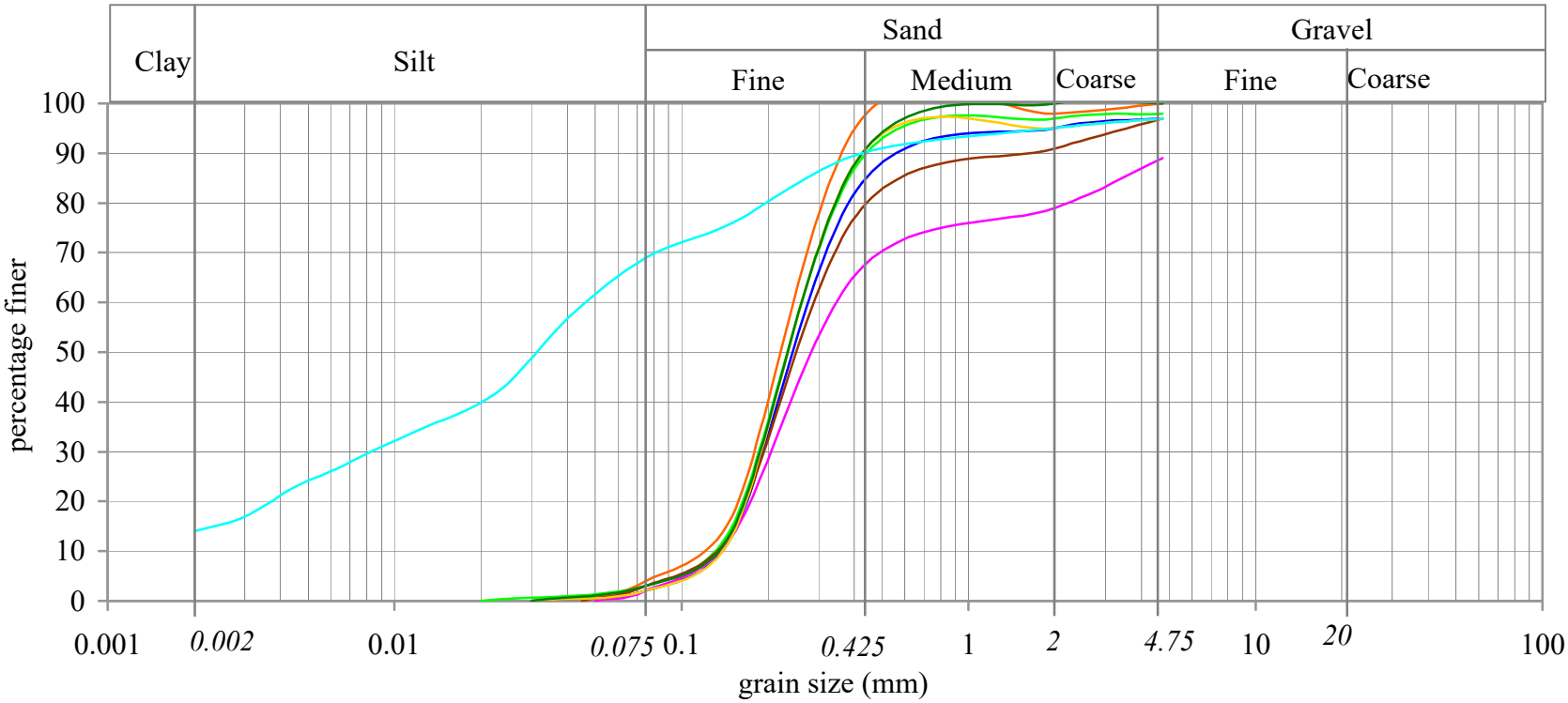
Job No. : G(D)4535

Sheet No. : 6i

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	4	9	Sand with traces of silt and gravel	3	95	2	0	0.26	0.15	1.7
	4	10.5	Sand with traces of silt	0	96	4	0	0.25	0.14	1.8
	4	12	Sand with traces of silt and gravel	2	95	3	0	0.26	0.15	1.7
	4	13.5	Sand with traces of silt and gravel	3	94	3	0	0.29	0.14	2.1
	4	15	Sand with traces of silt and gravel	11	87	2	0	0.35	0.15	2.3
	4	16.5	Sand with traces of silt and gravel	3	95	2	0	0.24	0.14	1.7
	4	18	Sand with traces of silt	0	97	3	0	0.24	0.15	#DIV/0!
	4	21	Clayey sandy silt with gravel	3	28	55	14	0.045	-	-

