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GEOTECHNICAL REPORT FOR

RESIDENTIAL BUILDING AT OTTIYAMBAKKAM VILLAGE, TAMBARAM TALUK, CHENGALPET DISTRICT

Client :

M/s. The Nest.,
Chennai

Architect :

Consultant :

Structural Consultant :

Job No G(C)9918 Date : 28.03.2024

NAGADI CONSULTANTS PRIVATE LIMITED

Branch :

Chennai

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GEOTECHNICAL INVESTIGATION REPORT

for Residential Building at Ottiyambakkam Village, Tambaram Taluk, Chengalpet District

EXECUTIVE SUMMARY

M/s. The Nest, Chennai are proposing to construct a Residential Building at Ottiyambakkam Main Road, Ottiyambakkam Village,Tambaram Taluk,Chenglepet District.

The site for the proposed project is situated at Survey Nos. 259/2A2, 259/2B2, 259/2C2, 259/2D2, 260/2A2 and 260/2B2 in Ottiyambakkam Main Road, Ottiyambakkam Village,Tambaram Taluk, Chenglepet District. The site approximately measures 1.3acres in area. The site is open on all the sides and is undulating with level differences of about 0.5m. The site is lower than the adjacent road by about 1m.

The proposed Residential Building consists of a ground floor and five upper floors.

Geotechnical investigations have been undertaken at the site as per the scope of investigations, stipulated by the client, which consisted of conducting 3 boreholes down to refusal/rock strata (where N-value is >100) and further drilling in refusal/rock strata by minimum 3m depth.

The results of borehole investigations indicate the presence of Grey clayey silty sand with gravel/ sandy silty clay from the existing ground level down to the depths of refusal strata encountered at 4.5/5.5m depth below existing ground level. The refusal strata is in the form of completely weathered rock (Charnockites based) down to the maximum investigated depths of 7.5/8.5m below existing ground level.

The soil strata is in a medium stiff/medium dense state from existing ground level down to the depths of refusal strata encountered between 4.5/5.5m depths below existing ground level.

Ground water table was encountered between -0.1 (i,e above the existing ground level by 0.1m) and 0.3m depth in the boreholes during the period of field investigations.

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In view of the observed subsoil strata conditions, the proposed Residential building can be supported on *Shallow Foundations - Isolated /Strip Footings laid at a minimum depth of 3m below the existing ground level. Net allowable bearing pressure for different widths of foundations are given below:*

Widths of Foundations (m)	***1.5***	***≥3***
Net Allowable Bearing Pressure (t/m²)	*16*	*17*

Alternatively, the Residential Building can be supported on *Bored Pile Foundations*. The safe pile capacities for different diameters of piles are given below:

Diameter of Pile (mm)	***Embedment of Pile in Refusal Strata***	***Safe Pile Capacity (t)***	***Safe Uplift Capacity (t)***
450		*80*	*15*
500	*3D*	*100*	*20*
600		*145*	*30*
450		*105*	*25*
500	*5D*	*130*	*35*
600		*185*	*50*

D-Diameter of Pile

For Shallow Foundations -Isolated/Strip Footings

The excavated soil cannot be used for backfilling purposes as the top soil is predominantly medium swelling type.

After the excavations for the foundations, the foundation surface should be watered for at least 24 hours. The top slush should then be removed and the surface compacted heavily. If any loose pockets are observed, the same shall be filled with brickbats/ gravel and compacted well. Foundations can subsequently be placed over such a prepared surface.

Stiff Tie-beams connecting the columns in both directions may be provided which will render additional rigidity to the structure.

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For Bored Pile Foundations

The bentonite slurry to be used for stabilising the pile bore during piling should conform to the requirements as given in BIS code IS:2911 (Part1/Sec2).

The bottom of the pile bore should be properly cleaned as per the procedure given in the BIS IS:2911 (Part1/Sec2), prior to carrying out the tremie concreting. This is essential to ensure that the end bearing capacity of the pile is fully mobilised.

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REPORT ON GEOTECHNICAL INVESTIGATION FOR RESIDENTIAL BUILDING AT at OTTIYAMBAKKAM VILLAGE, TAMBARAM TALUK, CHENGALPET DISTRICT

1.0 INTRODUCTION

1.1 Overview

1.1.1 M/s. The Nest, Chennai are proposing to construct a Residential Building at Ottiyambakkam Main Road, Ottiyambakkam Village,Tambaram Taluk,Chenglepet District.

1.1.2 The geotechnical investigations have been carried out to ascertain the soil conditions for the design of foundations of the proposed Residential Building.

1.2 Authority

A detailed geotechnical investigations programme has been conducted as per the authorisation by M/s. The Nest, Chennai vide your confirmation mail dated 12.03.2024.

2.0 PROJECT DETAILS

2.1 Site Location

The site for the proposed project is situated at Survey Nos. 259/2A2, 259/2B2, 259/2C2, 259/2D2, 260/2A2 and 260/2B2 in Ottiyambakkam Main Road, Ottiyambakkam Village,Tambaram Taluk, Chenglepet District.

2.2 Site Layout and Topography

2.2.1 The site approximately measures 1.3acres in area. The site is open on all the sides and is undulating with level differences of about 0.5m. The site is lower than the adjacent road by about 1m.

2.2.2 The colour of the exposed soil surface is Brown.

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2.3 The Structure

As per information provided by the client, the proposed Residential Building consists of a ground floor and five upper floors.

2.4 Seismic Zone

Site for the proposed Residential Building is situated in Ottiyambakkam Village, Chennai which falls under Seismic Zone III as per IS 1893 (Part 1) - 2016.

2.5 Geographical Information

2.5.1 Site for the proposed Residential Building is located at:

a) Latitude : 12°51'

b) Longitude : 80°11'

3.0 OBJECT OF INVESTIGATIONS

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

a) Type of foundation system.

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

c) Allowable bearing pressure at the foundations levels.

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

a) The subsoil profile indicating thicknesses of the various soil strata, to a depth down to 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 the strength of the 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.

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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 Scope of investigations as given in the work order consisted of:

a) Conducting 3 boreholes down to refusal strata (where N-value is >100); and further drilling in refusal/rock strata by a minimum of 3m depth, as required by the client.

b) Conducting standard penetration tests at regular intervals.

