GEOTECHNICAL INVESTIGATION REPORT for the Proposed Hospital Building at IP Extension, New Delhi

EXECUTIVE SUMMARY

Nirogi Charitable And Medical Research Trust, Delhi - 110092 are in the process of constructing a Hospital at their existing hospital premises at IP Extension, New Delhi.

The proposed structure consists of four basements, ground floor, service floor and ten upper floors.

The Geotechnical investigation programme has been undertaken at the site, as per the scope of investigations, stipulated by the client. The scope of work consisted of conducting boreholes in soil strata down to 45m depth at four locations and conducting percolation test at one location.

The borehole investigations indicate the presence of filled-up strata down to a maximum depth of about 1.5m below the existing ground level below which the subsoil strata predominantly consists of sandy soils down to the depth investigated except between 9.7m and 19m depths and also between 29m and 39m depths wherein clayey sandy silt has also been encountered.

The N-values indicate that below the filled-up strata, subsoil is loose to medium dense (N-values 6 - 18) down to about 6m depth below which the subsoil is medium dense (N-values 12 -71) down to the depth investigated.

Ground water table had been encountered in all the boreholes at a depth of about 18m below the existing ground level, during the period of field investigations i.e February 2023.

Considering the type of structure involved and the subsoil characteristics as determined from the geotechnical investigations, Raft foundations have been recommended for Hospital Building and Isolated/ Strip footings have been recommended for extended basement and minor structures at ground level.

For Raft foundations, net allowable bearing pressure of 23 t/m^2 and gross allowable bearing pressure of 45 t/m^2 have been recommended for an allowable settlement of 75mm at a depth between 15m and 16m below the existing ground level. For extended basement, Isolated/ Strip Footings, net allowable bearing pressures varying between 13 - 16 t/m^2 have been recommended for various widths of foundations for an allowable settlement of 50mm.

For minor structures at ground level, net allowable bearing pressures varying between 8 - 13 t/m^2 have been recommended for various widths of foundations for an allowable settlement of 50mm at a depth of 2m below the existing ground level or minimum 0.5m in virgin soil strata, whichever is deeper.

Precaution : - 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 Nirogi Charitable And Medical Research Trust, E-362, Second Floor, Nirman Vihar, Delhi - 110092 are in the process of constructing a Hospital Building at their existing hospital premises at IP Extension, New Delhi.

1.2 To design the substructures for the proposed structure, adequate information regarding the subsoil conditions is required. For this purpose, detailed geotechnical investigations have been undertaken at the site of the proposed structure.

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 Nirogi Charitable And Medical Research Trust, vide their work order reference no. NCMRT/PPG/PROJ/WO/20 22 - 23/10/003 dated 31st January 2023. This authorization has been given in response to our offer no. NCD/Q/MH/100/2021 dated 6th October 2021.

2.0 PROJECT DETAILS

2.1 Site Location

2.1.1 The site for the proposed project is located within the existing hospital premises of Nirogi Charitable And Medical Research Trust, East Delhi Office Complex, IP Extension, New Delhi which itself is situated at a distance of about 2.2 km from Anand Vihar Railway Station towards East Delhi, DC Office.

2.2 Site Layout and Topography

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

2.2.2 Photographs showing the view of the site and borehole under progress is given in fig. 1b of the report.

2.2.3 Maximum level differences of about 1.5m had been observed at the site, during the period of field investigation. However, the general level of the site had been observed to be about 0.5m below the adjacent road level.

2.2.4 A double storeyed structure had been observed to be existing at the site during the period of field investigations which is apparently to be demolished for the new construction.

2.2.5 A nalla had been observed to be flowing in North - East direction at a distance of about 100m from the site boundary.

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

2.2.7 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 seismicity, as per the seismic zoning map of India given in BIS code IS:1893 (Part1)-2016.

2.4 The Structure

2.4.1 The proposed structure is a Hospital building consisting of four basements, ground floor, service floor and ten upper floors.

2.4.2 The structure is understood to be a framed one and that the construction is proposed to be of Reinforced Cement Concrete.

3.0 OBJECT OF INVESTIGATIONS

3.1 For designing the foundation system of the proposed structure, 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 45m depth at four locations.

b) Conducting percolation test at one location.

c) Conducting relevant laboratory tests on soil samples recovered.

d) 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 3rd February 2023 and 14th February 2023.

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

5.2 Boreholes

5.2.1 All the boreholes were progressed by shell and auger method. Casing pipes were used to stabilise the sides of the boreholes.

5.2.2 Boreholes, BH1 to BH4 had been progressed down to the stipulated depth of 45m below the existing ground level.

5.2.3 The diameter of the boreholes was 150/100mm.

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

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

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

5.2.7 The ends of sample tubes were sealed by wax to prevent loss / ingress of moisture. Disturbed soil samples were enclosed in polythene bags.

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

5.2.9 Ground water table had been encountered in all the boreholes at following depths below the ground water table level, during the period of field investigation i.e. February 2023.

Borehole No.	Depth of Ground Water Table (m) below EGL
BH1	18.4
BH2	18.1
BH3	18.5
BH4	19.8

5.3 Percolation Test

5.3.1 The percolation rate is determined as per the guidelines of Appendix- A of IS:2470(Part I)-1968. Percolation test has been conducted to determine percolation rate at 1.5m below the existing ground level.

5.3.2 A pit was excavated down to 1.5m depth. At the bottom of the excavated pit, a square pit of 0.3 x 0.3m was excavated down to 50cm depth. The bottom and the sides of the pit were carefully scratched in order to remove any smeared soil surface and all the loose materials was removed from the hole. A layer of fine gravel was added for a depth of about 5cm to protect the bottom from scouring and sediment. Water was poured up to a depth of 30cm over the gravel and was left for saturation. Generally saturation process takes maximum 24 hour, however at the present site, as the substrata consists of sandy soils, the water seeps away within a few seconds in the subsoil and subsoil had been observed to be fully saturated. After the saturation process water was added to bring the depth of the water in the pit up to 15cm over the gravel. From a fixed reference point, time required for water to fall every 25mm was observed till the water was completely absorbed. The same process was repeated three times by refilling water 15cm over the gravel. The time in minutes required for water to drop final 25mm was used to calculate the percolation rate.

6.0 LABORATORY INVESTIGATIONS

6.1 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

6.2 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

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 four strata in the four boreholes:

a) Stratum - I : Filled-up soil with debris

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

c) Stratum - III : Clayey sandy silt with occasional gravel/sandy clayey silt

d) Stratum - IV : Silty sand with occasional clay and gravel

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

BH. No.	Strata (depth in m : from : to)			
	Stratum -I	Stratum -II	Stratum - III	Stratum - IV
1	0 - 0.3	0.3 - 9.7 19 - 29	9.7 - 13.5 15 - 19 29 - 36	13.5 - 15 36 - 45
2	0 - 1.2	1.2 - 11.8	11.8 - 14.4 15.9 - 17.8	14.4 - 15.9
3	0 - 1.8	1.8 - 11 21 - 31.5	11 - 18 31.5 - 39	18 - 21 39 - 45
4	0 - 1.3	1.3 - 12.9 17 - 32.4	12.9 - 17 32.4 - 37 40 - 45	37 - 40

7.2.3 The above results show that :

a) Stratum - I consisting of filled-up soils, has been encountered down to a maximum depth of about 1.5m below the existing ground level.

b) Stratum - II consisting predominantly of sandy soils, is predominant down to a maximum depth of about 32.4m below the existing ground level except between

9.7m and 21m depths wherein layers of Stratum - III and Stratum - IV have also been encountered.

c) Stratum - III consisting predominantly of silty soils with varying percentages of clay and sand, has been encountered between 9.7m and 19m depths and also beyond a depth of about 29m down to the maximum depth investigated i.e. 45m below the existing ground level.

d) Stratum - IV consisting predominantly of sandy soils with significant percentages s of silt, has been encountered in occasional thin layers between 13.5m and 21m depths and also beyond a depth of about 36m down to the maximum depth investigated.

7.3 Soil Composition

7.3.1 The grain size distributions of the selected soil samples in the four boreholes have been presented in the form of grain size analysis curves in figs. 5a to 5k.

7.3.2 The variations in the grain size distributions in each of the three strata (except Stratum - I i.e. filled-up soil with debris) in the four boreholes are as follows:

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

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	0 - 8	89 - 98	2 - 9	0
2	0 - 13	83 - 98	2 - 17	0
3	0 - 3	91 - 8	2 - 9	0
4	0 - 6	80 - 98	2 - 20	0

b) Stratum - III : Clayey sandy silt with occasional gravel/sandy clayey silt

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	0 - 3	13 - 44	51 - 63	9 - 31

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
2	0 - 3	6 - 48	47 - 64	4 - 30
3	2 - 5	7 - 33	55 - 68	9 - 25
4	0 - 28	12 - 43	38 - 53	6 - 46

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

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	0 - 2	73 - 76	24 - 25	0
2	0 - 6	48 - 73	27 - 44	5
3	0 - 2	70 - 75	25 - 28	0

This stratum has not been encountered in borehole BH4.

7.3.3 The above results indicate that :

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

b) Stratum - III consists of about 38% to 68% of silt, 6% to 48% of sand with rest of the soil matrix consisting of clay and gravel.

c) Stratum - IV consists of about 48% to 76% of sand and 22% to 44% 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 four boreholes vary as follows:

BH. No.	Bulk Density (g/cm^3)	Water Content (%)	Dry Density (g/cm^3)
1	1.58 - 2.11	9.5 - 25.9	1.54 - 1.74
2	1.80 - 2.15	9.4 - 22.9	1.58 - 1.75

BH. No.	Bulk Density (g/cm^3)	Water Content (%)	Dry Density (g/cm^3)
3	1.73 -2.15	5.9 - 32.8	1.47 - 1.83
4	1.75 - 2.16	6.7 - 25.0	1.62 - 1.79

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 four boreholes conducted, in fig. 3.

7.4.3 The above results indicate that the subsoil, below the filled-up strata, is in a loose to medium dense state down to about 6m depth below which the subsoil is in a medium dense state down to the depth investigated.

7.5 Atterberg Limits

7.5.1 The Atterberg limits indicate that the subsoil is predominantly non-plastic down to the depth investigated except between 9.7m and 19m depths and also between 29m and 39m depths wherein low plastic soils have also been encountered. Additionally, occasional layers of medium plastic to high plastic soils have also been encountered between 29m and 39m depths below the existing ground level.

7.6 Standard Penetration Test Values (N-values)

7.6.1 The observed Standard Penetration Test values (N-values) vary between 6 and 74 as indicated in the soil profile tables and as also shown in the fig. 4 wherein the observed N-values have been plotted with respect to depths.

7.6.2 The above results indicate that the subsoil, below the filled-up strata, is in a loose to medium dense state down to about 6m depth below which the subsoil is in a medium dense state down to the depth 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 and a bore well existing at the site, 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)
BH1	7	1010	618
BH4	7	104	247
Borewell	7	128	247

IS LIMITS	
pH value	*Not less than 6*
Chloride content (ppm)	*Maximum 500 ppm*
Sulphate content (ppm)	*Maximum 400 ppm*

7.9.2 The above results of chemical analysis on water samples are within the IS limits except for the water sample of borehole BH1 which has exceeded the IS limits. Hence, periodical chemical analysis of the water sample and also before the commencement of the construction work is advisable.