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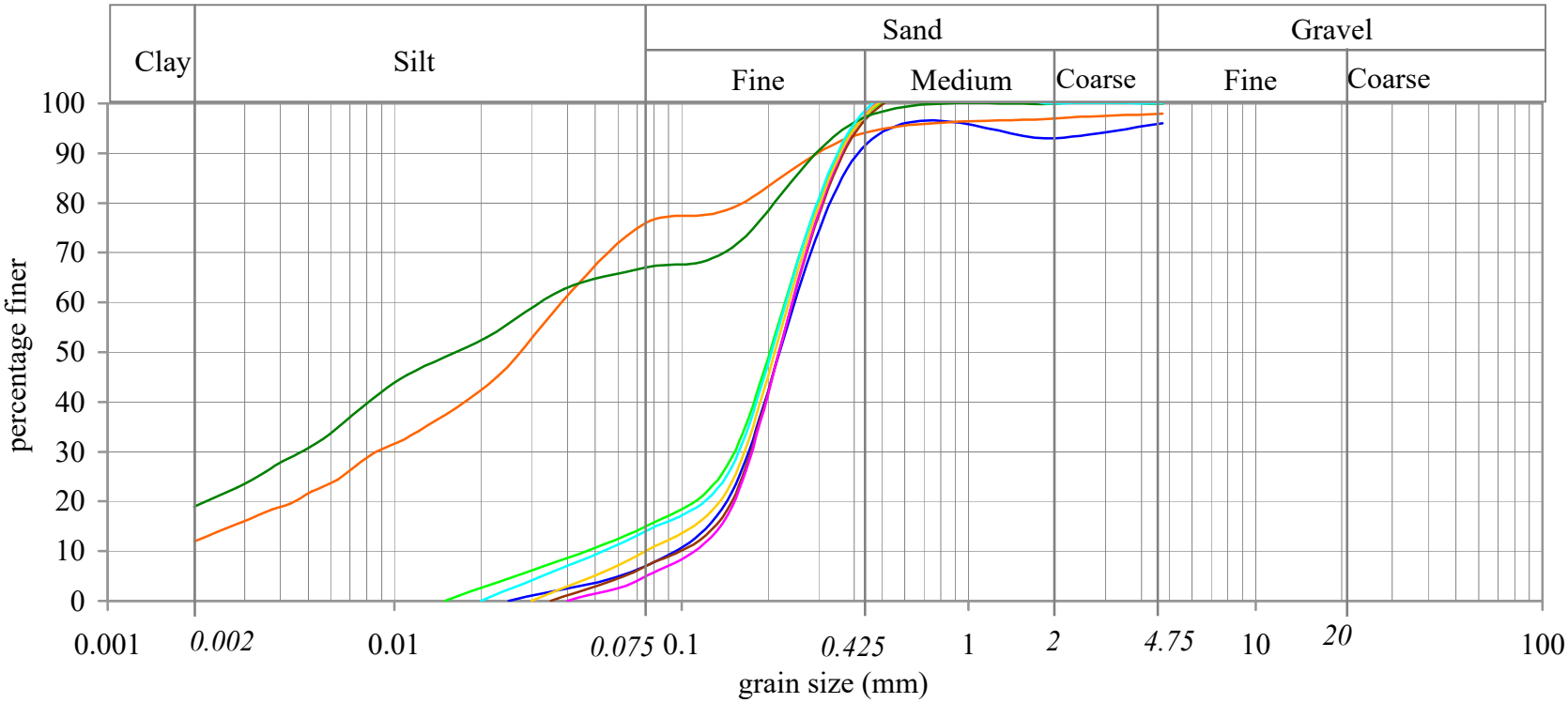
Job No. : G(D)4535

Sheet No. : 6j

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	4	24	Sand with traces of silt and gravel	4	89	7	0	0.24	0.095	2.5
	4	27	Clayey sandy silt with gravel	2	22	64	12	0.038	-	-
	4	30	Sand with silt	0	85	15	0	0.24	0.045	5.3
	4	33	Sand with traces of silt	0	93	7	0	0.25	0.095	2.6
	4	36	Sand with traces of silt	0	95	5	0	0.24	0.11	2.2
	4	39	Sand with traces of silt	0	90	10	0	0.25	0.075	3.3
	5	0.9	Clayey sandy silt	0	33	48	19	0.031	0.095	0.3
	5	2.4	Sand with silt	0	86	14	0	0.24	0.051	4.7