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

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

e) Conducting relevant laboratory tests on soil samples recovered.

f) Preparation and submission of a technical report containing the details of the tests carried out, their analysis and recommendations regarding the foundation system to be adopted. Two copies of the report are to be submitted.

5.0 FIELD INVESTIGATIONS

5.1 Preliminary Details

5.1.1 The locations of the boreholes were shown at site by the client's representative. A Schematic site plan showing the boreholes locations marked by the client is given in fig. 1.

5.1.2 Weather was clear during the period of field investigations which were carried out in the third week of March 2024.

5.2 Boreholes

5.2.1 The boreholes were progressed by mechanically operated rotary core drill method.

5.2.2 The boreholes were terminated after drilling a minimum of 3m in refusal strata (where

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N-value is >100). The refusal strata in the form of completely weathered rock (Charnockite Based) was encountered at 4.5/5.5m depth and continued down to the termination depths of 7.5/8.5m below existing ground level. The drilling in refusal/rock strata was conducted using NX size core barrel fitted with diamond bits.

5.2.3 The boreholes were to be terminated after drilling a minimum of 3m in refusal/rock strata as per the stipulated scope of work.

5.2.4 The depths at which ground water table was encountered in the boreholes during the period of field investigations, depths at which refusal strata was encountered and termination depths of the boreholes are given below:

BH No.	Depth of Ground Water Table Below EGL (cm)	Depth of Refusal/Rock Strata Below EGL (m)	Termination Depth Below EGL (m)
1	0.30	4.5	7.5
2	-0.10 (above EGL by 0.1m)	5.5	8.5
3	-0.10 (above EGL by 0.1m)	4.5	7.5

5.2.5 Ground water table was encountered between -0.1m (i,e 0.1m above EGL) and 0.3m depth in the boreholes during the period of field investigations.

5.2.6 Standard Penetration Tests were conducted in soil strata at 1.5m depth intervals.

5.2.7 Disturbed soil samples recovered from split spoon sampler were packed in polythene bags, labelled and retained for identification purposes.

5.2.8 Undisturbed soil samples were recovered by thin walled tubes conforming to IS 2132. These tubes had an area ratio of less than 10%. The diameter of soil samples were 50mm and length 45cm.

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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 density

d) Natural water content

e) Shear strength properties

6.2 In order to determine the above properties listed in 6.1, the following tests were conducted.

a) Sieve analysis on the coarse grained soil fraction

b) Hydrometer analysis on the fine grained soil fraction

c) Liquid and plastic limits

d) Natural Density and Water Content tests

e) Triaxial tests

f) Free Swell Index tests

7.0 RESULTS AND ANALYSIS

7.1 Presentation of Results

7.1.1 The results of borehole investigations and of the laboratory investigations conducted on the soil samples collected from the boreholes have been presented in the form of soil profile tables in Table Nos.1 to 3.

7.1.2 The soil profile tables indicate the following:

a) Standard Penetration Test Values (i.e. N- values observed) at various depths

b) Soil description identifying the type of soil

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c) Grain size analysis indicating composition of subsoil

d) Consistency limits

e) In-situ bulk density and Water content

f) Triaxial test results

7.2 Analysis of Soil Profile

7.2.1 A perusal of the data presented in the soil profile tables indicate the presence of the following substrata.

a) Stratum - I : Brown/grey Clayey silty sand with gravel

b) Stratum - II : Grey Sandy silty clay

c) Stratum - III : Brown Clayey silty sand

d) Stratum - IV : Refusal strata - Brown completely weathered rock (Charnockite Based)

7.2.2 The thicknesses in each borehole of each strata described in 7.2.1, are given in the table below:

BH No.	Depth (m) : from - to			
	Stratum - I	Stratum - II	Stratum - III	Stratum - IV
1	0.0 - 4.3	-	-	4.3 - 7.5
2	2.3 - 4	0.0 - 2.3	4 - 5.3	5.3 - 8.5
3	-	0.0 - 2.8	2.8 - 4.3	4.3 - 7.5

7.2.3 The above results- show that :

a) Stratum - I consisting of Brown/grey clayey silty sand with gravel having significant percentages of sand and varying percentages of clay, silt and gravel, has been encountered from ground level/2.3m to 4/4.3m depths below existing ground level only at the locations of boreholes BH1 and BH2.

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b) Stratum - II consisting of Grey sandy silty clay having significant percentages of clay and varying percentages of sand and silt has been encountered from ground level to 2.3/2.8m depths below existing ground level only at the locations of boreholes BH2 and BH3.

c) Stratum - III consisting of Brown clayey silty sand having significant percentages of sand and varying percentages of clay and silt, has been encountered from 2.8/4 down to 4.3/5.3m depths below existing ground level only at the locations of boreholes BH2 and BH3.

d) Stratum - IV consisting of Refusal strata - Brown completely weathered rock - Charnockites based was encountered from 4.5/5.5m down to the termination depths of 7.5/8.5m depths below existing ground level.

7.3 Soil Composition

7.3.1 The grain size distribution of the soil samples at various depths, as determined in the laboratory have been presented in the form of grain size analysis curves in figs. 3a and 3b.

7.3.2 The variations in the grain size distribution - strata wise across the boreholes are as follows:

a) Stratum - I : Brown/grey clayey silty sand with gravel

BH No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	2	44 - 49	29 - 32	20 - 21
2	2	74	14	10

This stratum was not encountered at the location of borehole BH3.

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b) Stratum - II : Grey sandy silty clay

BH No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
2	0	30	31	39
3	0	30	32	38

This stratum was not encountered at the location of borehole BH1.

c) Stratum - III : Brown clayey silty sand

BH No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
2	0	42	30	28
3	0	66	18	16

This stratum was not encountered at the location of borehole BH1

7.3.3 The above results indicate that the soil in :

a) Stratum - I consists of about 10-21% of clay, 14-32% of silt, 44-74% of sand and 2% of gravel.

b) Stratum - II consists of about 30% of sand, 31-32% of silt and 38-39% of clay.

c) Stratum - III consists of about 16-28% of clay, 18-30% of silt and 42-66% of sand.

7.4 In-situ Density and Water Content

7.4.1 The bulk/in-situ bulk densities, water content and dry density obtained from undisturbed soil sample are tabulated below.