7.10 Modulus of Subgrade reaction (k-value)

7.10.1 Considering the sub soil conditions at site, the modulus of sub-grade reaction (k-value) for a 30 x 30cm plate size or 30cm wide beam, based on Standard Penetration Test values (N-values) as per the guidelines of article B-1.1, clause 3.1(F) of appendix B, IS: 2950(part I)-1981, can be adopted as ***2.5 kg/cm³*** at a depth of about between ***15m and 16m below the existing ground level.***

7.11 Percolation Test :

7.11.1 On the basis of the results of the percolation test, the percolation rate determined, has been given hereunder.

Test No.	Depth of Test below EGL (m)	Percolation Rate (Second)
1	1.5	36

8.0 DESIGN CRITERIA

***8.1* Type of Foundation**

8.1.1 Type of foundation depends upon the configuration of loading points and the loading intensity at the foundation level and the prevailing subsoil conditions at the site.

8.1.2 The proposed structure is a Hospital buildings consisting of four basements, ground floor, service floor and ten upper floors. Considering this, heavy loads can be anticipated on the foundations.

8.1.3 The results of the investigations have shown that subsoil, below the filled-up strata, is in a loose to medium dense state down to about 6m depth below which the subsoil is in a medium dense state down to the depth investigated.

8.1.4 In view of the above points, the proposed structure can be supported over ***Raft foundations.*** However, extended basement and structures at ground level can be supported over ***Isolated/ Strip Footings.***

8.2 Depth of foundations

8.2.1 The minimum depth of foundation depends upon the following factors :

a) Top loose zone, 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

8.2.2 Filled-up soils have been encountered down to a maximum depth of about 1.5m below the existing ground level.

8.2.3 The results of the investigations have indicated that the subsoil, below the likely founding level, the subsoil is in a medium dense state down to the depth investigated.

8.2.4 Considering the above, and also that the proposed structure have four basement, with floor level of the lowest basement resting at a depth of about 14m below the existing ground level, the foundations for the proposed structure can be placed at a depth ***between 15m and 16m below the existing ground level.***

8.2.5 However, for Isolated/ Strip footings, minimum level difference of 1.5m has to be maintained between the lowest basement floor level and bottom of the footings, to provide adequate safety against shear failure.

8.2.6 The foundations for minor structures at ground level can be placed at a depth of about ***2m below the existing ground level or minimum 0.5m in virgin soil strata,*** whichever is deeper.

8.2.7 The stratum available at the founding level will either be ***Yellowish brown clayey sandy silt or sand with traces of silt.***

8.2.8 The excavations down to the above mentioned depths can be carried out by ordinary methods by providing necessary side slopes.

8.3 Allowable Bearing Pressure

8.3.1 Allowable bearing pressure depends upon the allowable settlements. Allowable settlements of 75mm and 50mm have been considered to evaluate the allowable bearing pressures for **Raft Foundations and Isolated/Strip Footings,** respectively.

8.3.2 Allowable bearing pressure has been evaluated by :

a) Shear failure criterion using average soil data

b) Settlement criterion taking SPT values

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

a) ***Raft Foundation***

Net allowable bearing pressure of 23 t/m^2 and gross allowable bearing pressure of 45t/m^2 can be adopted for an allowable settlement of 75mm at a depth between 15m and 16 depth below the existing ground level.

b) ***Isolated/ Strip Footings (extended basement),*** *for an allowable settlement of 50mm*

Width of foundation (m)	***1.5***	***3***	***>4.5***
Net Allowable Bearing Pressure (t/m²)	***13***	***15***	***16***

c) ***Isolated/ Strip Footings (for Minor Structures at Ground Level),*** *for an allowable settlement of 50mm at a depth of 2m below the existing ground level*

Width of foundation (m)	***1.5***	***3***	***>4.5***
Net Allowable Bearing Pressure (t/m²)	***8***	***11***	***13***

9.0 RECOMMENDATION

9.1 Type of Foundations

a) Raft Foundations (for Hospital Buildings)

b) Isolated/ Strip Footings (for extended basement and minor structures at ground level)

9.2 Depth of Foundations

a) ***For Raft Foundations (for Hospital Buildings)***

between 15m and 16m below the existing ground level (considering the floor level of the lowest basement resting at a depth of 14m below the existing ground level)

b) ***For Isolated/ Strip Footings (for Extended Basement)***

between 15m and 16m below the existing ground level (considering the floor level of the lowest basement resting at a depth of 14m below the existing ground level) However, for Isolated/ Strip footings, minimum level difference of 1.5m has to be maintained between the lowest basement floor level and bottom of the footings,

to provide adequate safety against shear failure.

c) For Isolated/ Strip Footings (for Minor Structures at Ground Level)

2m below the existing ground level or minimum 0.5m in virgin soil strata, whichever is deeper

9.3 Allowable Bearing pressure

a) ***For Raft Foundation (for Hospital Buildings)***

Net allowable bearing pressure of 23 t/m^2 and gross allowable bearing pressure of 45 t/m^2 can be adopted for an allowable settlement of 75mm at above recommended depths.

b) Isolated/ Strip Footings (for Extended Basement), *for an allowable settlement of 50mm*

Width of foundation (m)	***1.5***	***3***	***>4.5***
Net Allowable Bearing Pressure (t/m^2)	***13***	***15***	***16***

c) Isolated/ Strip Footings (for Minor Structures at Ground Level), *for an allowable settlement of 50mm at a depth of 2m below the existing ground level*

Width of foundation (m)	***1.5***	***3***	***>4.5***
Net Allowable Bearing Pressure (t/m^2)	***8***	***11***	***13***

9.4 Modulus of Subgrade Reaction (k-value)

9.4.1 Modulus of sub-grade reaction (k-value) for a 30 x 30cm plate size or 30cm wide beam, of ***2.5 kg/cm^3*** can be adopted for design of Raft Foundations laid at a depth between ***15m and 16m below the existing ground level.***

9.4.2 The modulus of sub-grade reaction (k-value) given above is based on Standard Penetration Test values (N-values) *as per the guidelines of article B-1.1 , clause 3.1(F) of appendix B, IS: 2950(part I)* -1981.

9.5 Excavations

9.5.1 As deep excavations have to be carried out in sandy soil stratum, adequate measures in the form of providing adequate slopes or properly designed shoring/strutting or sheetpiles, have to be taken to ensure safety against failure of the sides of the excavations.

9.6 Appendix

9.6.1 An appendix sheet showing the typical analysis of the allowable bearing pressure for Raft foundations has been given in Appendix - A of this report

9.6.2 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 - B.

9.7 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.

9.8 SPECIAL NOTE

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.

9.9 LIMITATIONS

This soil 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 location.

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Appendix A

(refer para no. 9.6.1)

ANALYSIS FOR ALLOWABLE BEARING PRESSURE

A.1 METHODOLOGY

A.1.1 The allowable bearing pressure is taken as the lower of the values obtained using two different criteria namely :

a. Shear failure criterion

b. Settlement criterion.

A.1.2 The shear failure criterion gives the safe bearing capacity which is based on the capacity of the soil to carry the load without undergoing shear failure.

A.1.3 The settlement criterion gives the safe bearing pressure which is the bearing pressure corresponding to an allowable settlement of the foundations.

A.2 DATA

A.2.1 Soil Properties

The soil properties considered for the analysis for the allowable bearing pressure have been taken as the weighted average of the soil properties obtained from laboratory tests within the depth of influence of the foundations.

a. Unit weight of the soil, γ = 1.8 g/cc

b. Cohesion, c = 0.10 kg/cm^2

c. Angle of shearing resistance ϕ = 28^O

A.2.2 Depth of Foundation

The depth of foundation has been taken as per section 8.2 as : D = 15m

A.2.3 Allowable Settlement

The allowable settlement adopted for the proposed structure is 's' = 75 mm

A.3 SHEAR FAILURE CRITERION

The safe bearing capacity is determined as per IS 6403 - 1981.

A.3.1 Bearing Capacity Factors

For the above mentioned value of angle of shearing resistance ϕ, the bearing capacity factors are :

a. N_c' = 20.09

b. N_q' = 10.41

c. N_γ' = 10.87

A.3.2 Water Table Correction Factor

Water table correction factor has been adopted as R_w' = 0.5.

A.3.3 Safe bearing capacity

The safe bearing capacity is obtained using the equation given below wherein the factor of safety has been taken as equal to 3. Thereafter, the safe bearing capacity for different widths of foundation have been given.

$$q_b = \frac{1}{3} \cdot \left(c \cdot N_c + \gamma \cdot D \cdot N_q + 0.5 \cdot \gamma \cdot B \cdot N_\gamma \cdot R_w \right) - \gamma \cdot D$$

Considering the widths of foundations greater than 5m, the safe bearing capacity works out to be **55 t/m^2**.

A.4 SETTLEMENT CRITERION (Ref. IS : 8009)

The safe bearing pressure corresponding to an allowable settlement of the foundation is determined based on the N- values

A.4.1 Based on N Values

Considering a **weighted average N-value of 19** determined based on the recorded N-values in the boreholes, the safe bearing pressure for widths of foundations greater than 10m determined as per IS 8009-1976 (Part 1) works out be **23.5 t/m^2.**

A.5 RECOMMENDED ALLOWABLE BEARING PRESSURE

On the basis of the above, the recommended net allowable bearing pressure for Raft Foundations is **23 t/m^2 .**

Note :To obtain gross allowable bearing pressure, weight of soil overburden removed should be added to the above value.

Appendix - B

(refer para no. 9.6.2)

LIST OF IS CODES

Field Investigation

1. IS : 1892 - 1979 : 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)

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.

Foundation Construction

1.	IS : 1080 - 1986 :	Code of practice for design and construction of shallow foundations on soils (other than raft, ring and shell) (Second revision)
2.	IS : 1904 - 1986 :	Code of practice for design and construction of foundation in soils: General requirements (Third revision)
3.	IS : 6403 - 1981 :	Code of practice for determination of bearing capacity of shallow foundations : First revision (Amendment 1)
4.	IS : 8009 - 1976 (Part 1) :	Code of practice for calculation of settlements of foundations : Shallow foundations subject to symmetrical static vertical loads (Amendment 2)

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.4m | Term. Depth : 45m | 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	Filled-up soil with debris											
	0.3	Change of the strata											
6	0.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	1.5								1.58	2.7			
9	2.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	3.0								1.62	2.7	CD	0.02	25
9	3.9	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	4.5								1.70	6.0			
8	5.4	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	6.0								1.75	3.0			
12	6.9	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	7.5								1.78	14.6	CD	0.03	26
15	8.4	Grey sand with traces of silt and gravel	8	89	3	0	Non	Plastic					
	9.0								1.79	11.1			
	9.7	Change of the strata											
24	9.9	Yellowish brown clayey sandy silt	0	37	53	10	31	20					

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Job No. : G(D)4526

Sheet No. : 1

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.4m | Term. Depth : 45m | 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								2.02	18.6			
20	11.4	Yellowish brown clayey sandy silt	0	21	63	16	32	20					
	12.0								2.04	17.2			
22	12.9	Yellowish brown clayey sandy silt	0	21	60	19	33	21					
	13.5	Change of the strata							1.90	19.1			
51	14.4	Yellowish brown silty sand	0	76	24	0	Non	Plastic					
	15.0	Change of the strata							1.79	9.5	CD	0.10	28
38	15.9	Yellowish brown clayey sandy silt with gravel	2	44	45	9	Non	Plastic					
	16.5								2.05	18.2			
34	17.4	Yellowish brown clayey sandy silt	0	41	50	9	Non	Plastic					
	18.0								1.92	15.0			
	19.0	Change of the strata											
38	20.4	Grey sand with traces of silt	0	91	9	0	Non	Plastic					
	21.0								Sample	slip			
42	23.4	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	24.0												