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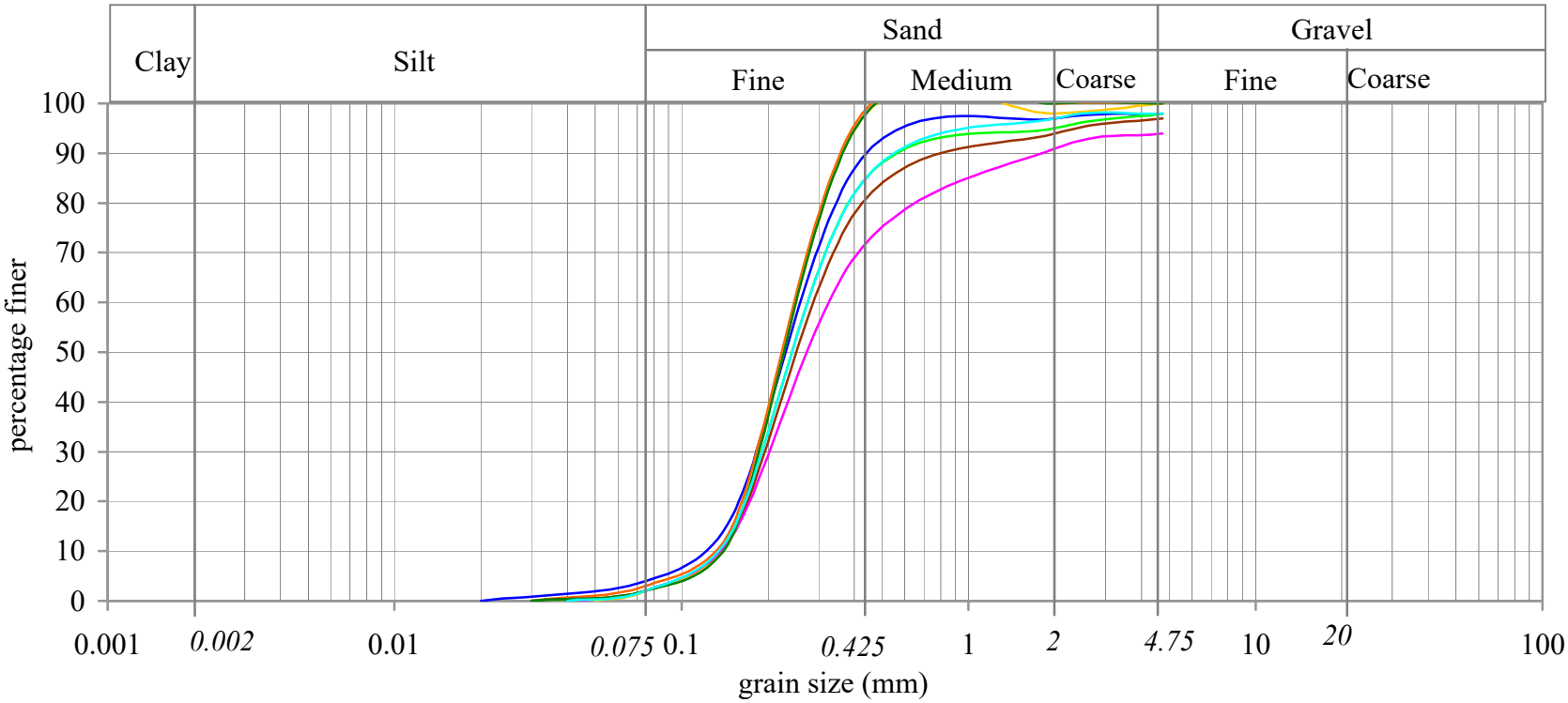
Sheet No. : 6k

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	5	3.9	Sand with traces of silt and gravel	2	94	4	0	0.25	0.13	1.9
	5	5.4	Sand with traces of silt	0	97	3	0	0.24	0.13	1.8
	5	6.9	Sand with traces of silt and gravel	2	96	2	0	0.25	0.15	1.7
	5	8.4	Sand with traces of silt and gravel	3	95	2	0	0.24	0.15	1.6
	5	9.9	Sand with traces of silt and gravel	6	92	2	0	0.32	0.14	2.3
	5	11.4	Sand with traces of silt	0	98	2	0	0.25	0.15	1.7
	5	12.9	Sand with traces of silt	0	98	2	0	0.24	0.15	1.6
	5	14.4	Sand with traces of silt and gravel	2	96	2	0	0.27	0.15	1.8