BH No.	Depth (m)	In-situ Bulk Density (g/cm^3)	Water Content (%)	Dry Density (g/cm^3)
1	3.5	1.88	13.9	1.65
2	4.5	1.88	15.2	1.63
3	3.5	1.87	15.2	1.62

7.4.2 The above results indicate that the subsoil is in a medium stiff/medium dense state.

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Undisturbed soil samples could not be collected satisfactorily at some depths, as the samples were in a soft/loose state and sampling was done below ground water table level.

7.5 Consistency Limits

7.5.1 The Consistency Limits determined for the soil in Stratum - I (Brown/grey clayey silty sand with gravel) indicate that the liquid limit varies between 29% to 32%, plastic limit varies at 15% and plasticity index varies between 14% to 17 %.

7.5.2 The Consistency Limits determined for the soil in Stratum - II (Grey sandy silty clay) indicate that the liquid limit varies between 49% to 50%, plastic limit varies between 19% and 20% and plasticity index is 30%.

7.5.3 The Consistency Limits determined for the soil in Stratum - III (Brown clayey silty sand) indicate that the liquid limit varies between 24% to 39%, plastic limit varies between 14% and 17% and plasticity index varies between 10% to 22 %.

7.5.4 The Consistency Limits indicate that the soil in :

a) Stratum - I (Brown/grey clayey silty sand with gravel) is low plastic in nature.

b) Stratum - II (Grey sandy silty clay) is high plastic in nature.

c) Stratum - III (Brown clayey silty sand) is low to medium plastic in nature.

7.6 Standard Penetration Tests

7.6.1 Standard Penetration Test values (N-values observed) are presented in the soil profile table nos.1 to 3.

7.6.2 Standard Penetration Test values (N-values observed) have also been presented in form of plots of N-values vs depth in fig. 4.

7.6.3 The N-values indicate that the soil strata encountered down to the depths of refusal strata is in a medium stiff/ medium dense state with observed N-values ranging between

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4 and 19.

7.7 Triaxial Test Results

7.7.1 The cohesion 'c' obtained from consolidated drained triaxial compression test varies between 0.12 to 0.19kg/cm² and the angle of shearing resistance 'ϕ' of the soil varies between 22° & 25°.

7.8 Free Swell Index

7.8.1 The free swell index of the soil samples collected at various depths are given below:

BH No.	Free Swell Index (%) at Depth (m)			
	1	1.5	2.5	3
1	-	16.7	-	15.2
2	48.6	-	10.8	-
3	-	44.3	-	13.9

7.8.2 The above results indicate that the soil strata is predominantly medium swelling in nature. Hence, the excavated soil can be used for backfilling purposes.

7.9 Compiled Soil Profile

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

7.9.2 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 along with the depth at which undisturbed soil samples were collected.

8.0 DESIGN CRITERIA

8.1 Design Parameters

8.1.1 The parameters required for the design of foundation system for the proposed Residential Building are:

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a) Type of foundation to be adopted

b) Depth at which the foundations have to be laid/termination depth of pile

c) Allowable bearing pressure on the soil at the foundation level/ safe pile capacity

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

8.2 Type of Foundations

8.2.1 The type of foundation depends on the following:

a) Subsoil conditions

b) Type of structure

c) Configuration at loading points

d) Loading intensity on each sub-structure/structural element.

8.2.2 As per information provided by the client, the proposed Residential Building consists of a ground floor and five upper floors.

8.2.3 The results of the investigations are shown that the subsoil encountered is in a medium stiff/ medium dense state from existing ground level down to the depths of refusal strata encountered between 4.5/5.5m depth below existing ground level.

8.2.4 In view of the above, *Shallow Foundations - Isolated /Strip Footings* can be adopted for the proposed villas. *Alternatively, Bored Pile foundations* may be adopted.

8.3 Depth of Foundations

8.3.1 The depth at which shallow foundations should be laid will be governed by the following criteria.

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

b) There should be sufficient thickness of soil above the footing/foundations so that the bearing capacity of the soil can be fully mobilised.

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c) Soil below the level of footings/foundations should have the requisite strength to support the anticipated bearing pressures on the foundations without allowing the settlement of footings/foundations to exceed the acceptable limits.

d) Requirements of the type of structure (Residential Building consisting of a ground floor and five upper floors).

8.3.2 The results of the investigations have shown that the soil encountered down to the depths of refusal strata, is in a medium stiff/ medium dense state.

8.3.3 In view of the above factors, shallow foundations of the proposed Residential Building can be made to rest at a minimum depth of *3m below the existing ground level*. The soil available at the founding level will be brown clayey silty sand with/without gravel.

8.4 Allowable Bearing Pressure

8.4.1 Allowable bearing pressure has been evaluated by:

a) Shear failure criteria based on the average soil data

b) Settlement criteria based on the SPT values (N-values)

c) Settlement criteria based on deformation modulus

8.4.2 An allowable settlement of 50mm has been considered to evaluate the allowable bearing pressure for Isolated/Strip Footings.

8.4.3 A water table correction factor of 0.5 has been considered.

8.4.4 On the basis of the above analysis, *net allowable bearing pressure for various widths of foundations are given below:*

Widths of Foundations (m)	***1.5***	***≥3***
Net Allowable Bearing Pressure (t/m²)	*16*	*17*

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8.5 Depth of Pile Foundations

8.5.1 To ensure similarity of settlement of all the pile foundations for the proposed Residential building, the pile foundations should be founded in the refusal/rock strata.

8.5.2 As the pile foundations will be founded in refusal/rock strata, to achieve economy as well as maximum efficacy, the pile foundations should preferably be loaded to the safe structural capacity.

8.5.3 To ensure the mobilization of the full safe structural capacity, the Bored Piles should be embedded or socketed in refusal/completely weathered rock strata to a minimum depth equivalent to 5 times the diameter of the pile.

8.5.4 Alternatively, the Bored Piles with lower pile capacities can also be adopted when the piles are embedded or socketed in refusal/completely weathered rock strata to a minimum of 3 times the diameter of pile.