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Job No. : G(D)4526

Sheet No. : 2

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.4m | Term. Depth : 45m | 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 (°)
40	26.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	27.0								Sample	slip			
	29.0	Change of the strata											
50	29.4	Yellowish brown sandy clayey silt with gravel	3	15	51	31	48	28					
	30.0								2.11	22.3			
56	32.4	Yellowish brown sandy clayey silt with gravel	3	13	56	28	45	26					
	33.0								2.19	25.9	CD	0.14	30
74	35.4	Yellowish brown clayey sandy silt with gravel	2	36	58	4	28	19					
	36.0	Change of the strata							2.05	17.5			
62	38.4	Brownish grey silty sand	0	75	25	0	Non	Plastic					
	39.0								Sample	slip			
69	41.4	Brownish grey silty sand	0	76	24	0	Non	Plastic					
	42.0								Sample	slip			
71	44.4	Brownish grey silty sand with gravel	2	73	24	0	Non	Plastic					
	45.0								Sample	slip			

Observed 'N' Values

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Job No. G(D)4526

Sheet No. : 3

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.1m | Term. Depth : 45m | 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	Filled-up soil with debris											
	1.2	Change of the strata											
7	1.5	Grey sand with traces of silt and gravel	2	94	4	0	Non	Plastic					
	2.4								1.93	22.2			
9	3.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	3.9								1.90	20.2	CD	0.03	26
11	4.5	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	5.4								1.99	19.7			
13	6.0	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	6.9								2.00	20.4			
16	7.5	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	8.4								1.92	17.8	CD	0.02	27
28	9.0	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	9.9								2.02	21.1			

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Job No. : G(D)4526

Sheet No. : 4

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.1m | Term. Depth : 45m | 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 (°)
48	10.5	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	11.4								1.90	15.6			
	11.8	Change of the strata											
19	12.0	Yellowish brown clayey sandy silt with gravel	3	25	57	15	31	21					
	12.9								2.05	19.1			
36	13.5	Yellowish brown clayey sandy silt	0	31	55	14	30	20					
	14.4	Change of the strata							1.83	9.4	CD	0.06	30
67	15.0	Yellowish brown silty sand	0	73	27	0	Non	Plastic					
	15.9	Change of the strata							1.85	11.8			
61	16.5	Yellowish brown clayey sandy silt	0	47	47	6	28	19					
	17.4								2.00	17.4			
	17.8	Change of the strata											
81	18.0	Grey sand with silt	0	85	15	0	Non	Plastic					
	20.4								Sample	slip			
49	21.0	Grey sand with silt	0	83	17	0	Non	Plastic					
	23.4								Sample	slip			
50	24.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					

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Job No. : G(D)4526

Sheet No. : 5

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.1m | Term. Depth : 45m | 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	Type	c (kg/cm^2)	Φ (°)
	26.4								Sample	slip			
45	27.0	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	29.4								Sample	slip			
51	30.0	Grey sand with traces of silt and gravel	13	85	2	0	Non	Plastic					
	31.0	Change of the strata											
	32.4								2.15	24.9	CD	0.18	27
38	33.0	Yellowish brown sandy clayey silt	0	6	64	30	45	26					
	35.4								2.01	20.5			
58	36.0	Yellowish brown clayey sandy silt	0	48	48	4	26	18					
	38.4	Change of the strata							1.99	17.5			
50	39.0	Yellowish brown clayey silty sand with gravel	6	50	39	5	Low	Plastic					
	41.4								2.01	14.9	CD	0.10	31
65	42.0	Yellowish brown clayey silty sand with gravel	3	50	42	5	26	18					
	44.4								2.02	17.9			
68	45.0	Yellowish brown clayey silty sand with gravel	3	48	44	5	25	18					

Observed 'N' Values

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Job No. : G(D)4526

Sheet No. : 6

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.5m | Term. Depth : 45m | 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	Filled-up soil with debris											
	1.8	Change of the strata											
8	2.4	Grey sand with traces of silt	0	91	9	0	Non	Plastic					
	3.0								1.63	5.3	CD	0.03	27
18	3.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	4.5								1.87	7.9			
12	5.4	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	6.0								1.86	18.9			
15	6.9	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	7.5								1.84	19.9	CD	0.02	26
18	8.4	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	9.0								1.73	17.9			
20	9.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					

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Job No. : G(D)4526

Sheet No. : 7

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.5m | Term. Depth : 45m | 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 (°)
	10.5								1.73	15.4			
	11.0	Change of the strata											
20	11.4	Yellowish brown clayey sandy silt	0	27	57	16	31	21					
	12.0								1.94	16.8	CD	0.12	27
22	12.9	Yellowish brown clayey sandy silt with gravel	5	20	58	17	33	21					
	13.5								2.04	18.9			
38	14.4	Yellowish brown clayey sandy silt with gravel	3	30	58	9	27	19					
	15.0								2.11	15.0			
40	15.9	Yellowish brown clayey sandy silt with gravel	2	33	55	10	27	18					
	16.5								1.80	6.4			
27	17.4	Yellowish brown clayey sandy silt with gravel	8	23	60	9	26	18					
	18.0	Change of the strata							2.07	22.7	CD	0.06	27
35	20.4	Yellowish brown silty sand	0	75	25	0	Non	Plastic					
	21.0	Change of the strata							2.05	20.5			
40	23.4	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	24.0								1.98	32.8			

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Job No. : G(D)4526

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SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 18.5m | Term. Depth : 45m | 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 (°)
48	26.4	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	27.0								Sample	slip			
56	29.4	Grey sand with traces of silt and gravel	2	92	6	0	Non	Plastic					
	30.0								Sample	slip			
	31.5	Change of the strata											
53	32.4	Yellowish brown sandy clayey silt	0	7	68	25	46	28					
	33.0								2.15	26.7	CD	0.19	28
55	35.4	Yellowish brown sandy clayey silt	0	10	66	24	40	24					
	36.0								2.12	24.5			
47	38.4	Yellowish brown clayey sandy silt with gravel	3	24	57	16	43	26					
	39.0	Change of the strata							2.07	23.9			
65	41.4	Yellowish brown silty sand with gravel	2	70	28	0	Non	Plastic					
	42.0								Sample	slip			
69	44.4	Yellowish brown silty sand	0	75	25	0	Non	Plastic					
	45.0								Sample	slip			
		Observed 'N' Values											

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SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 19.8m | Term. Depth : 45m | 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	Filled-up soil with debris											
	1.3	Change of the strata											
33	1.5	Grey sand with silt	0	86	14	0	Non	Plastic					
	2.4								1.75	6.7	CD	0.03	25
6	3.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	3.9								1.88	15.6			
10	4.5	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	5.4								1.95	20.5			
20	6.0	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	6.9								1.98	11.5			
25	7.5	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	8.4								1.87	12.2	CD	0.02	27
26	9.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	9.9								1.90	15.6			

Job No. : G(D)4526

Sheet No. : 10

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 19.8m | Term. Depth : 45m | 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 (°)
24	10.5	Grey sand with traces of silt and gravel	6	92	2	0	Non	Plastic					
	11.4								1.85	13.9			
20	12.0	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	12.9	Change of the strata							1.87	14.2	CD	0.10	27
28	13.5	Yellowish brown clayey sandy silt with gavel	28	22	42	8	26	18					
	14.4								1.88	12.1			
30	15.0	Yellowish brown clayey sandy silt with gravel	6	42	45	7	29	20					
	15.9								1.99	17.9			
33	16.5	Yellowish brown clayey sandy silt with gravel	8	43	43	6	25	17					
	17.0	Change of the strata											
	17.4								Sample	slip			
30	18.0	Grey sand with silt	0	81	19	0	Non	Plastic					
	20.4								Sample	slip			
40	21.0	Grey sand with silt	0	80	20	0	Non	Plastic					
	23.4								Sample	slip			
47	24.0	Grey sand with traces of silt and gravel	2	93	5	0	Non	Plastic					

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Job No. : G(D)4526

Sheet No. : 11

SOIL PROFILE

Project : Proposed Hospital Building at IP Extension, New Delhi

B.H. Location : | Water Table : 19.8m | Term. Depth : 45m | 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 (°)
	26.4								Sample	slip			
48	27.0	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	29.4								Sample	slip			
57	30.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	32.4	Change of the strata							2.16	25.0			
56	33.0	Yellowish brown sandy silty clay with gravel	4	12	38	46	55	32					
	35.4								2.15	23.2	CD	0.16	31
64	36.0	Yellowish brown clayey sandy silt with gravel	23	12	53	12	30	20					
	37.0	Change of the strata											
	38.4								2.06	18.6			
55	39.0	Yellowish brown silty sand	0	70	30	0	Non	Plastic					
	40.0	Change of the strata											
	41.4								2.13	20.4	CD	0.11	30
61	42.0	Yellowish brown clayey sandy silt with gravel	4	36	52	8	26	18					
	44.4								2.10	21.9			
71	45.0	Yellowish brown clayey sandy silt	0	39	52	9	27	19					

Observed 'N' Values

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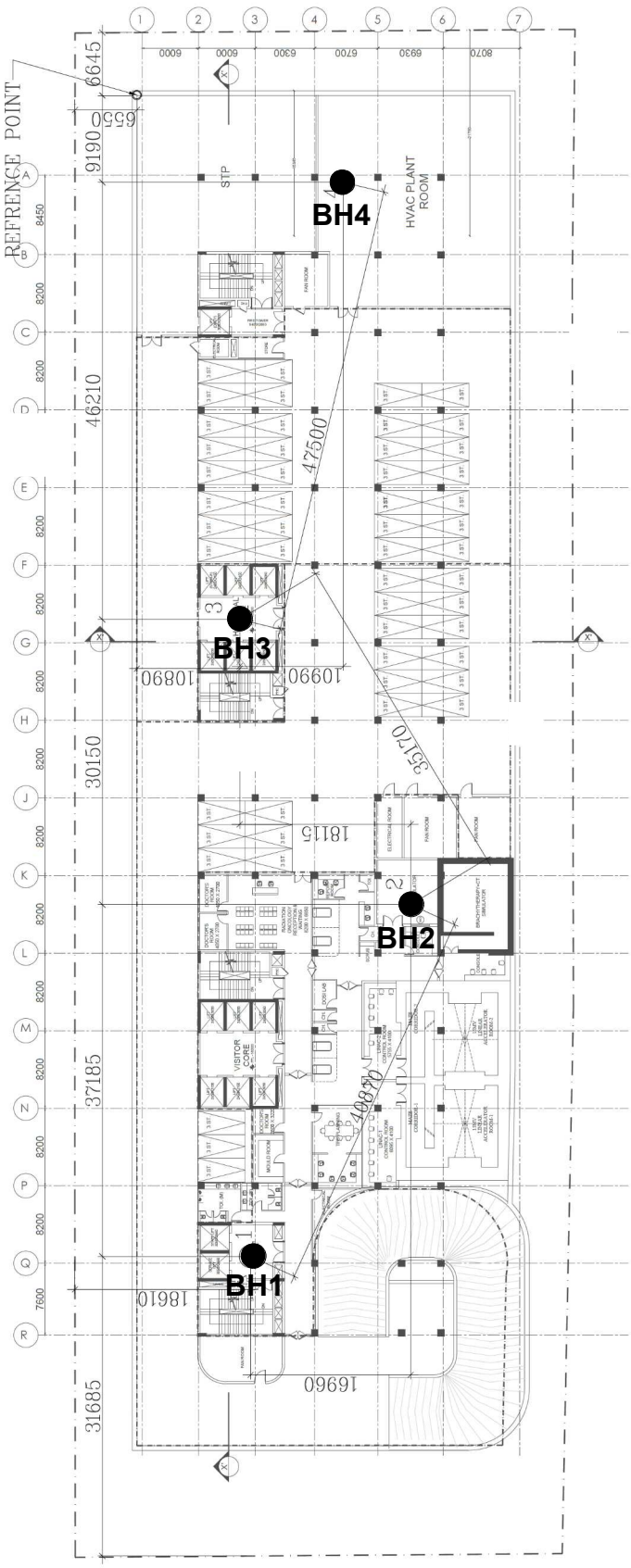
Job No. : G(D)4526