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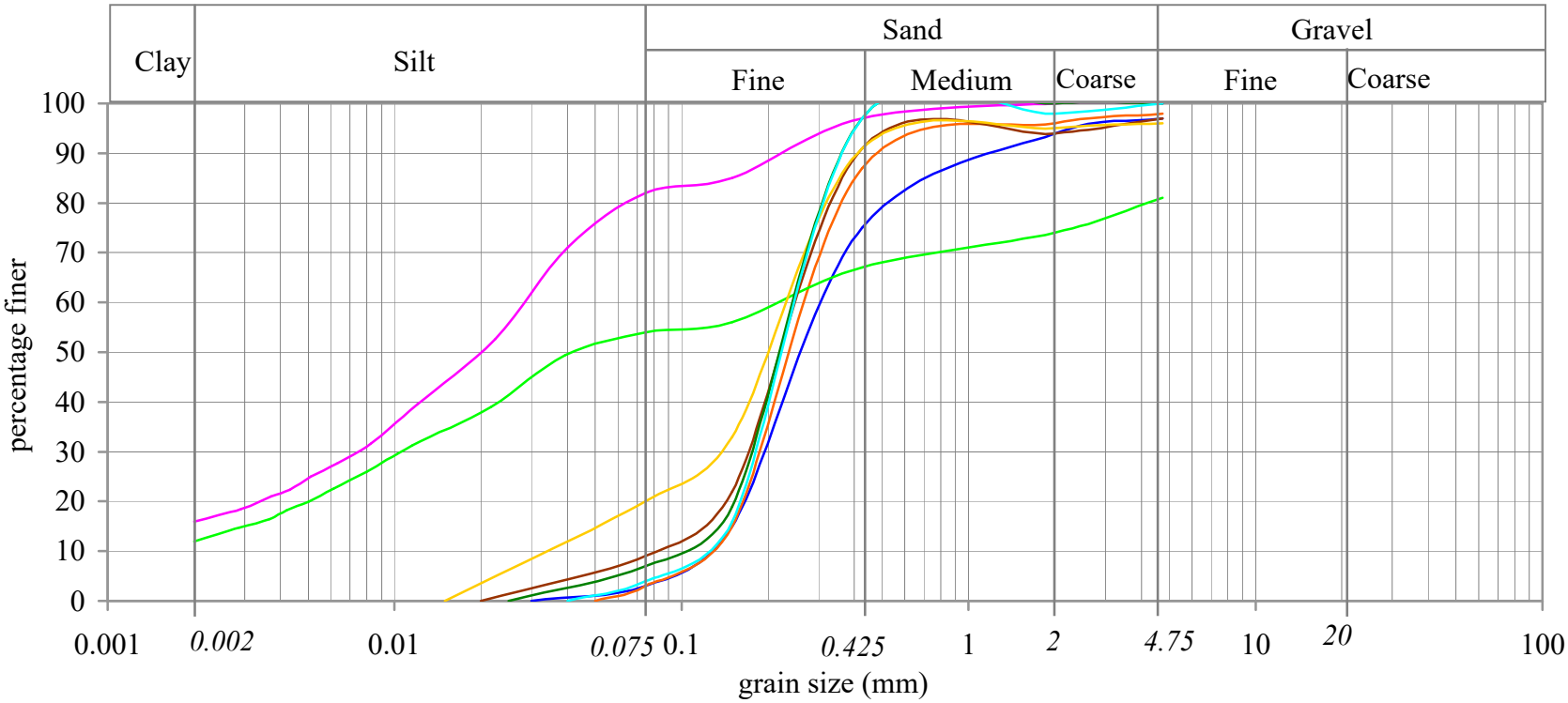
Sheet No. : 61

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	5	15.9	Sand with traces of silt and gravel	3	94	3	0	0.31	0.15	2.1
	5	17.4	Sand with traces of silt and gravel	2	95	3	0	0.25	0.14	1.8
	5	20.4	Clayey sandy silt with gravel	19	27	42	12	0.22	-	-
	5	23.4	Sand with traces of silt and gravel	3	88	9	0	0.24	0.081	3.0
	5	26.4	Clayey sandy silt	0	18	66	16	0.029	-	-
	5	29.4	Sand with silt and gravel	4	76	20	0	0.22	0.034	6.5
	5	32.4	Sand with traces of silt	0	93	7	0	0.23	0.11	2.1
	5	35.4	Sand with traces of silt	0	96	4	0	0.24	0.13	1.8

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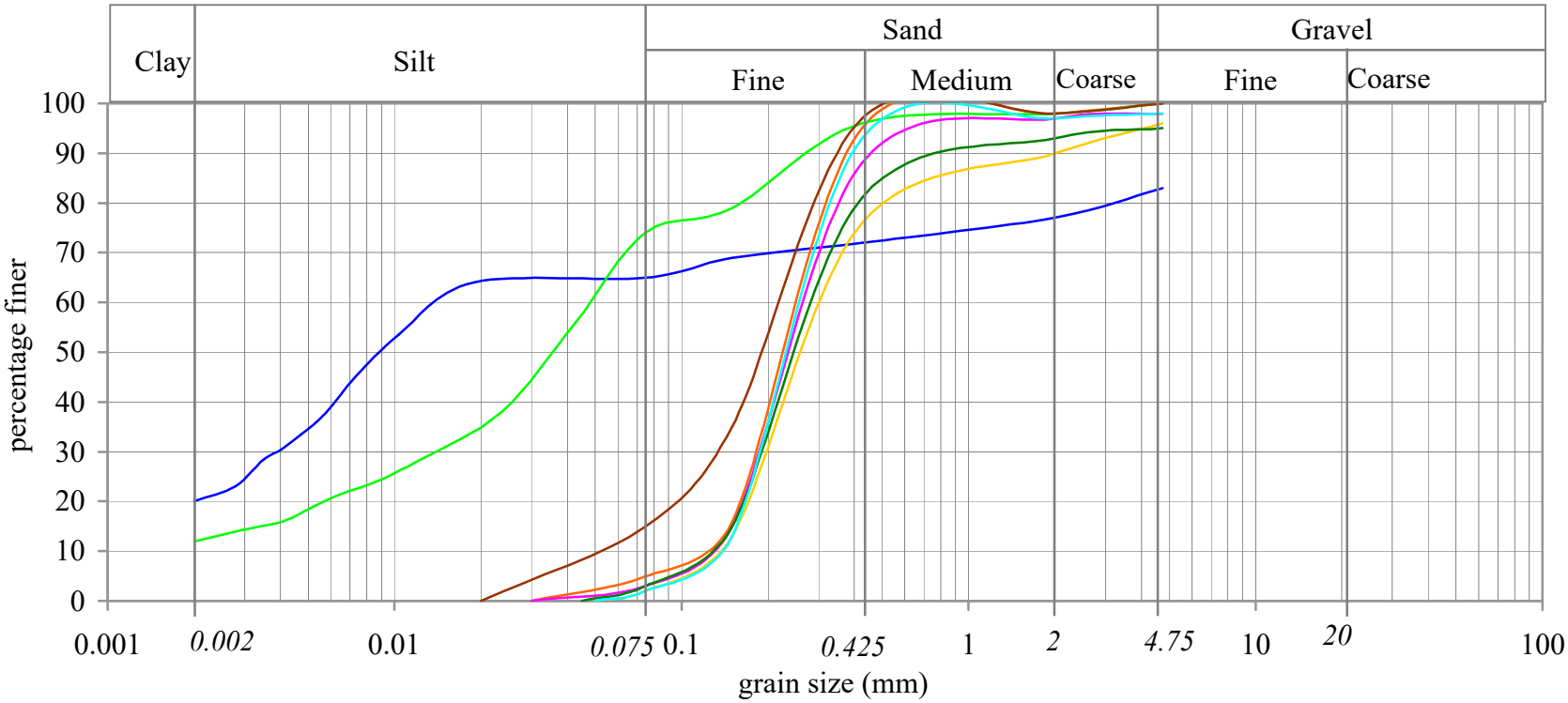
Job No. : G(D)4535