8.6 Pile Capacities

8.6.1 The safe pile capacities and safe uplift capacities for different diameters of piles are given below:

Diameter of Pile (mm)	*Embedment of Pile in Refusal Strata*	*Safe Pile Capacity (t)*	*Safe Uplift Capacity (t)*
450		*80*	*15*
500	*3D*	*100*	*20*
600		*145*	*30*
450		*105*	*25*
500	*5D*	*130*	*35*
600		*185*	*50*

D-Diameter of Pile

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9.0 *RECOMMENDATIONS*

9.1 Type of Foundations

a) *Shallow Foundations - Isolated/Strip Footings OR*

b) *Bored Pile Foundations*

9.2 Depth of Foundations

Minimum 3m below the existing ground level

9.3 Allowable Bearing Pressure

Net allowable bearing pressure for various widths of foundations for an allowable settlement of 50mm.

Widths of Foundations (m)	***1.5***	***≥3***
Net Allowable Bearing Pressure (t/m²)	*16*	*17*

9.4 Pile Capacities

Safe pile capacities for different diameters are given below :

Diameter of Pile (mm)	***Embedment of Pile in Refusal Strata***	***Safe Pile Capacity (t)***	***Safe Uplift Capacity (t)***
450		*80*	*15*
500	*3D*	*100*	*20*
600		*145*	*30*
450		*105*	*25*
500	*5D*	*130*	*35*
600		*185*	*50*

D-Diameter of Pile

9.5 Construction Advisories

9.5.1 The soil of each strata has been described with name, colour etc. During excavation, any

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variations observed in the nature and condition of the soil from those given in this Report should be noted and appropriate action should be taken.

9.5.2 *For Shallow Foundations -Isolated/Strip Footings*

9.5.2.1 The excavated soil cannot be used for backfilling purposes as the top soil is predominantly medium swelling type.

9.5.2.2 After the excavations for the foundations, the foundation surface should be watered for at least 24 hours. The top slush should then be removed and the surface compacted heavily. If any loose pockets are observed, the same shall be filled with brickbats/ gravel and compacted well. Foundations can subsequently be placed over such a prepared surface.

9.5.2.3 Stiff Tie-beams connecting the columns in both directions may be provided which will render additional rigidity to the structure.

9.5.3 *For Bored Pile Foundations*

9.5.3.1 The bentonite slurry to be used for stabilising the pile bore during piling should conform to the requirements as given in BIS code IS:2911 (Part1/Sec2).

9.5.3.2 The bottom of the pile bore should be properly cleaned as per the procedure given in the BIS IS:2911 (Part1/Sec2), prior to carrying out the tremie concreting. This is essential to ensure that the end bearing capacity of the pile is fully mobilised.

9.6 Appendices

9.6.1 The calculations for the allowable bearing pressure have been provided in Appendix-A of this report.

9.6.2 The typical analysis of the capacity of piles has been given in Appendix-B of this report.

9.6.3 The List of IS codes referred for providing the recommendations and that which might be required to implement the same have been given in Appendix-C of this report.

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9.7 Notes

9.7.1 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.

9.7.2 The entire report should be studied before adopting the recommendations given in the report.

10.0 LIMITATIONS

This Geotechnical investigation has been carried out at locations in the site chosen by the client as representing the entire site. The recommendations provided in this Report are hence valid only for those test locations. However, if there is any change in the subsoil conditions and properties at places between or beyond the chosen test locations, Nagadi may be contacted for further actions. Fresh investigations will have to be carried out at such locations.

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ANALYSIS FOR ALLOWABLE BEARING PRESSURE

Data

(i) Soil Properties :

c (kg/cm^2) = 0.19 $\phi = 22^\circ$ γ (g/cm^3) = 1.9

(ii) Depth of Foundation, D (m) = 3

(iii) Allowable Settlement, s (mm) = 50

Shear Failure Criterion (Ref. IS : 6403)

N_c = 13.95 (1G+1L) N_q = 5.89 (1G+1L) N_γ = 4.90 (1G+1L) R_w = 0.50 R_w' = 0.50

$$q_s = \frac{1}{2.5}\left(c \cdot N_c + \gamma \cdot D \cdot N_q \cdot R_w + 0.5 \cdot \gamma \cdot B \cdot N_\gamma \cdot R'_w\right) - \gamma \cdot D \cdot R_w$$

B (m)	1.5	≥3
q_s (t/m^2)	15.9	17.3

Settlement Criterion (Ref. IS : 8009)

(i) From N Values

B (m)	1.5	≥3
H (m)	2.5	2.5
N_{av}	57	69
q_a (t/m^2)	67.3	69.1

(ii) From Triaxial Compression Tests : $q_a = \dfrac{s \cdot E}{0.7 \cdot H}$

B (m)	1.5	≥3
H (m)	2.5	2.5
E (kg/cm^2)	85	110
q_a (t/m^2)	24.2	31.4

ADOPT	**B (m)**	**1.5**	**≥3**
	q (t/m^2)	**16**	**17**

Note : q_s and q_a are NET VALUES, Weight of backfill etc. need not be added to the loading except in case of filling above original G.L.

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TYPICAL CALCULATIONS OF PILE CAPACITIES

Typical calculations for the pile capacity has been given hereunder for a pile of diameter 500mm. For piles of other diameters, a similar procedure has been used to arrive at the recommended pile capacities.

A.1 Pile Capacity

A.1.1 As per IS 2911 (Part 1/sec 2):2010, the safe pile capacity or the allowable load on the pile is calculated using the formula given below :

$Q_a = C_{u1}N_c.\pi B^2/4F_s + \alpha c_{u2}.\pi BL/F_s$

Where, c_{u1} = shear strength of rock below the base of the pile, in kN/m²

= 1000kN/m² (as per fig 3 of IS 2911 (Part I/Sec 2)-2010)

N_c = bearing capacity factor taken as 9;

F_s = factor of safety usually taken as 3;

α = 0.9 (recommended value);

c_{u2} = average shear strength of rock in the socketed length of pile, in kN/m²

= 600kN/m² (as per fig 3 of IS 2911 (Part I/Sec 2)-2010)

B = minimum width of pile shaft (diameter in case of circular piles), in m

= 0.5m

L = socket length of pile, in m = 5 x 0.5 = 2.5m.

