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GEOTECHNICAL INVESTIGATION REPORT

PROJECT: Geotechnical investigation for the proposed construction of Stilt+05 Residential RCC Framed Structure at Plot No: 5, 6 & 7, S. Nos: 168/20, 168/22 & 168/4A1B1A, Karthikeyapuram 2nd Cross Street & Deivanai Nagar 4th Street, Madipakkam, Chennai- 600091.

CLIENT: Mr.D.Ravikumar & Mr.D.Muthulingam

Soil Investigation carried out and Report prepared by:

GLOBE GEOTECHNIQUES

CMDA REG.NO.GTE/19/03/012

DTCP REG.NO.GTE/TVLR/01/2019

REPORT NO: GS_OCT22_CPN_045_MADIPAKKAM


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INTRODUCTION

This report presents the results of the geotechnical investigations carried out by **GLOBE GEOTECHNIQUES**, for the proposed construction of Stilt+05 Residential RCC Framed Structure at Plot No: 5, 6 & 7, S. Nos: 168/20, 168/22 & 168/4A1B1A, Karthikeyapuram 2nd Cross Street & Deivanai Nagar 4th Street, Madipakkam, Chennai- 600091.

This work was authorized by **Mr.D.Ravikumar & Mr.D.Muthulingam**. This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

Three (03) Standard Penetration Testing bores were drilled at the proposed site up to maximum depth of 05.00 m, 04.80 m and 05.50 m at Borehole locations BH-01, BH-02 and BH-03 respectively below existing ground level as per the request of the client.

The investigation consists of drilling Three (03) boreholes, soil sampling, field and laboratory testing and preparation of a Geotechnical Report for the proposed construction of Stilt+05 Residential RCC Framed Structure at Plot No: 5, 6 & 7, S. Nos: 168/20, 168/22 & 168/4A1B1A, Karthikeyapuram 2nd Cross Street & Deivanai Nagar 4th Street, Madipakkam, Chennai- 600091.

OBJECTIVE

The objective of soil investigation is to ascertain the nature and characteristics of sub-soil below the ground level at the site and to establish relevant properties for determination of safe bearing capacity of soil.


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SCOPE OF WORK

The scope of this investigation is to: Mobilization of equipment to the site and demobilization of the same on completion of field work. Determine the soil profile at the site by conducting Standard Penetration tests at various depths, with ground water observation.

- i) Collection of disturbed samples and undisturbed samples wherever possible.
- ii) Laboratory tests for determination of Index and Engineering Properties of soil.

Recommend a suitable foundation system and safe bearing pressure at the founding levels for the proposed construction of Stilt+05 Residential RCC Framed Structure at Plot No: 5, 6 & 7, S. Nos: 168/20, 168/22 & 168/4A1B1A, Karthikeyapuram 2nd Cross Street & Deivanai Nagar 4th Street, Madipakkam, Chennai- 600091.

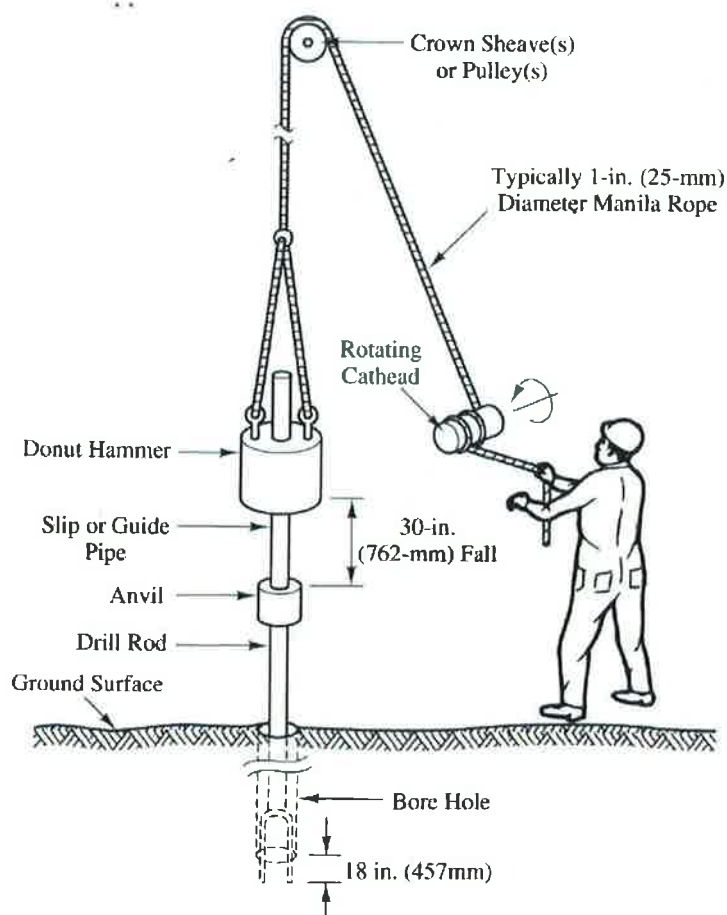
To achieve the above, Three (03) bores were drilled at the proposed site up to maximum depth of 05.00 m, 04.80 m and 05.50 m at Borehole locations BH-01, BH-02 and BH-03 respectively. The borehole location was selected by our geotechnical engineer in-charge. Soil samples were collected for visual identification, classification and laboratory testing.