Sheet No. : 6m

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	5	38.4	Sandy clayey silt with gravel	17	18	45	20	0.014	-	-
	5	40	Sand with traces of silt	0	95	5	0	0.25	0.13	1.9
	6	1.5	Clayey sandy silt	0	26	62	12	0.049	-	-
	6	3	Sand with silt	0	85	15	0	0.22	0.051	4.3
	6	4.5	Sand with traces of silt and gravel	2	95	3	0	0.25	0.14	1.8
	6	6	Sand with traces of silt and gravel	4	94	2	0	0.3	0.14	2.1
	6	7.5	Sand with traces of silt and gravel	5	92	3	0	0.29	0.14	2.1
	6	9	Sand with traces of silt and gravel	2	96	2	0	0.27	0.15	1.8

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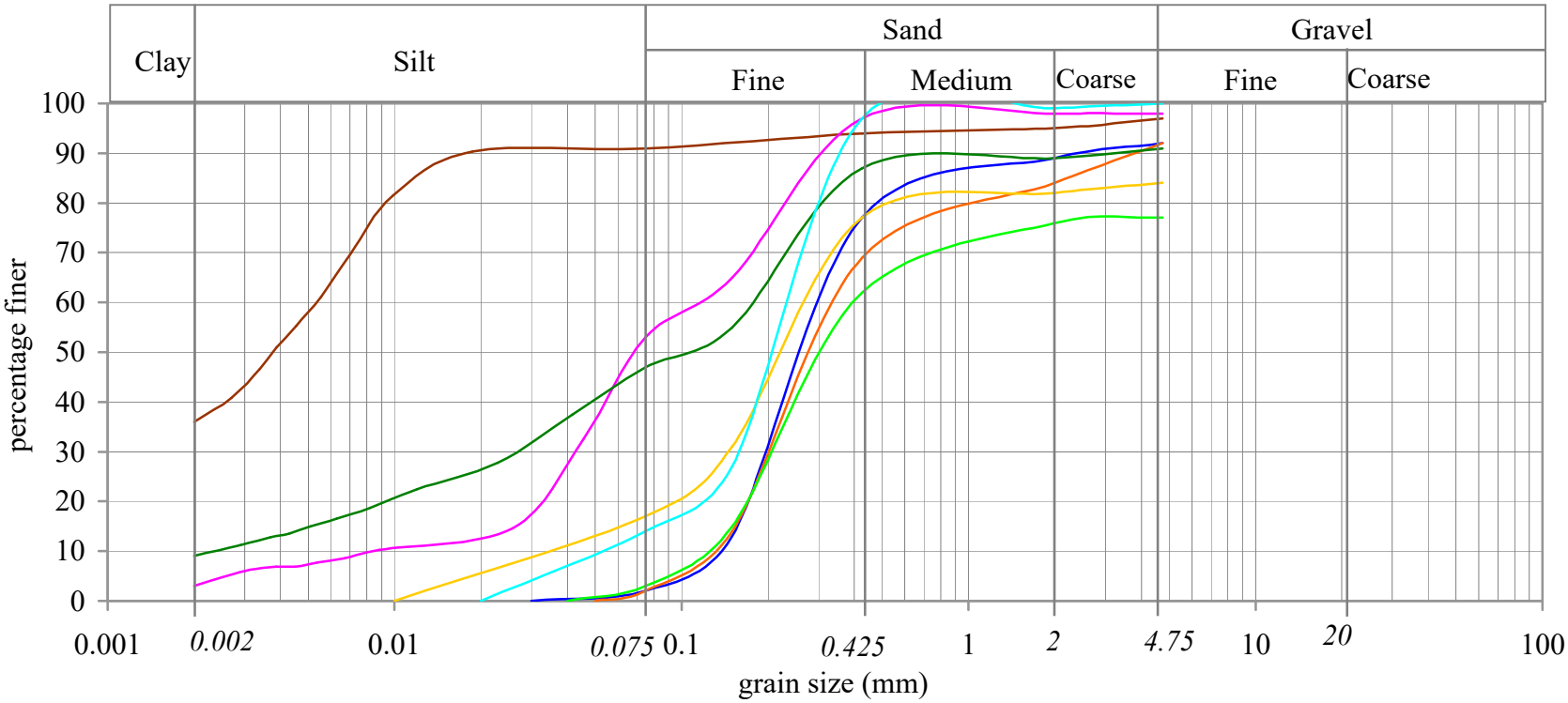
Sheet No. : 6n