A.1.2 Substituting the values in the above equation we get,

Q_a = 58.9t + 70.68t

= 129.6t

A.1.3 Therefore, adopt ***Safe Pile Capacity = 130t***

A.2 Uplift Capacity

A.2.1 The safe uplift capacity is calculated based on the safe skin friction capacity of the pile in uplift using the formula given below :

$Q_{au} = \alpha c_u.\pi BL/F_s$

where α = 0.9 (recommended value);

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c_u	=	average shear strength of rock in the socketed length of pile, in kN/m²
	=	600kN/m² (as per fig 3 of IS 2911 (Part I/Sec 2)-2010)
B	=	minimum width of pile shaft (diameter in case of circular piles)=0.5m
L	=	socket length of pile, in m = 5 x 0.5 = 2.5m.
F_s	=	factor of safety usually taken as 6

A.2.2 Substituting the values in the above equation we get Q_a = 35.3t.

A.2.3 Therefore adopt ***Safe Uplift Capacity = 35t***

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LIST OF IS CODES

Field Investigation

1. IS : 1498 - 1970 : Classification and identification of soils for general engineering purposes (First Revision) (Amendment 2)
2. IS : 1892 - 1979 : Code of practice for sub surface investigations for foundations (First revision)
3. IS : 2131 - 1981 : Method of Standard Penetration Tests for soils (First revision)
4. 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 - 1985 (Part 5) : Method of test for soils : Determination of liquid and plastic limit (Second revision)
7. IS : 2720 - 1977 (Part 40) : Methods of tests for soils: Determination of free swell index of soils.

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)
5. IS 2911 (Part I to IV) : Design and construction of Pile Foundations.

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TABLES

NAGADI

SOIL PROFILE

Project: Residential Building at Ottiyambakkam Village,Tambaram Taluk,Chenglepet District

B. H. Location: | Water Table: 0.30cm | Term. Depth : 7.5m | B.H. No. : 1

N - Value#	Depth (m)	Soil Description	Grain Size Analysis: Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Atterberg Limits: Liquid (%)	Plastic (%)	In-situ properties: Density * (g/cm³)	Water Cont (%)	Triaxial Test: Type	c (kg/cm²)	Φ (°)
	0.0	Ground level											
6	1.5	Grey clayey silty sand with gravel	2	44	32	21	32	15					
	2.0	Grey clayey silty sand with gravel							Soft sample				
11	3.0	Brown clayey silty sand with gravel	2	49	29	20	29	15					
	3.5	Brown clayey silty sand with gravel							1.88	13.9	CD	0.12	25
	4.3	Change of strata											
>100 (147/32cm)	4.5	Brown weathered rock (Charnockites based)											
>100 (160/10cm)	6.0	Brown weathered rock (Charnockites based)											
>100 (39/12cm)	7.5	Brown weathered rock (Charnockites based)											

*-Natural Bulk Density # -N Values (Observed)

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Sheet No. : 1

SOIL PROFILE

Project: Residential Building at Ottiyambakkam Village,Tambaram Taluk,Chenglepet District

B. H. Location: | Water Table: 0.10cm | Term. Depth : 8.5m | B.H. No. : 2

N - Value#	Depth (m)	Soil Description	Grain Size Analysis: Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Atterberg Limits: Liquid (%)	Plastic (%)	In-situ properties: Density* (g/cm³)	Water Cont (%)	Triaxial Test: Type	c (kg/cm²)	Φ (°)
	0.0	Ground level											
4	1.0	Grey sandy silty clay	0	30	31	39	50	20					
	1.5	Grey sandy silty clay							Soft sample				
	2.3	Change of strata											
10	2.5	Brown clayey silty sand with gravel	2	74	14	10	-	NP					
	3.0	Brown clayey silty sand with gravel							Sample slipped				
19	4.0	Brown clayey silty sand	0	42	30	28	39	17					
	4.5	Brown clayey silty sand							1.88	15.2	CD	0.19	22
	5.3	Change of strata											
100 (143/35cm)	5.5	Brown weathered rock (Charnockites based)											
100 (97/18cm)	7.0	Brown weathered rock (Charnockites based)											
	8.5	Brown weathered rock (Charnockites based)											

*-Natural Bulk Density # -N Values (Observed)

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Sheet No. : 2

SOIL PROFILE

Project: Residential Building at Ottiyambakkam Village,Tambaram Taluk,Chenglepet District

B. H. Location: | Water Table: 0.10cm | Term. Depth : 7.5m | B.H. No. : 3

N - Value#	Depth (m)	Soil Description	Grain Size Analysis: Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Atterberg Limits: Liquid (%)	Plastic (%)	In-situ properties: Density * (g/cm³)	Water Cont (%)	Triaxial Test: Type	c (kg/cm²)	Φ (°)
	0.0	Ground level											
4	1.5	Grey sandy silty clay	0	30	32	38	47	19					
	2.0	Grey sandy silty clay							Soft sample				
	2.8	Change of strata											
12	3.0	Brown clayey silty sand	0	66	18	16	24	14					
	3.5	Brown clayey silty sand							1.87	15.2	CD	0.12	25
	4.3	Change of strata											
>100 (132/40cm)	4.5	Brown weathered rock (Charnockites based)											
>100 (97/18cm)	6.0	Brown weathered rock (Charnockites based)											
>100 (50/5cm)	7.5	Brown weathered rock (Charnockites based)											

*-Natural Bulk Density # -N Values (Observed)