Sheet No. : 12



SCHEMATIC SITE PLAN

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Job No. : G(D)4526

Sheet No. : 1a

PHOTOGRAPHS SHOWING
VIEW OF THE SITE & BOREHOLES UNDER PROGRESS

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Job No. : G(D)4526

Sheet No. : 1b

PHOTOGRAPHS SHOWING
VIEW OF THE SITE & BOREHOLES UNDER PROGRESS

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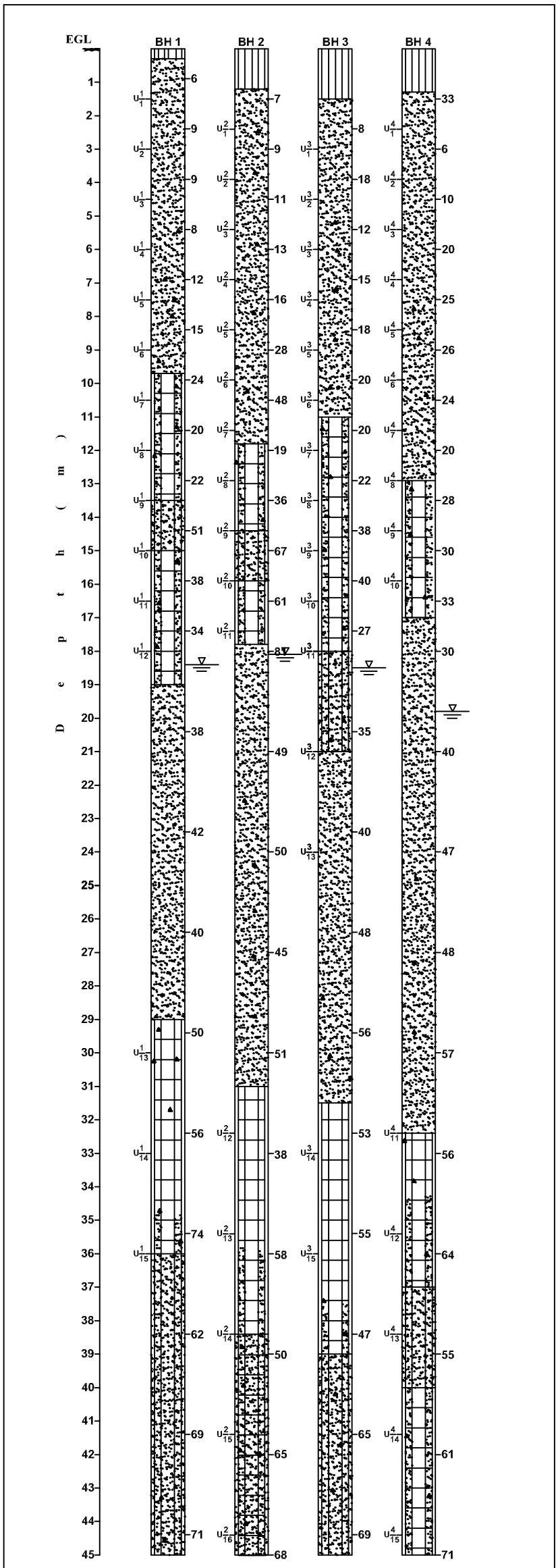
Job No. : G(D)4526

Sheet No. : 1c



LEGEND

Filled-up soil with debris

Grey sand with silt and occasional gravel/ sand with silt (80-98)% (2-20)% (0-13)%

Yellowish brown clayey sandy silt with occasional gravel / sandy clayey silt (4-46)% (6-48)% (38-68)% (4-46)%

Brownish grey silty sand with occasional clay and gravel (24-44)% (48-76)% (0-5)% (0-6)%

62 Observed ' N ' Values

U_2^1 2nd undisturbed soil sample of BH 1

Ground Water table has been encountered as on February 2023

COMPILED SOIL PROFILE

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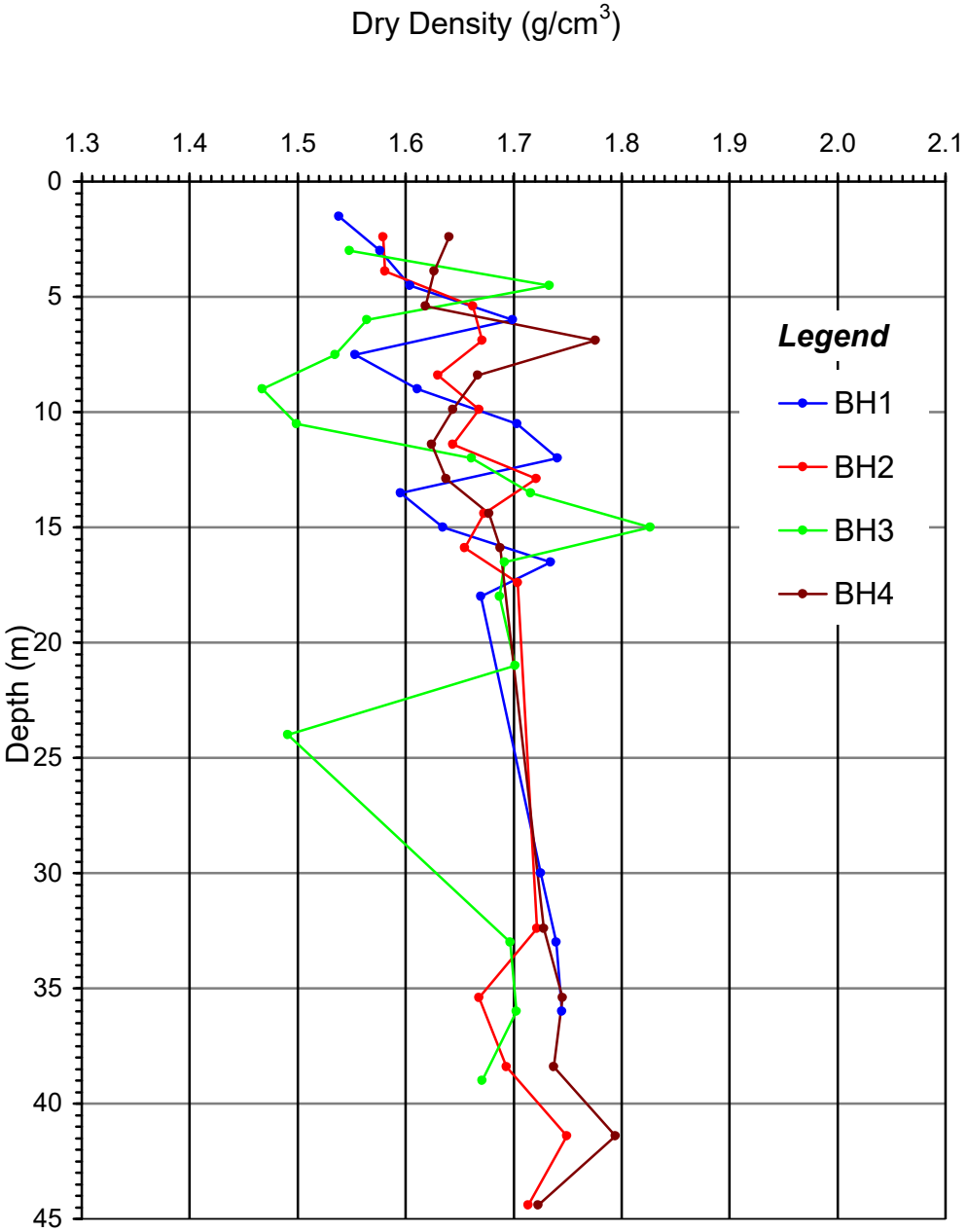
Sheet No: 2



Dry Density vs Depth Curves

(Refer paragraph no. 7.4.2)

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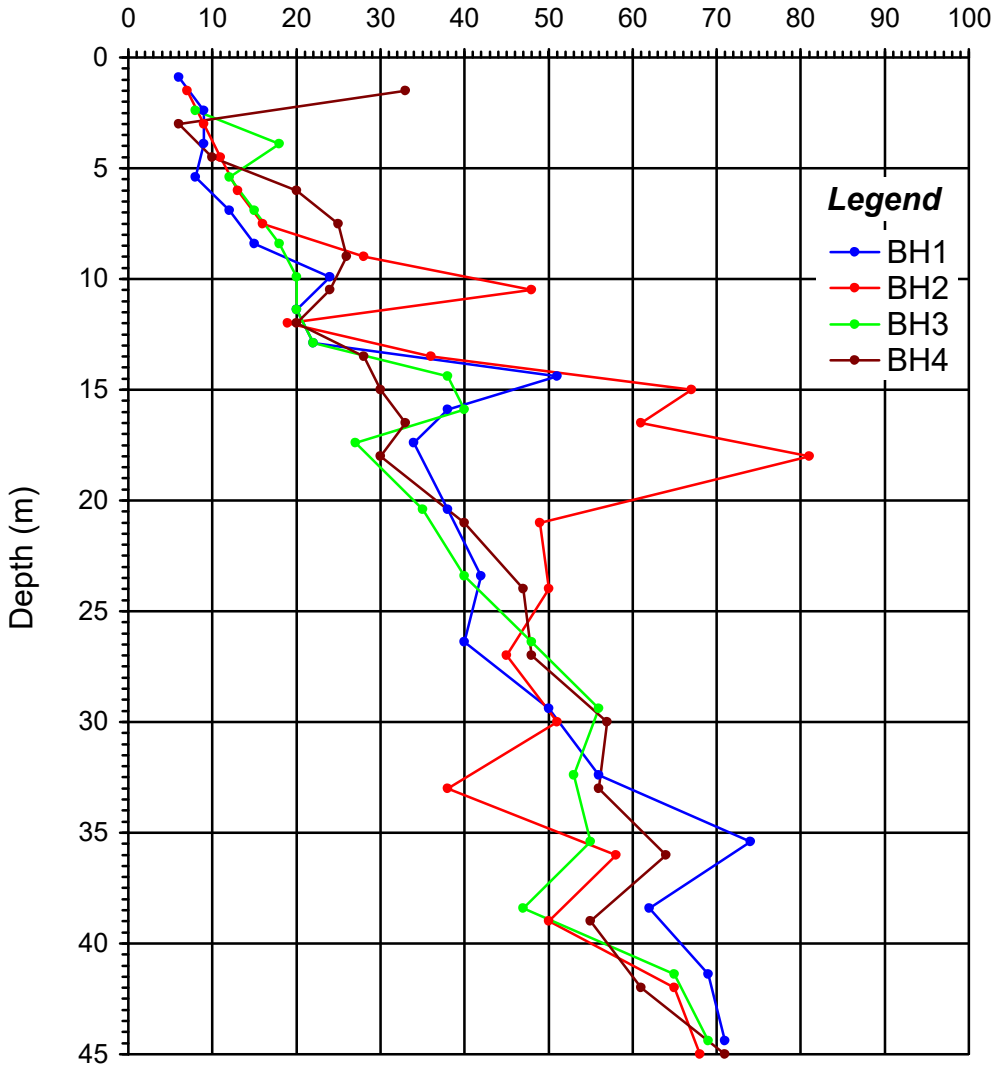
Job No. G(D)4526

N - Values (Observed)



N - Values vs Depth Curves

(Refer paragraph no. 7.6.1)