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	6	10.5	Sand with traces of silt and gravel	8	90	2	0	0.29	0.15	1.9
	6	12	Sand with traces of silt and gravel	8	90	2	0	0.32	0.14	2.3
	6	13.5	Sand with traces of silt and gravel	23	74	3	0	0.39	0.13	3.0
	6	15	Sandy clayey silt with gravel	3	6	55	36	0.0054	-	-
	6	16.5	Clayey sandy silt withgravel	2	45	50	3	0.13	0.0081	16.0
	6	18	Sand with silt and gravel	16	67	17	0	0.27	0.035	7.7
	6	21	Clayey silty sand with gravel	9	44	38	9	0.17	0.0022	77.3
	6	24	Sand with silt	0	86	14	0	0.23	0.051	4.5

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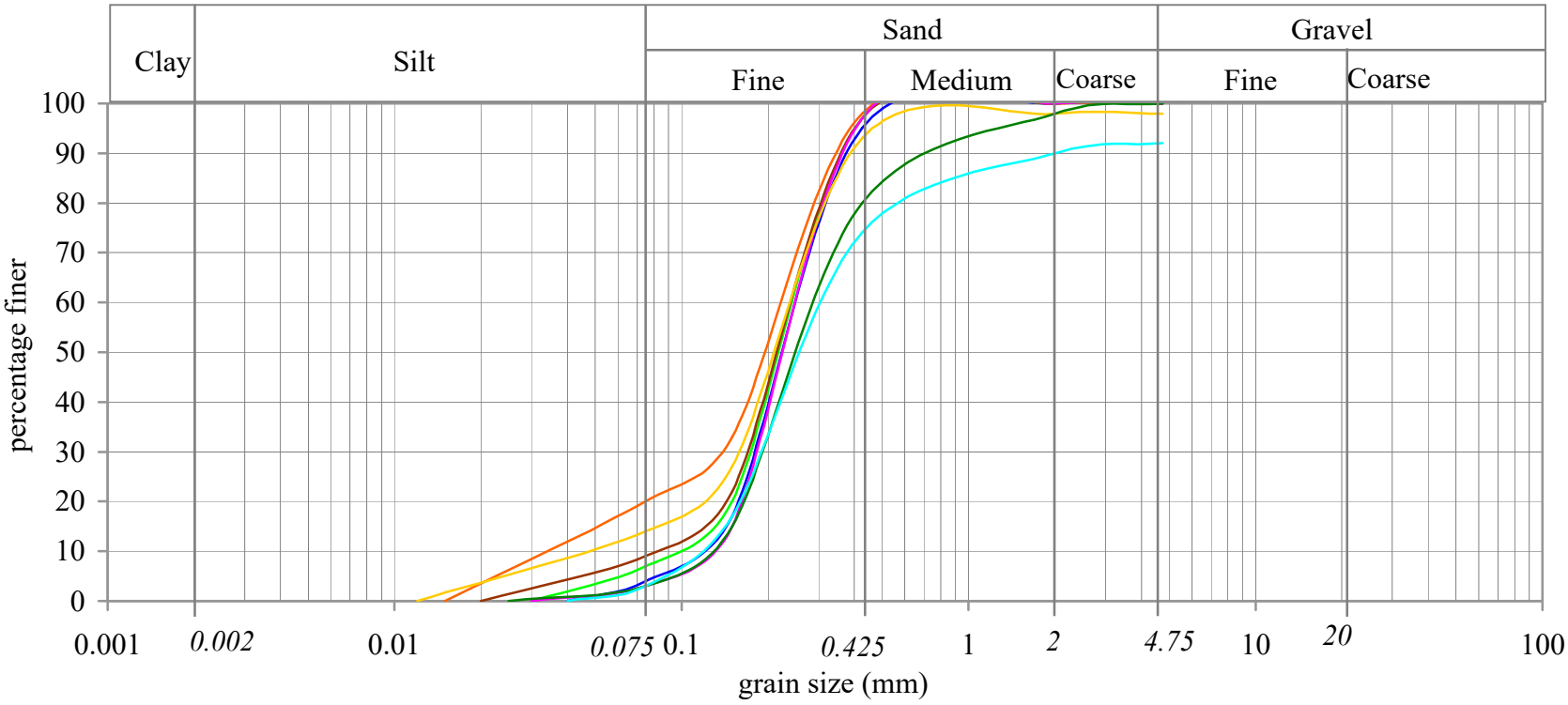
Sheet No. : 60