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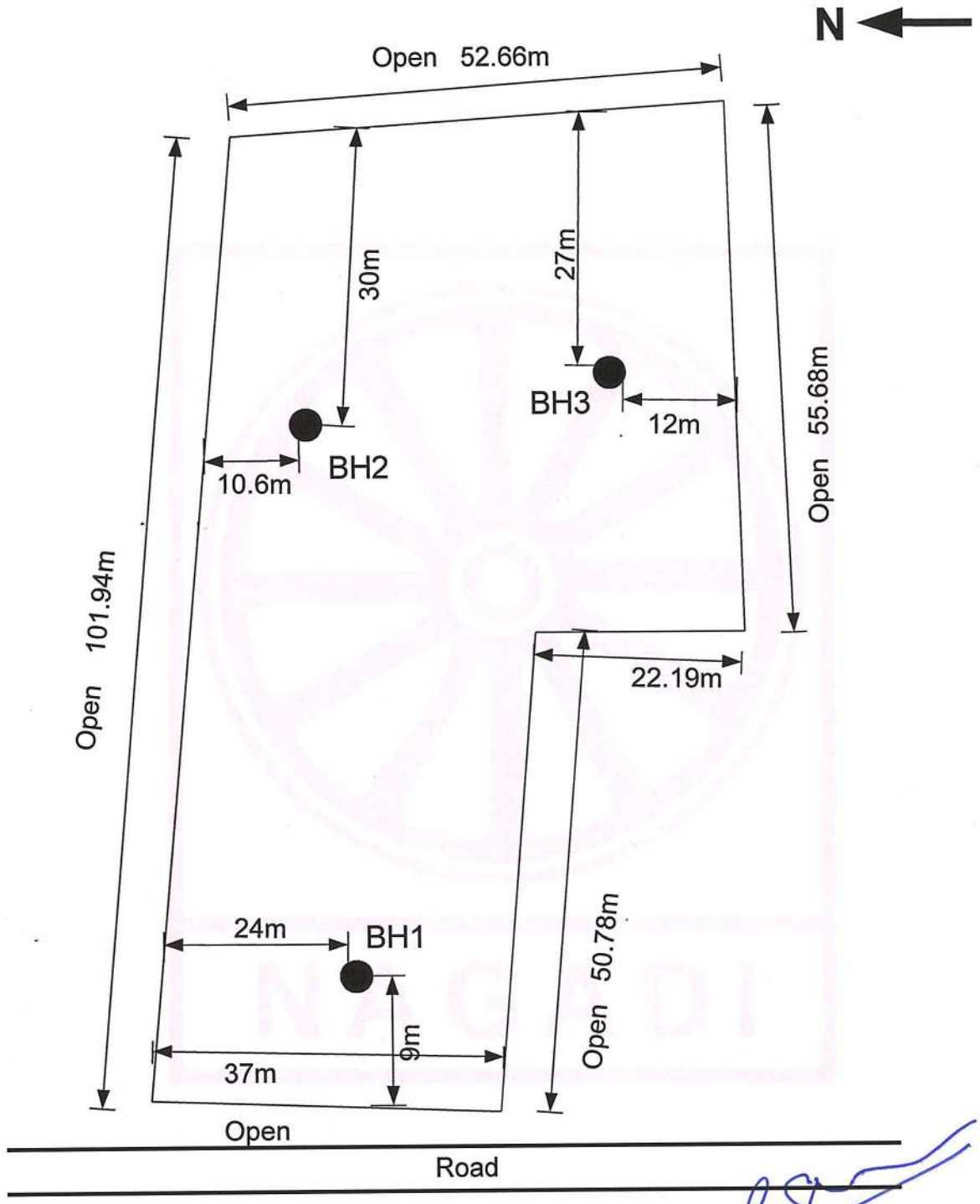
FIGURES



LEGEND

● BH : Bore Hole

SCHEMATIC SITE PLAN
(NOT TO SCALE)

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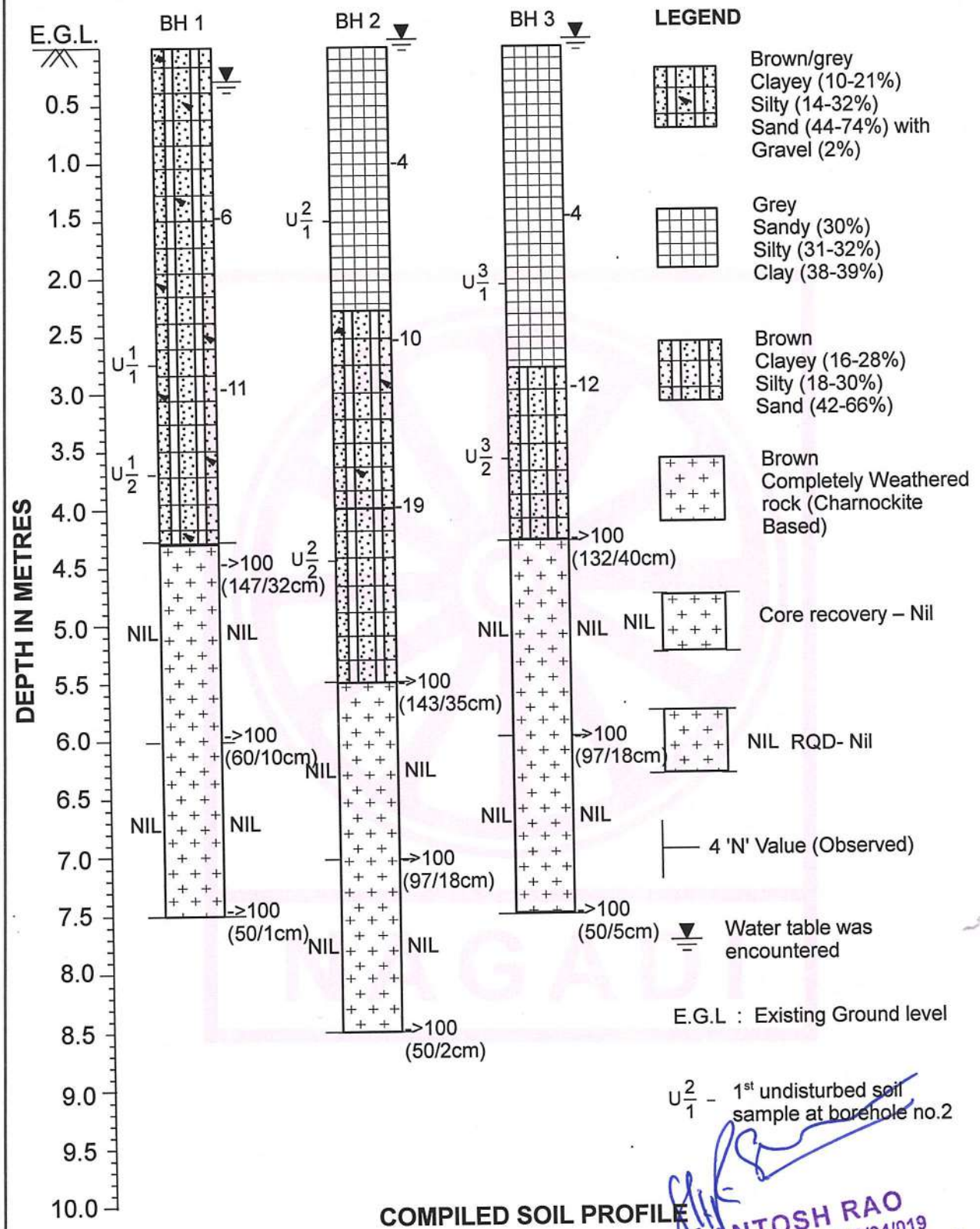