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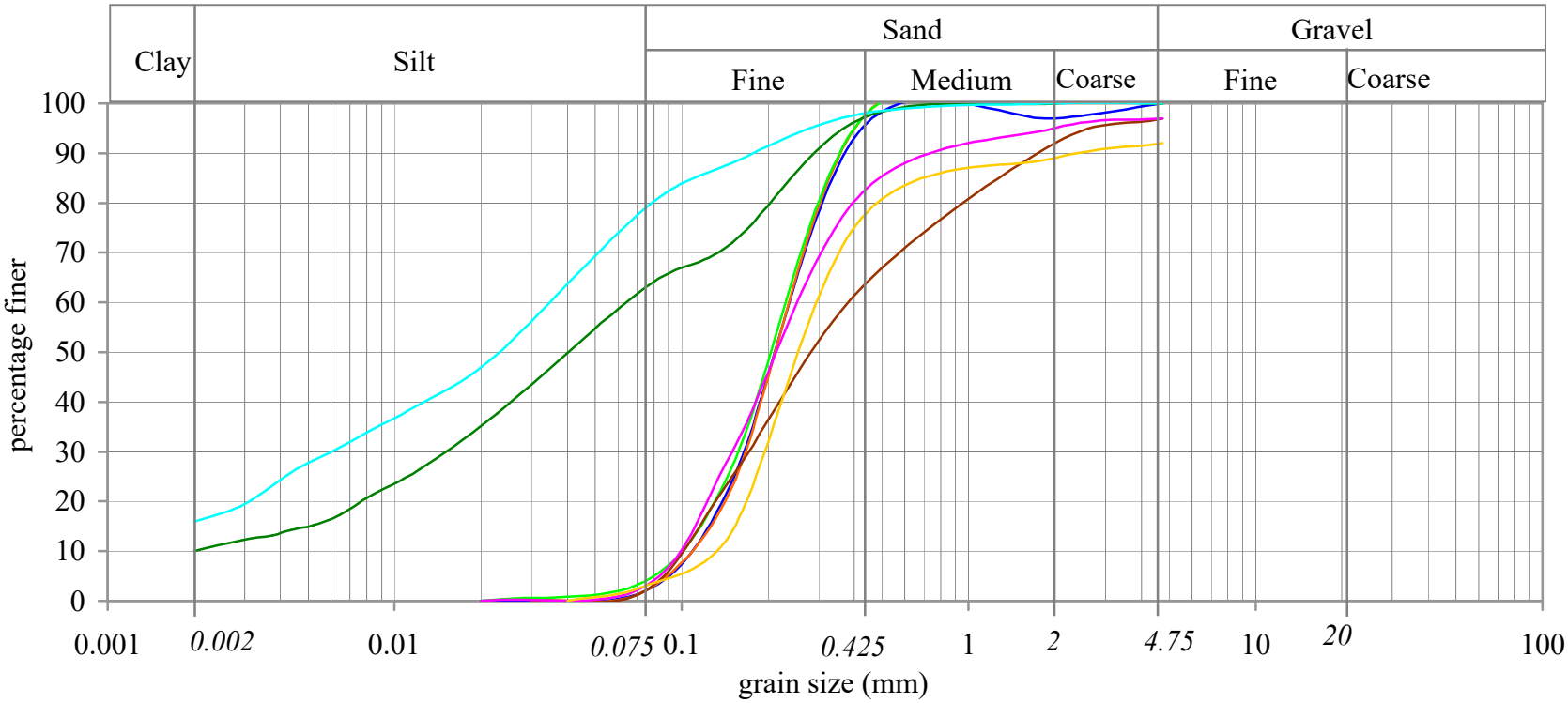
Job No. : G(D)4526

Sheet No. : 5a

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	Sand with traces of silt	0	98	2	0	0.24	0.11	2.2
	1	2.4	Sand with traces of silt	0	98	2	0	0.24	0.12	2.0
	1	3.9	Sand with traces of silt	0	96	4	0	0.23	0.11	2.1
	1	5.4	Sand with traces of silt and gravel	3	95	2	0	0.23	0.12	1.9
	1	6.9	Sand with traces of silt and gravel	3	94	3	0	0.25	0.12	2.1
	1	8.4	Sand with traces of silt and gravel	8	89	3	0	0.29	0.14	2.1
	1	9.9	Clayey sandy silt	0	37	53	10	0.065	0.002	32.5
	1	11.4	Clayey sandy silt	0	21	63	16	0.035	-	-

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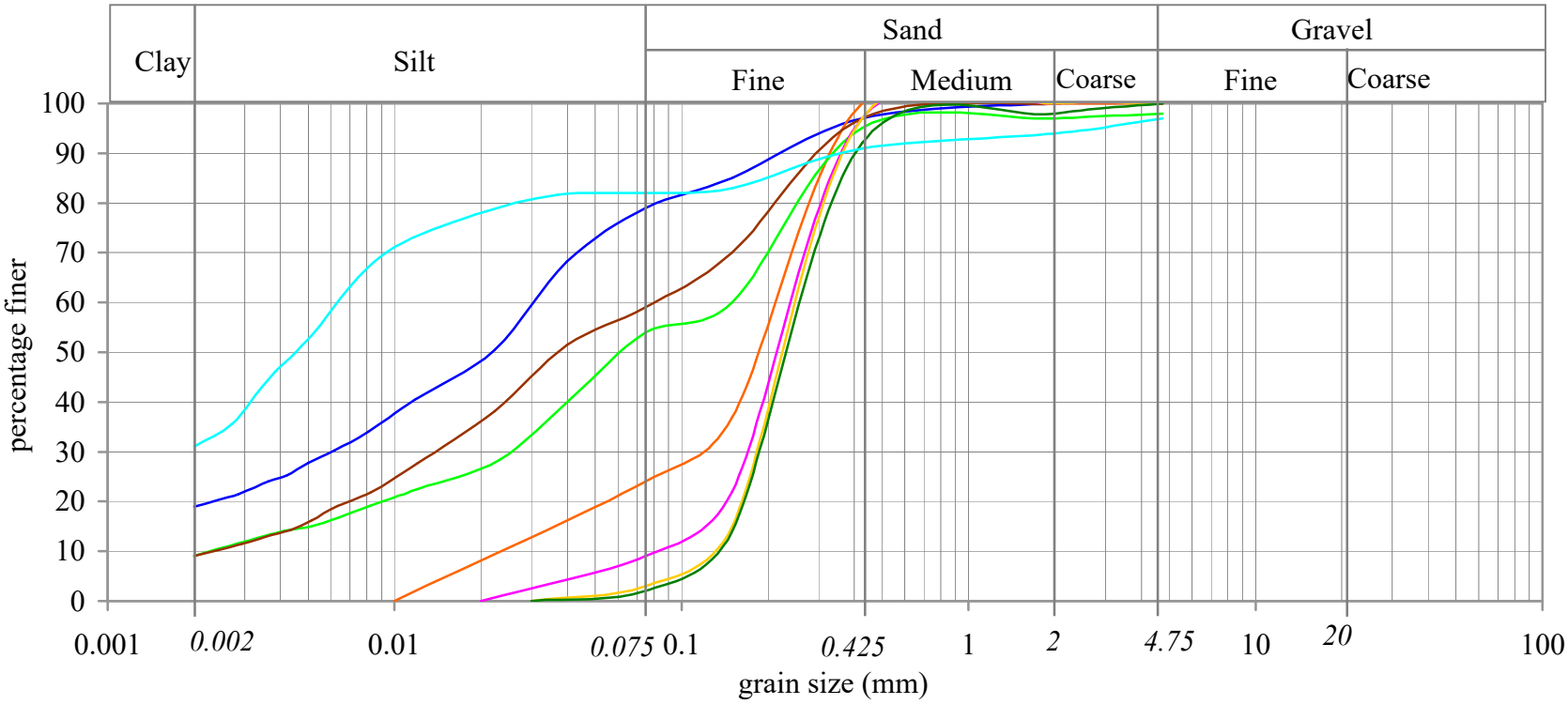
Job No. : G(D)4526

Sheet No. : 5b

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	Clayey sandy silt	0	21	60	19	0.031	-	-
	1	14.4	Silty sand	0	76	24	0	0.22	0.023	9.6
	1	15.9	Clayey sandy silt with gravel	2	44	45	9	0.15	0.0023	65.2
	1	17.4	Clayey sandy silt	0	41	50	9	0.081	0.0024	33.8
	1	20.4	Sand with traces of silt	0	91	9	0	0.25	0.081	3.1
	1	23.4	Sand with traces of silt	0	97	3	0	0.24	0.13	1.8
	1	26.4	Sand with traces of silt	0	98	2	0	0.25	0.14	1.8
	1	29.4	Sandy clayey silt with gravel	3	15	51	31	0.0061	-	-

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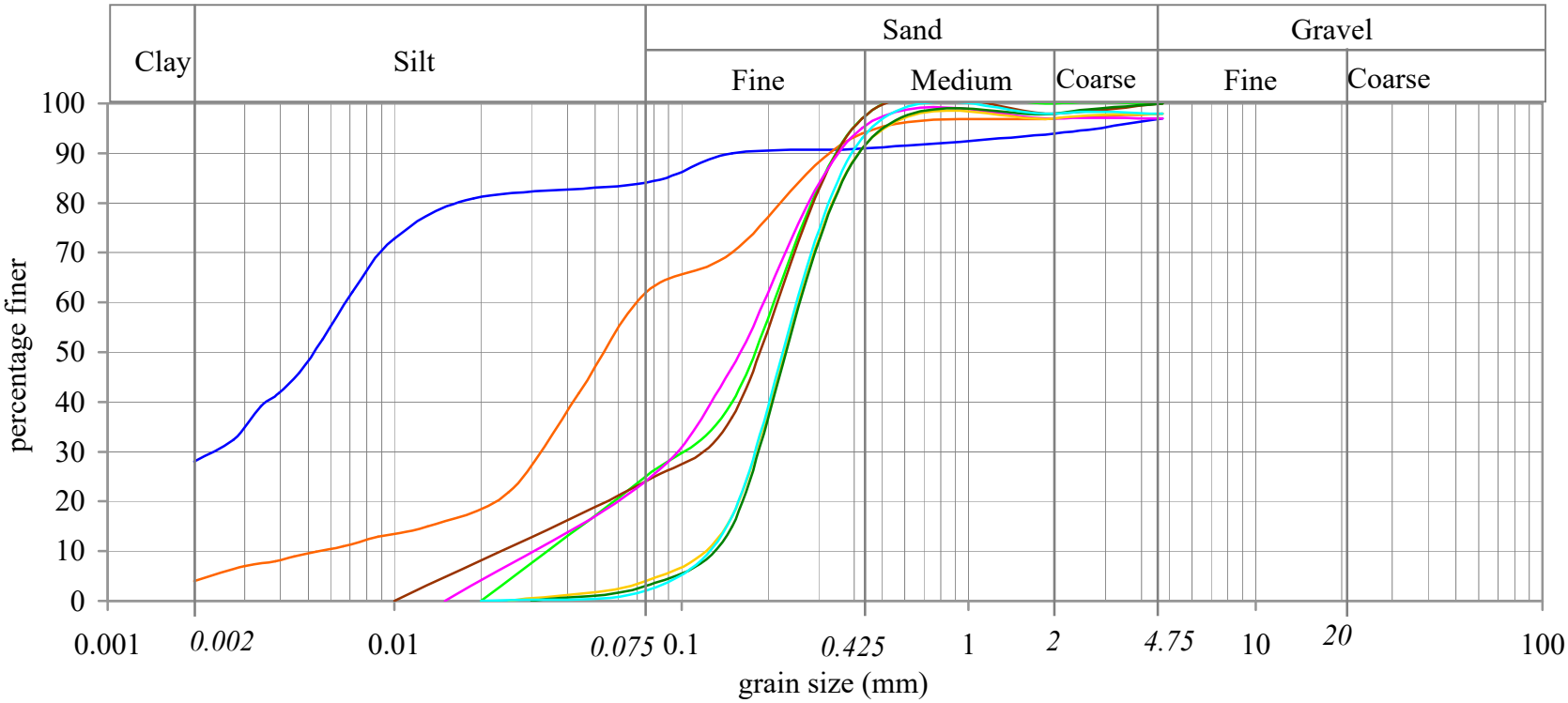
Job No. : G(D)4526