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	6	27	Sand with traces of silt	0	96	4	0	0.25	0.13	1.9
	6	30	Sand with silt	0	80	20	0	0.24	0.032	7.5
	6	33	Sand with traces of silt	0	93	7	0	0.24	0.095	2.5
	6	36	Sand with traces of silt	0	91	9	0	0.27	0.081	3.3
	6	39	Sand with traces of silt	0	97	3	0	0.25	0.14	1.8
	7	0.9	Sand with silt and gravel	2	84	14	0	0.24	0.045	5.3
	7	2.4	Sand with traces of silt	0	97	3	0	0.29	0.14	2.1
	7	3.9	Sand with traces of silt and gravel	8	89	3	0	0.31	0.13	2.4

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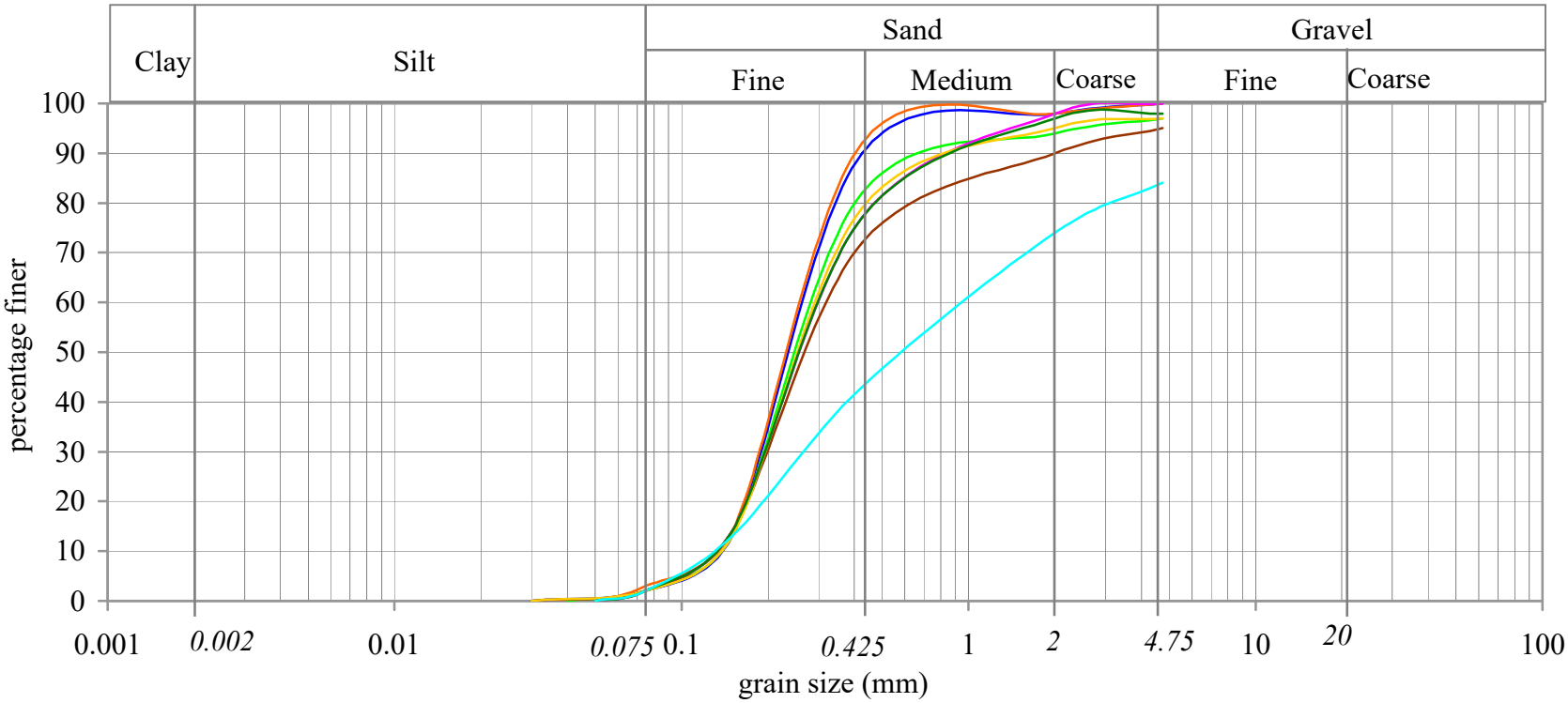
Sheet No. : 6p