COMPILED SOIL PROFILE

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PROJECT : Residential Building at Ottiyambakkam Main Road, Ottiyambakkam Village, Tambaram Taluk, Chengalapet District

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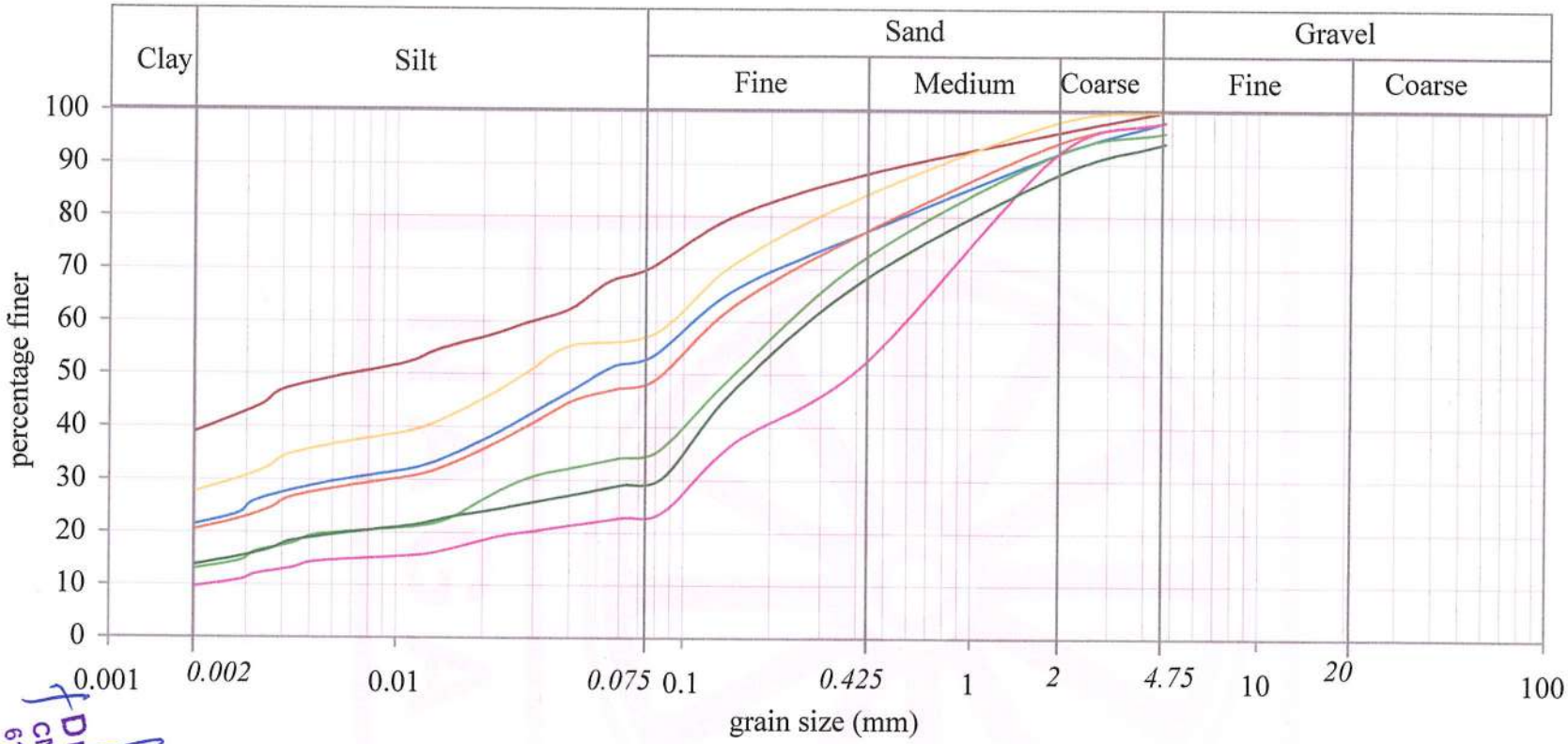

Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	U
	1	1.5	Clayey silty sand with gravel	2	44	32	21	0.110	-	-
	1	3.0	Clayey silty sand with gravel	2	49	29	20	0.140	-	-
	1	4.5	Clayey silty sand with gravel	4	60	23	13	0.230	-	-
	2	1.0	Sandy silty clay	0	30	31	39	0.020	-	-
	2	2.5	Clayey silty sand with gravel	2	74	14	10	0.600	-	-
	2	4.0	Clayey silty sand	0	42	30	28	0.090	-	-