Sheet No. : 5c

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	Sandy clayey silt with gravel	3	13	56	28	0.0067	-	-
	1	35.4	Clayey sandy silt with gravel	2	36	58	4	0.069	0.0051	13.5
	1	38.4	Silty sand	0	75	25	0	0.21	0.032	6.6
	1	41.4	Silty sand	0	76	24	0	0.22	0.023	9.6
	1	44.4	Silty sand with gravel	3	73	24	0	0.19	0.029	6.6
	2	1.5	Sand with traces of silt and gravel	2	94	4	0	0.25	0.13	1.9
	2	3	Sand with traces of silt	0	97	3	0	0.25	0.14	1.8
	2	4.5	Sand with traces of silt and gravel	2	96	2	0	0.24	0.13	1.8

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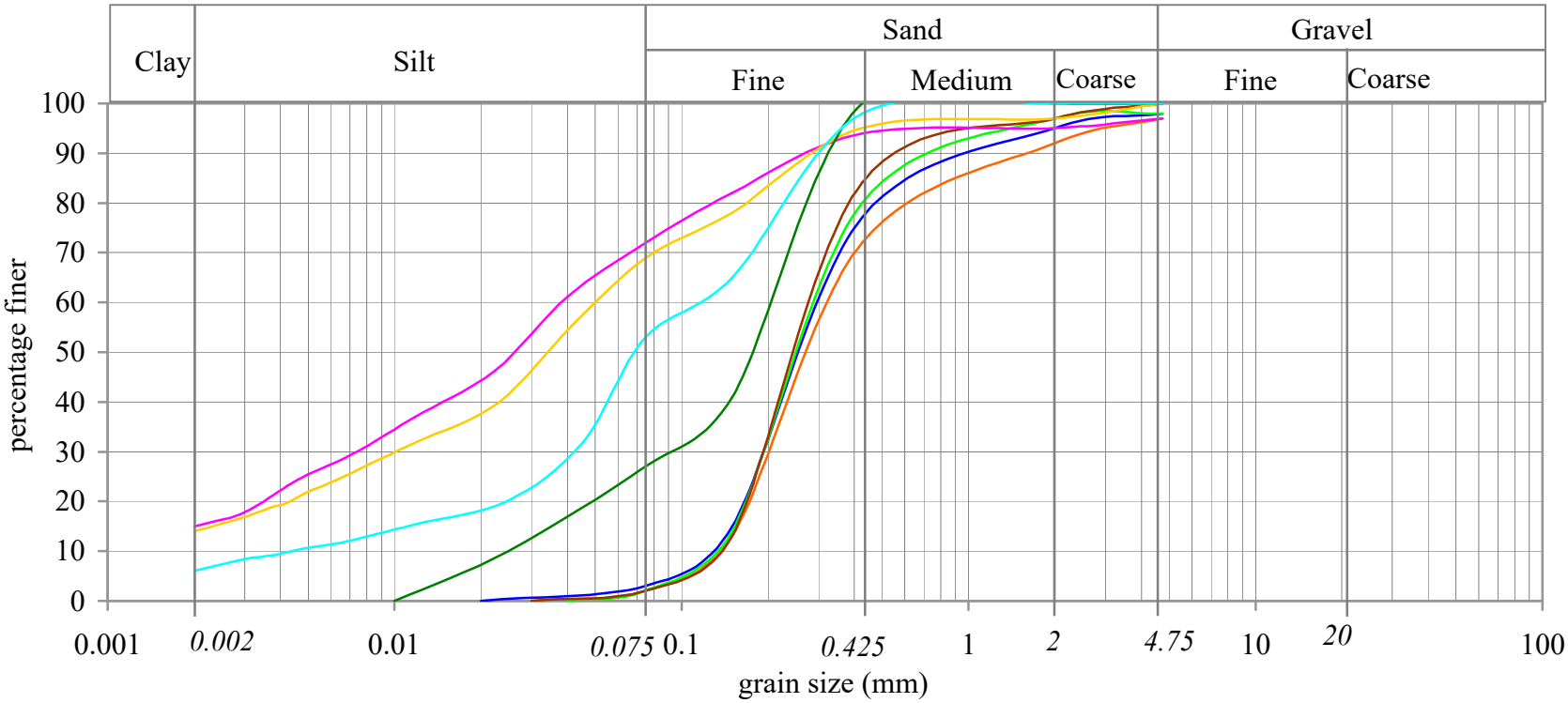
Job No. : G(D)4526

Sheet No. : 5d

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	6	Sand with traces of silt and gravel	2	95	3	0	0.29	0.15	1.9
	2	7.5	Sand with traces of silt and gravel	3	95	2	0	0.32	0.13	2.5
	2	9	Sand with traces of silt and gravel	2	96	2	0	0.28	0.14	2.0
	2	10.5	Sand with traces of silt	0	98	2	0	0.27	0.14	1.9
	2	12	Clayey sandy silt with gravel	3	25	57	15	0.039	-	-
	2	13.5	Clayey sandy silt	0	31	55	14	0.051	-	-
	2	15	Silty sand	0	73	27	0	0.21	0.025	8.4
	2	16.5	Clayey sandy silt	0	47	47	6	0.12	0.0041	29.3

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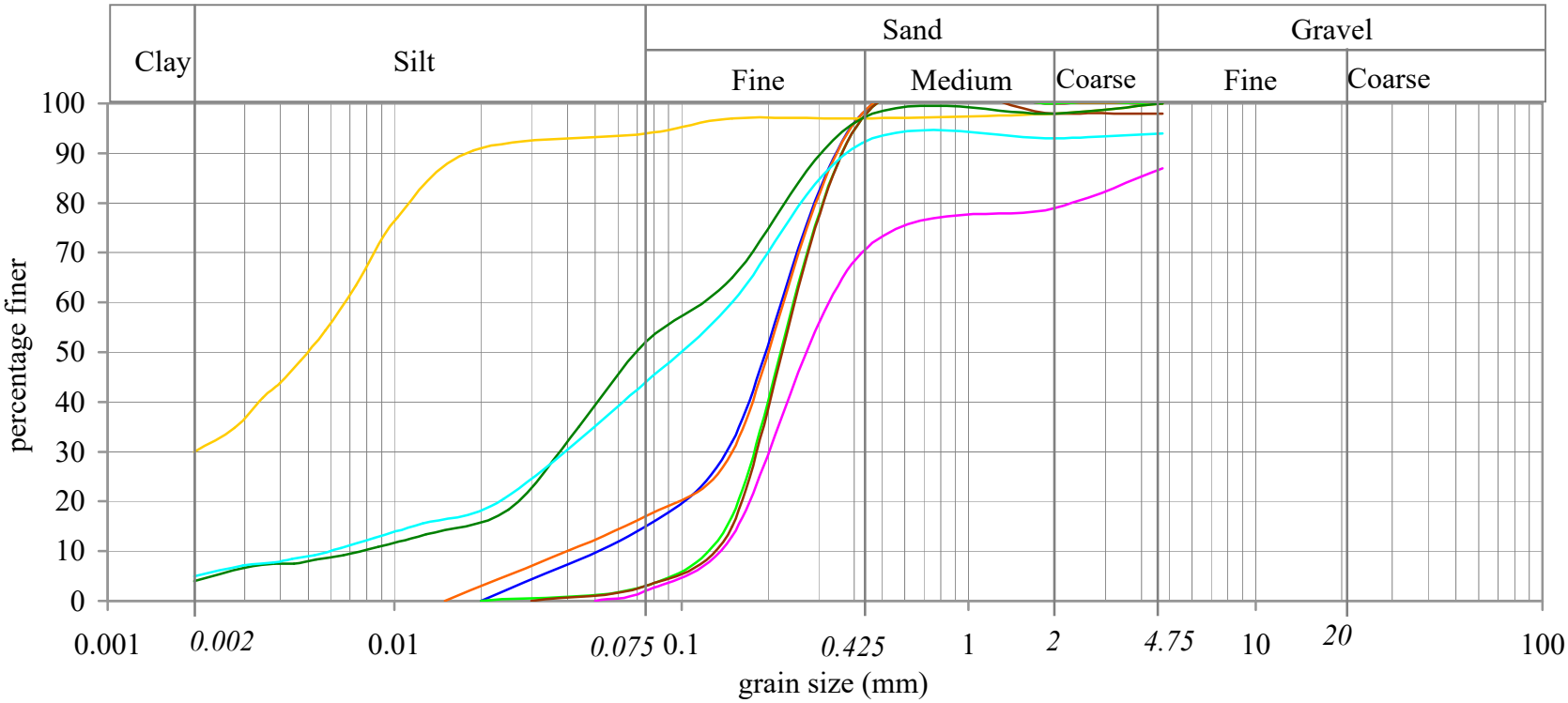
Job No. : G(D)4526

Sheet No. : 5e

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	18	Sand with silt	0	85	15	0	0.23	0.051	4.5
	2	21	Sand with silt	0	83	17	0	0.23	0.039	5.9
	2	24	Sand with traces of silt	0	97	3	0	0.23	0.13	1.8
	2	27	Sand with traces of silt and gravel	2	95	3	0	0.25	0.12	2.1
	2	30	Sand with traces of silt and gravel	13	85	2	0	0.32	0.14	2.3
	2	33	Sandy clayey silt	0	6	64	30	0.0067	-	-
	2	36	Clayey sandy silt	0	48	48	4	0.12	0.0071	16.9
	2	39	Clayey silty sand with gravel	6	50	39	5	0.15	0.0059	25.4

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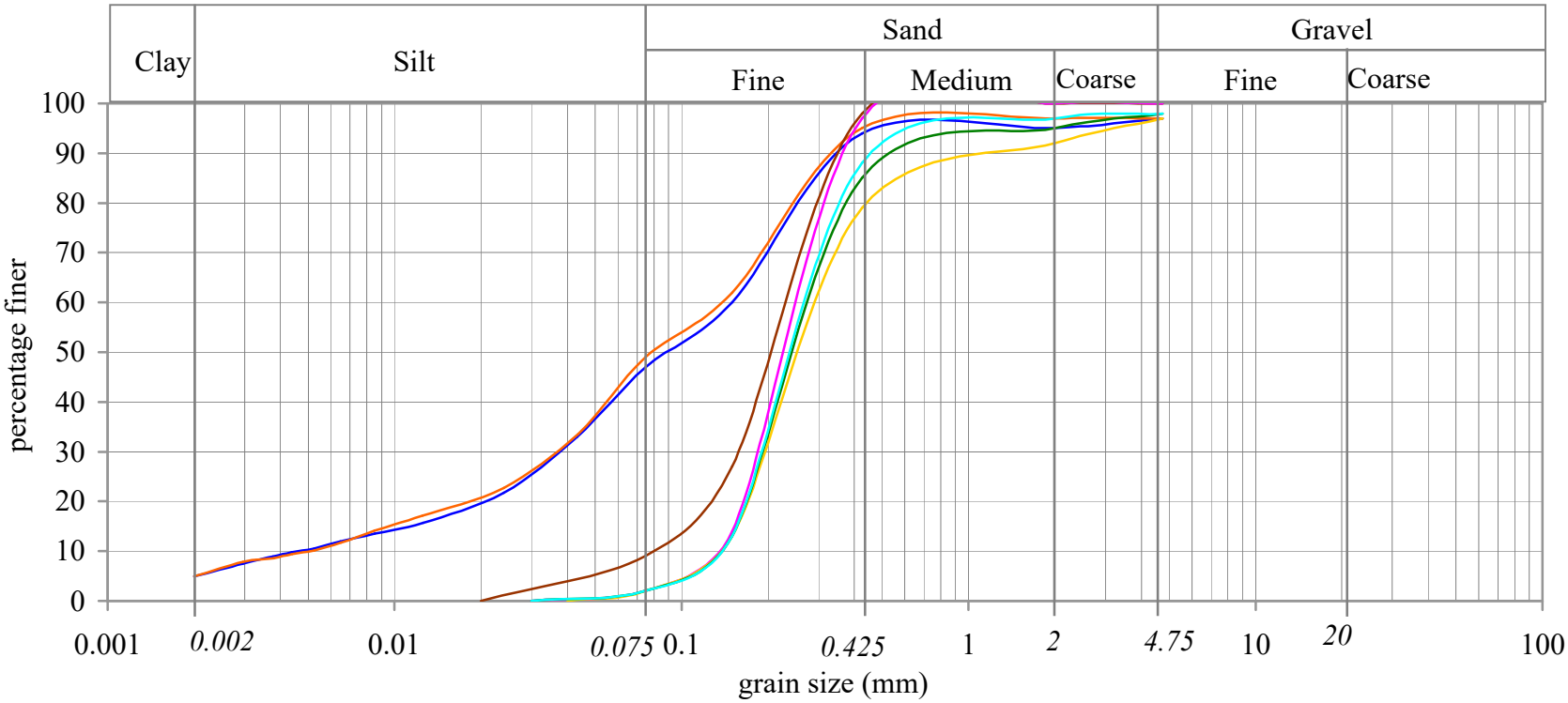
Job No. : G(D)4526