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	7	5.4	Sand with traces of silt	0	98	2	0	0.26	0.15	1.7
	7	6.9	Sand with traces of silt	0	97	3	0	0.24	0.14	1.7
	7	8.4	Sand with traces of silt and gravel	3	95	2	0	0.25	0.15	1.7
	7	9.9	Sand with traces of silt and gravel	5	93	2	0	0.26	0.14	1.9
	7	11.4	Sand with traces of silt	0	98	2	0	0.25	0.15	1.7
	7	12.9	Sand with traces of silt and gravel	3	95	2	0	0.29	0.15	1.9
	7	14.4	Sand with traces of silt and gravel	2	96	2	0	0.3	0.15	2.0
	7	15.9	Sand with traces of silt and gravel	16	82	2	0	0.91	0.15	6.1

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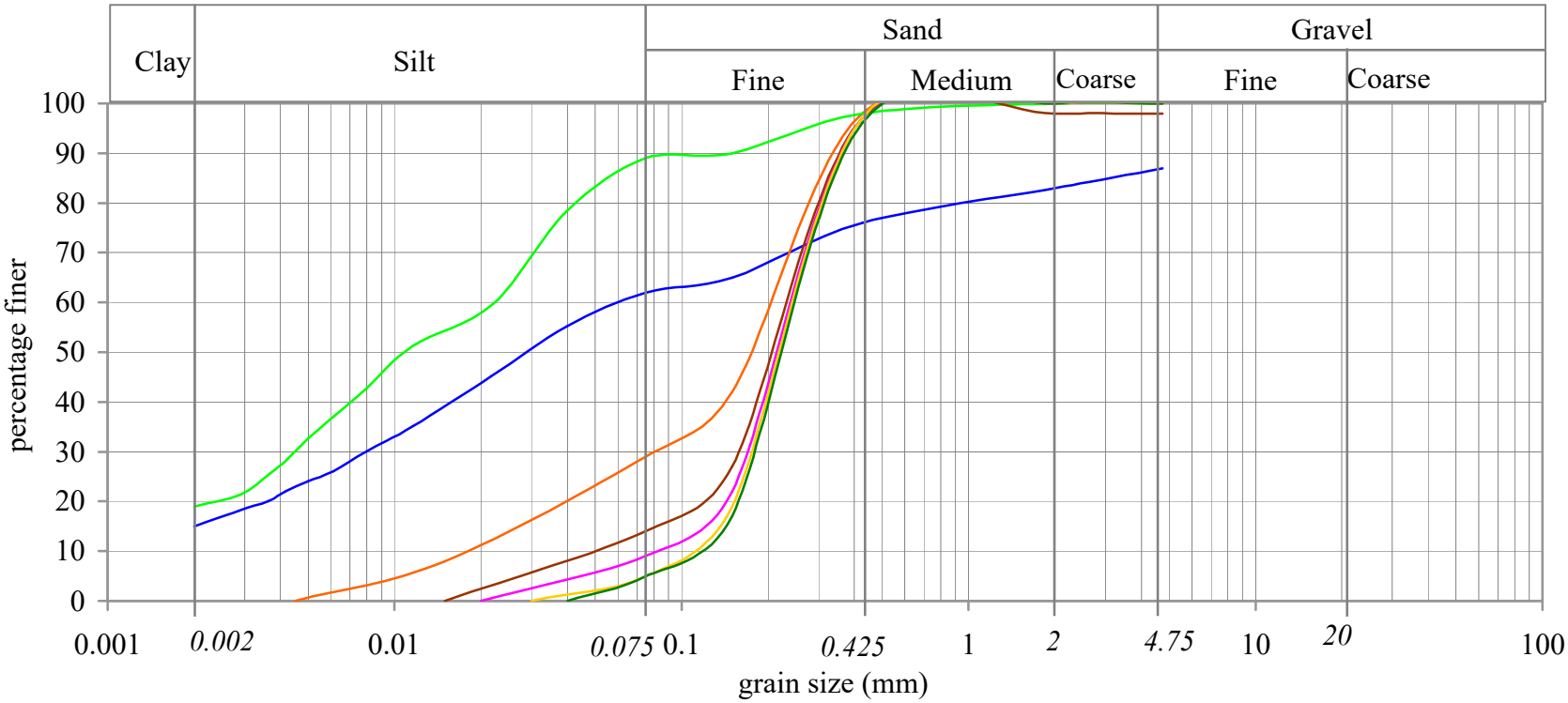
Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	7	17.4	Clayey sandy silt withgravel	13	25	47	15	0.059	-	-
	7	20.4	Silty sand	0	71	29	0	0.21	0.028	7.5
	7	23.4	Sandy clayey silt	0	11	70	19	0.022	-	-
	7	26.4	Sand with silt and gravel	2	84	14	0	0.23	0.049	4.7
	7	29.4	Sand with traces of silt	0	91	9	0	0.24	0.081	3.0
	7	32.4	Sand with traces of silt	0	95	5	0	0.25	0.11	2.3
	7	35.4	Sand with traces of silt	0	95	5	0	0.24	0.13	1.8