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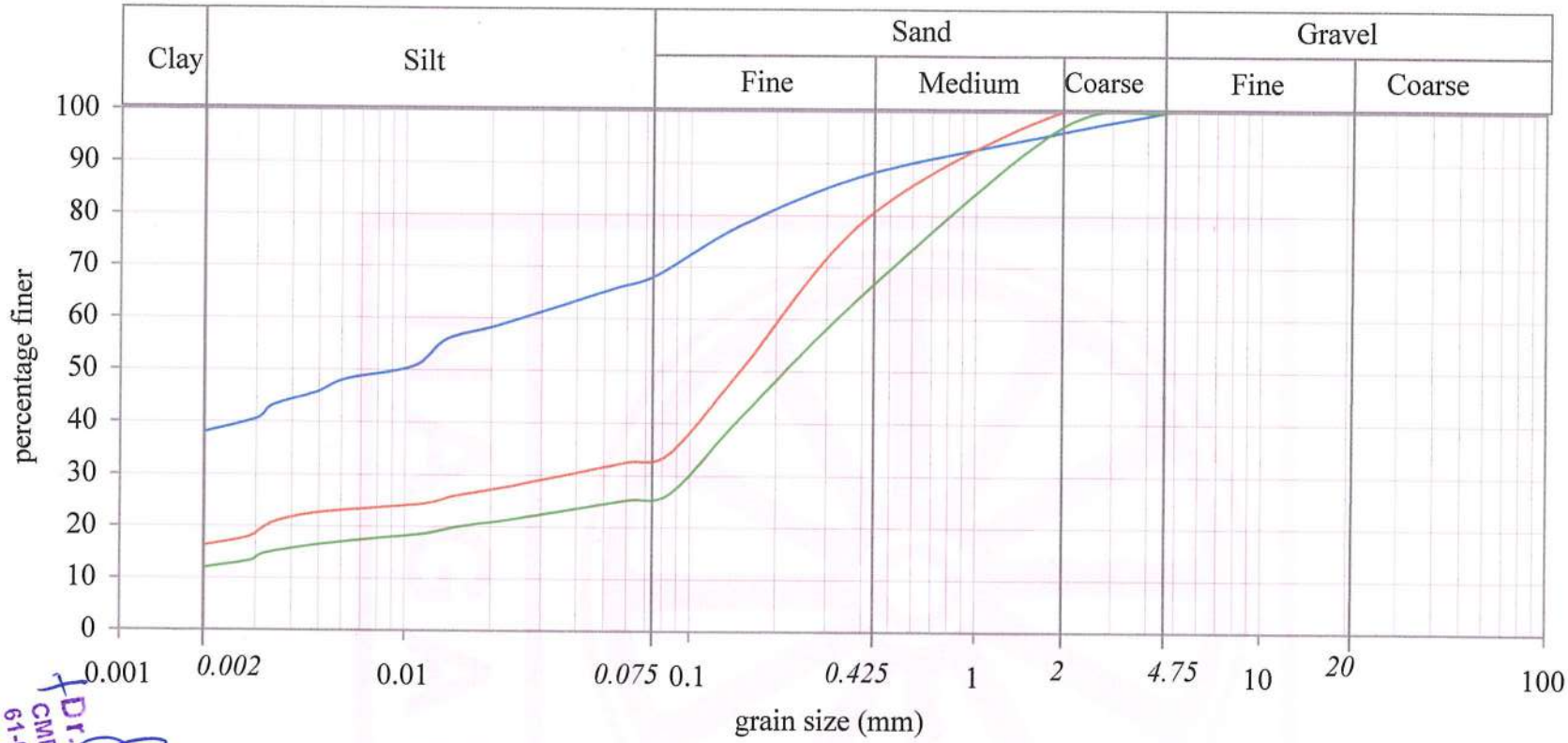

Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	U
	3	1.5	Sandy silty clay	0	30	32	38	0.029	-	-
	3	3.0	Clayey silty sand	0	66	18	16	0.200	-	-
	3	4.5	Clayey silty sand	0	73	15	12	0.310	-	-

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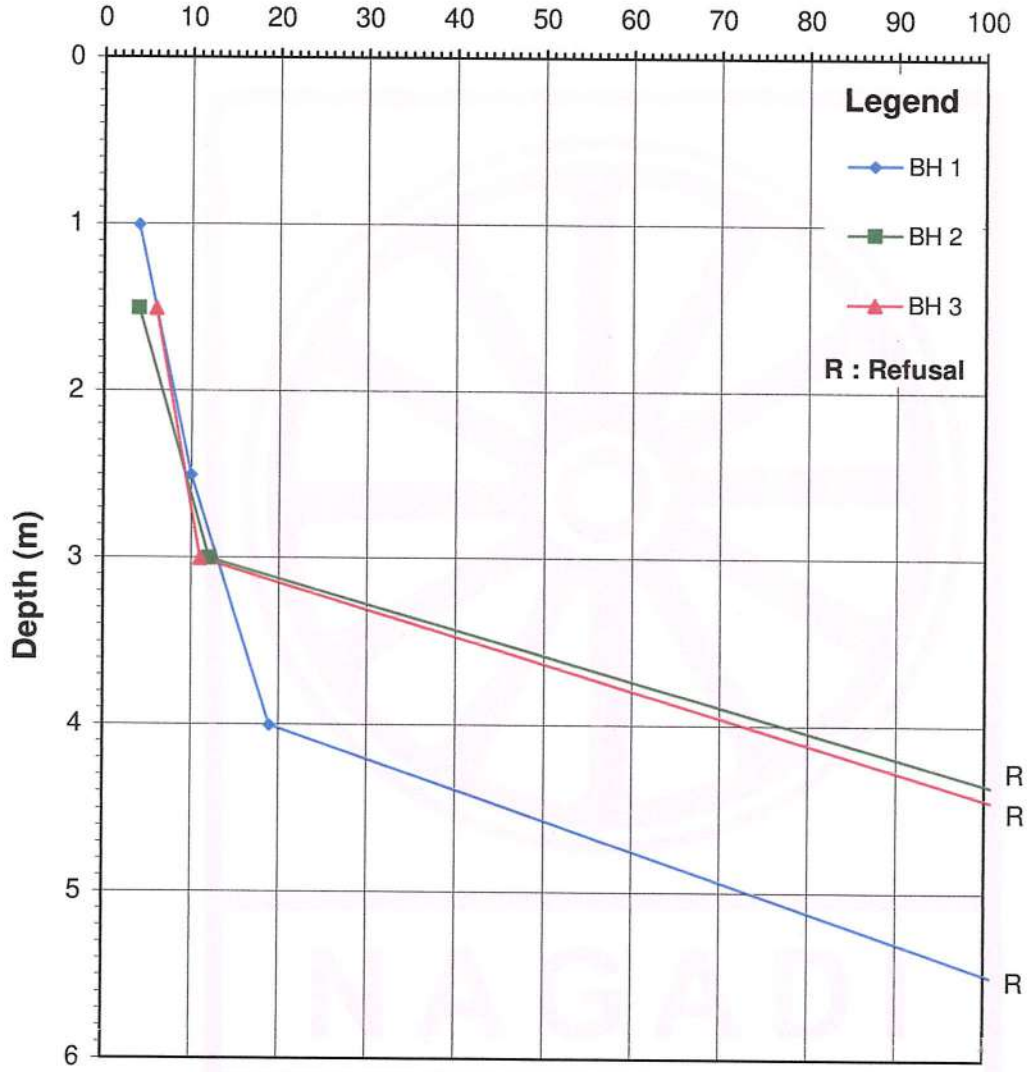
SPT Values (Observed)



SPT Values (Observed) Vs Depth Curves

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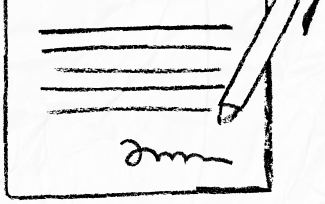

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