Sheet No. : 5f

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	42	Clayey silty sand with gravel	3	50	42	5	0.15	0.0045	33.3
	2	45	Clayey silty sand with gravel	3	48	44	5	0.14	0.0045	31.1
	3	0.9		100	0	0	0			#DIV/0!
	3	2.4	Sand with traces of silt	0	91	9	0	0.25	0.081	3.1
	3	3.9	Sand with traces of silt	0	98	2	0	0.25	0.14	1.8
	3	5.4	Sand with traces of silt with gravel	3	95	2	0	0.29	0.14	2.1
	3	6.9	Sand with traces of silt with gravel	2	96	2	0	0.27	0.14	1.9
	3	8.4	Sand with traces of silt with gravel	2	96	2	0	0.27	0.14	1.9

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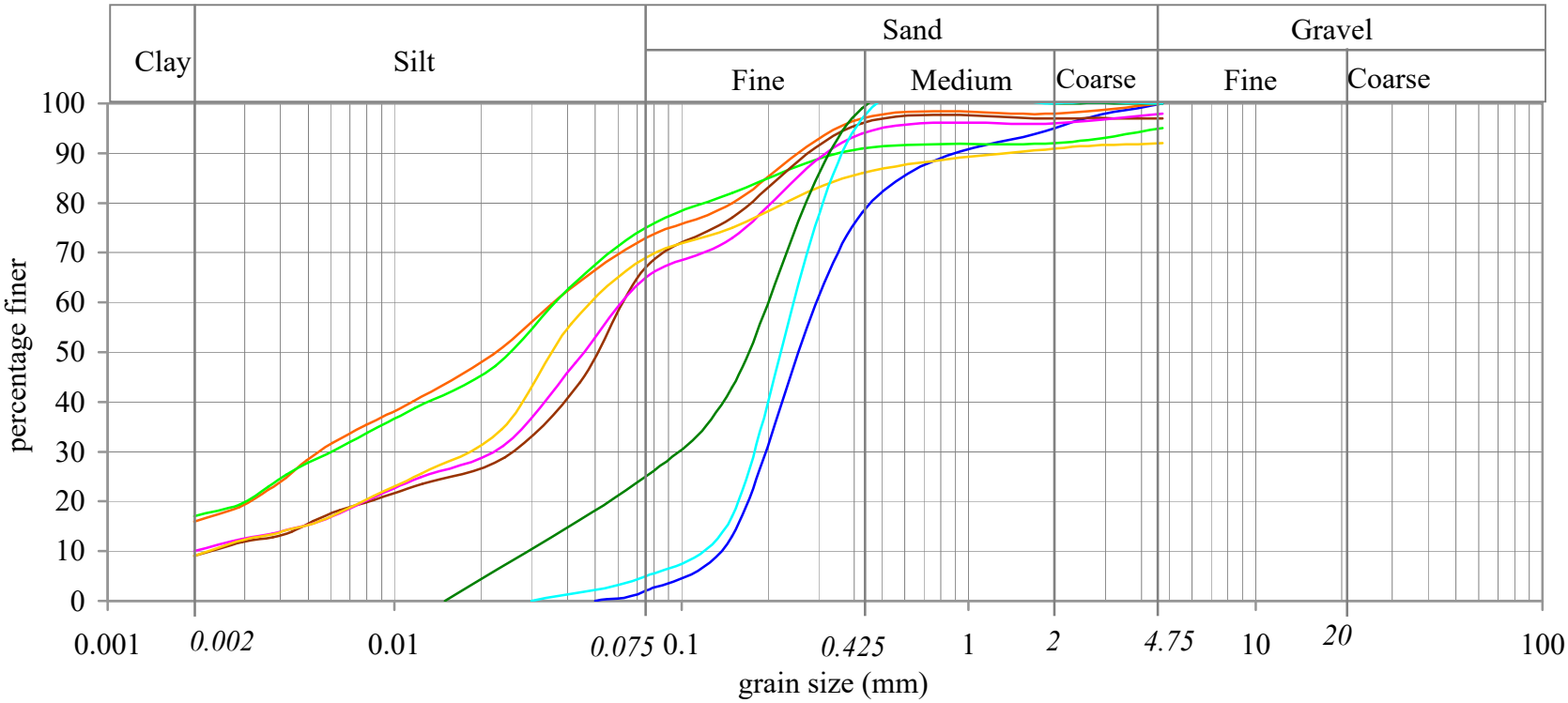
Job No. : G(D)4526

Sheet No. : 5g

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	9.9	Sand with traces of silt	0	98	2	0	0.29	0.15	1.9
	3	11.4	Clayey sandy silt	0	27	57	16	0.035	-	-
	3	12.9	Clayey sandy silt with gravel	5	20	58	17	0.035	-	-
	3	14.4	Clayey sandy silt with gravel	3	30	58	9	0.062	0.0022	28.2
	3	15.9	Clayey sandy silt with gravel	2	33	55	10	0.062	0.002	31.0
	3	17.4	Clayey sandy silt with gravel	8	23	60	9	0.048	0.0022	21.8
	3	20.4	Silty sand	0	75	25	0	0.2	0.029	6.9
	3	23.4	Sand with traces of silt	0	95	5	0	0.25	0.12	2.1

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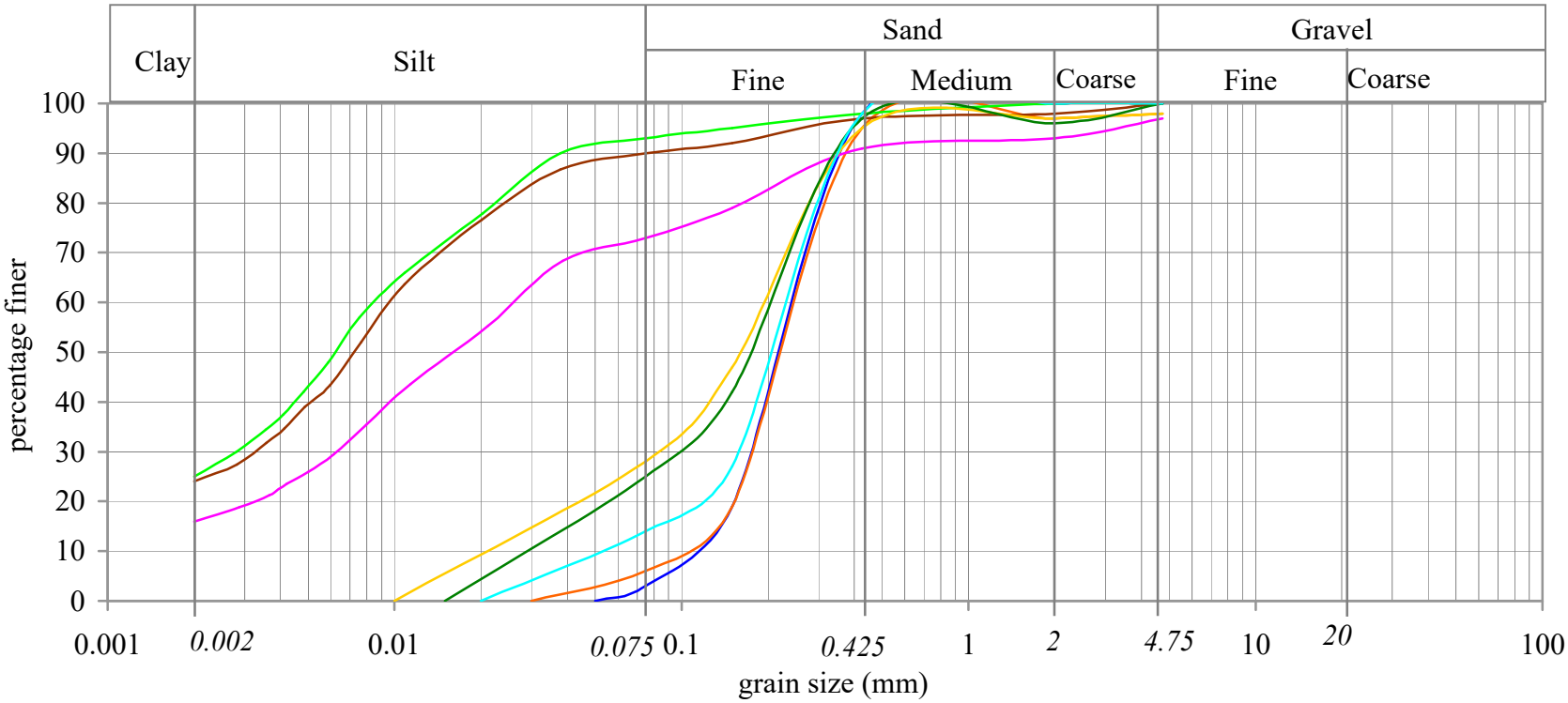
Job No. : G(D)4526

Sheet No. : 5h

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	26.4	Sand with traces of silt	0	97	3	0	0.25	0.12	2.1
	3	29.4	Sand with traces of silt and gravel	2	92	6	0	0.25	0.11	2.3
	3	32.4	Sandy clayey silt	0	7	68	25	0.0071	-	-
	3	35.4	Sandy clayey silt	0	10	66	24	0.0085	-	-
	3	38.4	Clayey sandy silt with gravel	3	24	57	16	0.025	-	-
	3	41.4	Silty sand with gravel	2	70	28	0	0.19	0.021	9.0
	3	44.4	Silty sand	0	75	25	0	0.21	0.029	7.2
	4	1.5	Sand with silt	0	86	14	0	0.25	0.051	4.9

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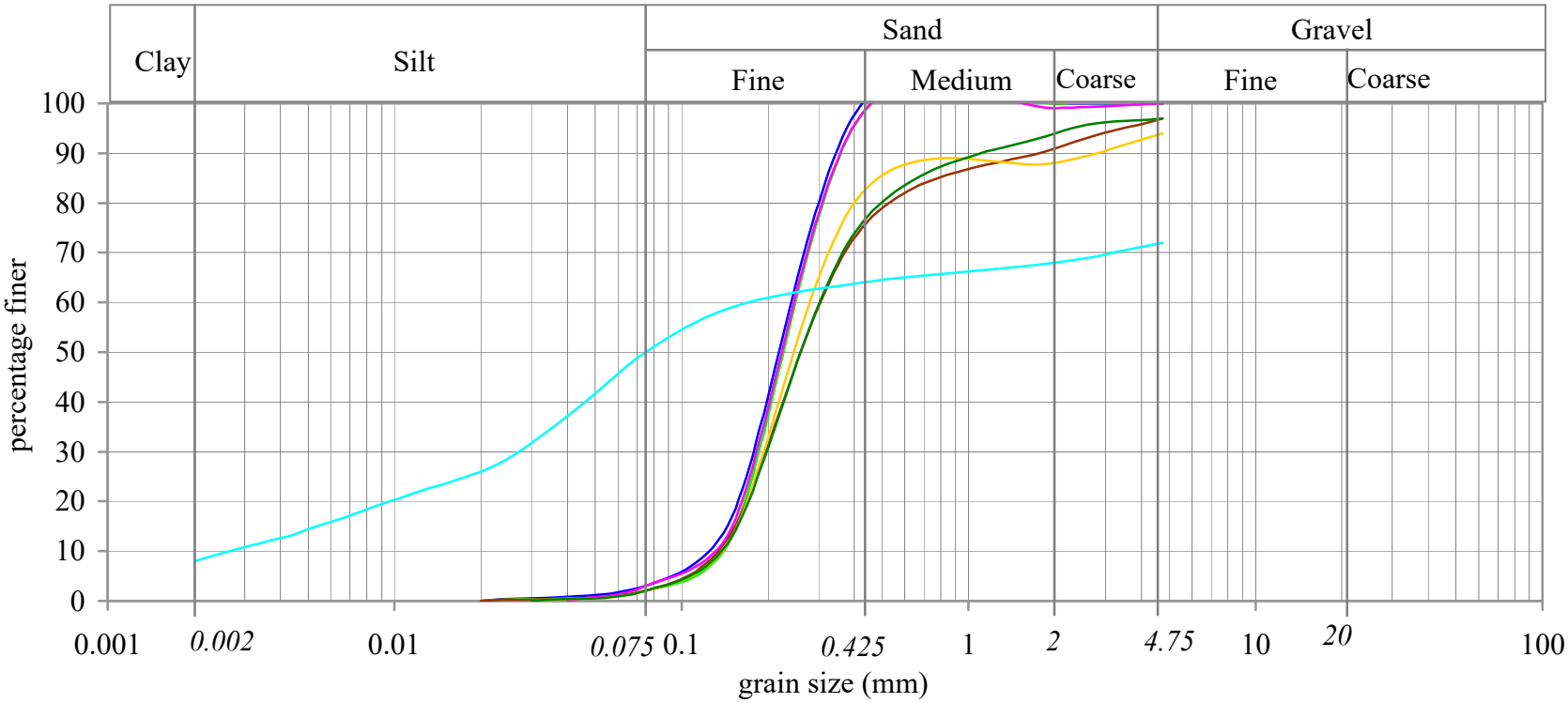
Job No. : G(D)4526

Sheet No. : 5i

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	3	Sand with traces of silt	0	97	3	0	0.24	0.13	1.8
	4	4.5	Sand with traces of silt	0	98	2	0	0.25	0.13	1.9
	4	6	Sand with traces of silt	0	98	2	0	0.31	0.15	2.1
	4	7.5	Sand with traces of silt and gravel	3	95	2	0	0.25	0.14	1.8
	4	9	Sand with traces of silt	0	97	3	0	0.24	0.14	1.7
	4	10.5	Sand with traces of silt and gravel	6	92	2	0	0.28	0.15	1.9
	4	12	Sand with traces of silt and gravel	3	95	2	0	0.24	0.15	1.6
	4	13.5	Clayey sandy silt with gravel	28	22	42	8	0.18	0.0025	72.0

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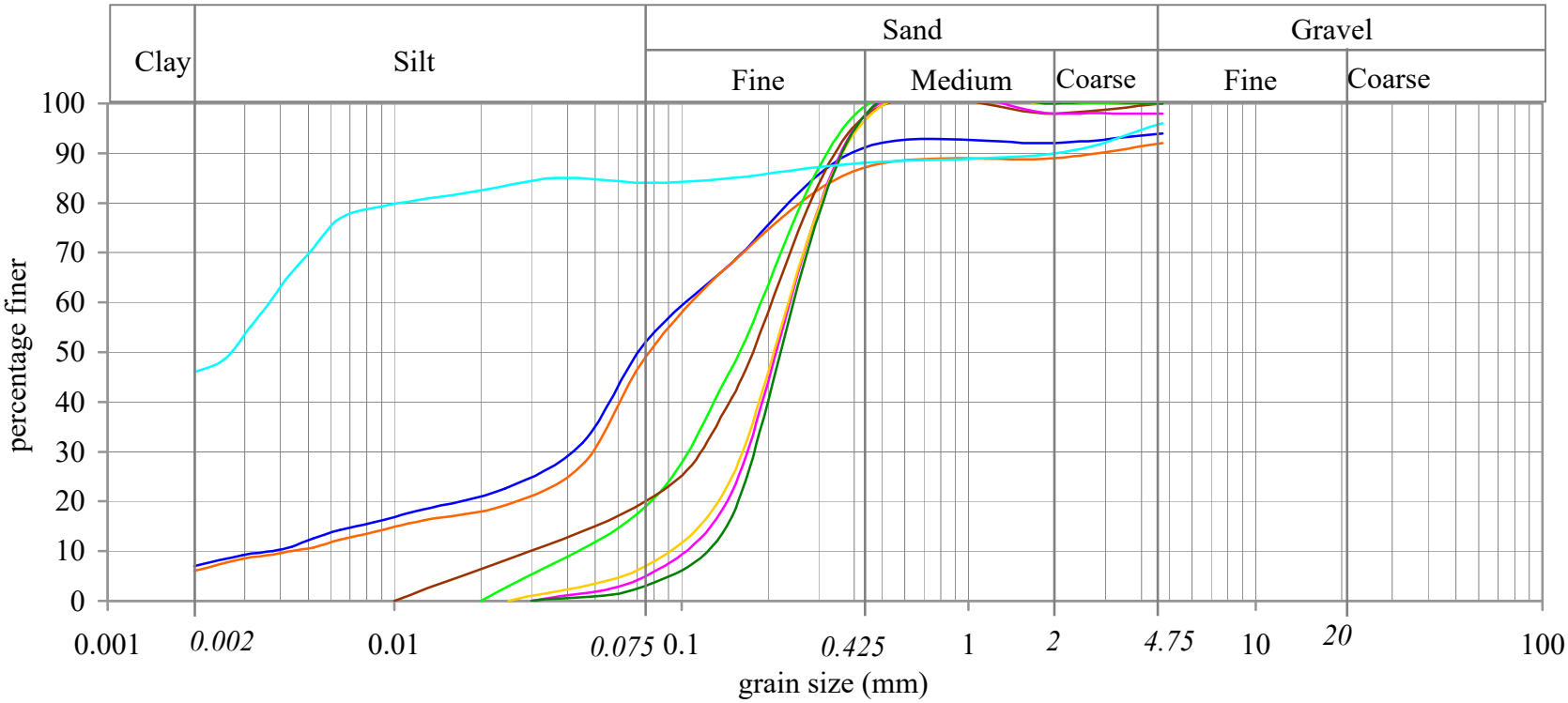
Job No. : G(D)4526

Sheet No. : 5j

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	15	Clayey sandy silt with gravel	6	42	45	7	0.11	0.0035	31.4
	4	16.5	Clayey sandy silt with gravel	8	43	43	6	0.12	0.0039	30.8
	4	18	Sand with silt	0	81	19	0	0.18	0.041	4.4
	4	21	Sand with silt	0	80	20	0	0.21	0.025	8.4
	4	24	Sand with traces of silt and gravel	2	93	5	0	0.25	0.1	2.5
	4	27	Sand with traces of silt	0	93	7	0	0.24	0.091	2.6
	4	30	Sand with traces of silt	0	97	3	0	0.24	0.13	1.8
	4	33	Sandy silty clay with gravel	4	12	38	46	0.0037	-	-

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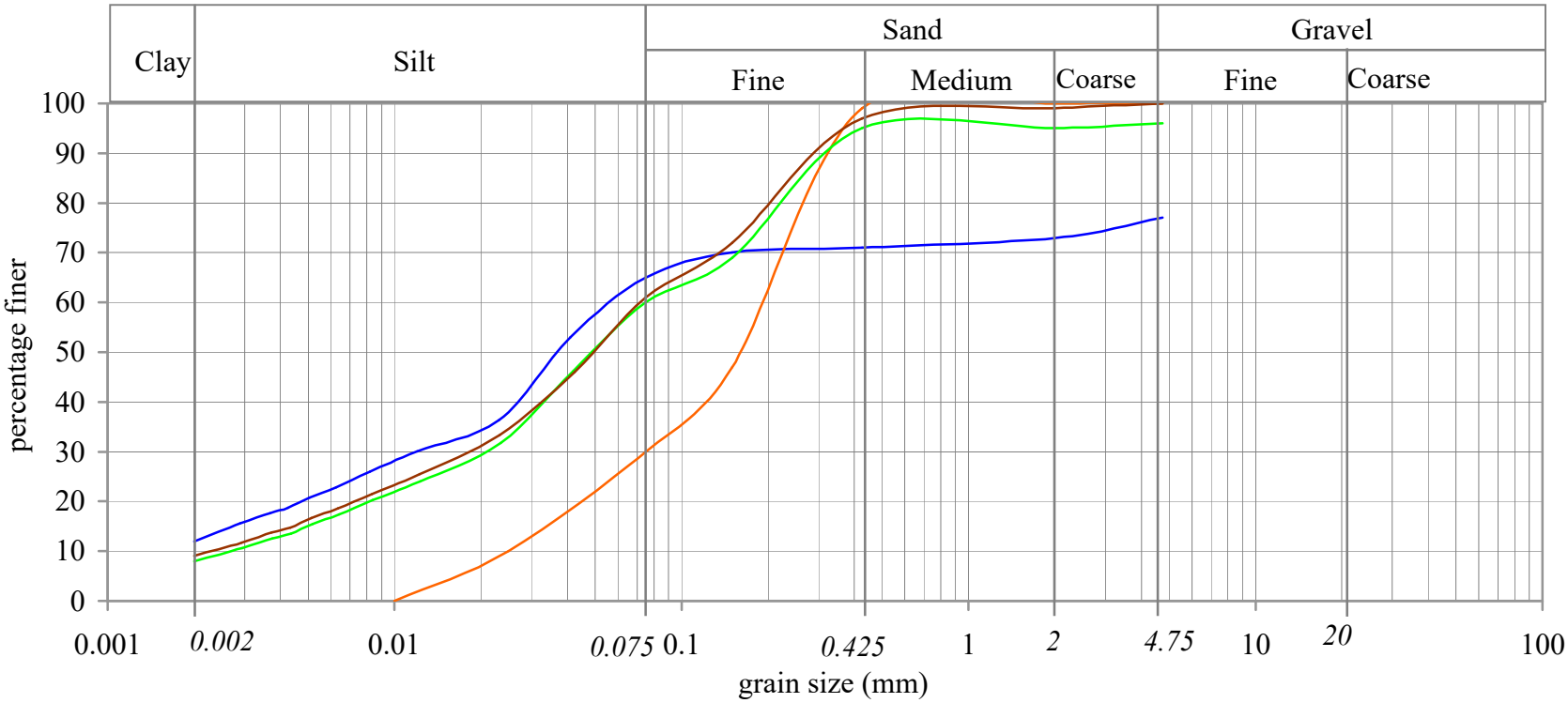
Job No. : G(D)4526

Sheet No. : 5k

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	36	Clayey sandy silt with gravel	23	12	53	12	0.054	-	-
	4	39	Silty sand	0	70	30	0	0.19	0.024	7.9
	4	42	Clayey sandy silt with gravel	4	36	52	8	0.071	0.0026	27.3
	4	45	Clayey sandy silt	0	39	52	9	0.072	0.0025	28.8