The Borehole log is given in Appendix ~A~ and the laboratory test results is presented in Appendix ~B~.

INVESTIGATION PROGRAM & TECHNIQUES

After the visual inspection of the site, the subsurface investigation was started on 07th October 2022 and completed on the same day of 07th October 2022.

Three (03) bores were drilled at the proposed site up to maximum depth of 05.00 m, 04.80 m and 05.50 m at Borehole locations BH-01, BH-02 and BH-03 respectively selected by the geotechnical engineer in-charge. Rotary drilling was performed using water as drilling fluid in the sub soil with casing pipe to stabilize the boreholes up to the required depth. Field testing and sampling were conducted in accordance with IS: 2131-1981.



Standard penetration tests were conducted at the borehole locations, in accordance with IS: 2131. The tests were conducted at every change of strata up to the depth of termination of the borehole as directed by the engineer-in-charge. In this test, a standard split spoon of length about 460 mm and external/internal diameter of 51/35 mm initially penetrates the soil for 15cm to bypass the expected accumulated sludge at the bottom of the hole by means of a **63.5 kg (140 lb) hammer** falling freely along a guide from a height of 760 mm.

The total number of blows (N) required, to advance the spoon into the bore, for another two successive 15cm (a total of 30 cm) is recorded as a measure of the soil relative density or consistency as given in Table # 1.0. The fieldwork was carried out under the close supervision of our engineer in accordance with Indian Standard mentioned earlier.

LABORATORY TESTING PROGRAM

All the extracted soil samples were brought to the Geotechnical & Materials Testing Laboratory of GLOBE GEOTECHNIQUES, for further examination in accordance with IS: 1498-1970. These samples were used for visual and physical identification and for conducting laboratory classification tests as per I.S.1498-1970.

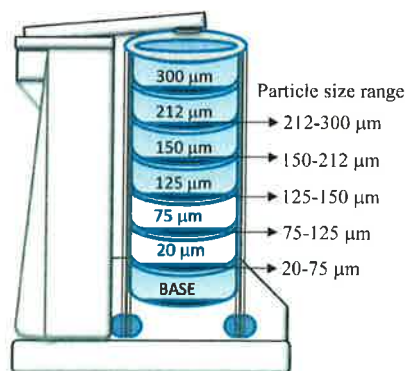
1. Moisture Content
2. Liquid limit (IS: 2720 Part V – 1985)
3. Plastic Limit and Plasticity Index
(IS: 2720 Part VI – 1972)
4. Sieve Analysis (IS: 2720 Part IV – 1985)

The laboratory test results are given in Appendix "B".

Coarse Grained Samples:

Grain size Analysis Tests:

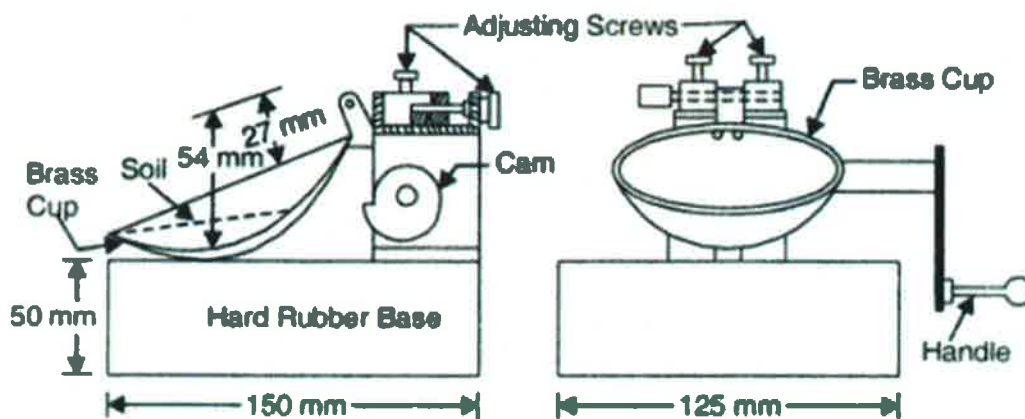
On the coarse-grained samples, grain size distribution tests were conducted as per I.S.2720 (Part 4)-1985, to know the gradation characteristics and to classify them. These results are presented in Tables.



Fine Grained Samples:

Index Property – Free Swell Tests:

Atterberg's Limits were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally Liquid limits, Plastic limits and Shrinkage Limits tests were conducted as per I.S.2720 (Part-5)-1985 and I.S.2720 (Part 6)-1972. On such type of strata encountered at the investigation locations, such tests were conducted and the test results are presented in tables.



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SUBSURFACE SOIL DESCRIPTION

Based on the bore-hole information, the existing sub surface soil profile at the captioned site is illustrated below.

Borehole I	
Layers	Description of Soil
00.00 m - 01.20 m	Filled Up / Made Up Soil
01.20 m – 02.70 m	Greyish Sandy Clay
02.70 m – 04.20 m	Yellowish Grey Clayey Sand with Limestone
04.20 m – 05.00 m	Soft Weathered / Disintegrated Rock
Below 05.00 m	Soft Rock
Drilling stopped at 05.00 m below EGL	

Borehole II	
Layers	Description of Soil
00.00 m - 01.60 m	Filled Up / Made Up Soil
01.60 m – 02.60 m	Greyish Sandy Clay
02.60 m – 04.80 m	Yellowish Grey Clayey Sand with Limestone
Below 04.80 m	Soft Rock
Drilling stopped at 04.80 m below EGL	

Borehole III	
Layers	Description of Soil
00.00 m - 01.20 m	Filled Up / Made Up Soil
01.20 m – 03.80 m	Whitish Greyish Clayey Sand with Limestone
03.80 m – 05.10 m	Greyish Clayey Sand with Limestone
05.10 m – 05.50 m	Soft Weathered / Disintegrated Rock
Below 05.50 m	Soft Rock
Drilling stopped at 05.50 m below EGL	

GROUND WATER

GROUND WATER TABLE	
Borehole Location	Depth of Ground Water Table
Borehole I - III	Not Encountered during field tests

SAFE BEARING CAPACITY:

IS CODE (IS: 6403-1981) recommends a bearing capacity equation to take into account, the shape of the footing, inclination of loading, depth of embedment and effect of water table.

For General shear failure:

$$q_{nf} = cN_c \cdot s_c \cdot d_c \cdot i_c + \sigma (N_q - 1) s_q \cdot d_q \cdot i_q + 0.5 B \cdot Y \cdot N_\gamma \cdot s_\gamma \cdot d_\gamma \cdot i_\gamma W'$$

For Local shear failure:

$$q_{nf} = \frac{2}{3} cN'_c \cdot s_c \cdot d_c \cdot i_c + \sigma (N'_q - 1) s_q \cdot d_q \cdot i_q + 0.5 B \cdot Y \cdot N'_\gamma \cdot s_\gamma \cdot d_\gamma \cdot i_\gamma W'$$

SHAPE FACTORS (IS: 6403-1981)

Shape of base	Shape factors		
	s_c	s_q	s_γ
1. Continuous strip	1.0	1.0	1.0
2. Rectangle	$(1+0.2B/L)$	$(1+0.2B/L)$	$(1-0.4B/L)$
3. Square	1.3	1.2	0.8
4. Circle	1.3	1.2	0.6

PILE LOAD CAPACITY:

STATIC FORMULA:

PILE LOAD CAPACITY = POINT BEARING RESISTANCE + END BEARING RESISTANCE.

Rock Quality Designation: RQD is defined as the percentage of intact drill core pieces longer than 10cm recovered during a single core run. The general equation is expressed as shown in below.

$$RQD: (\Sigma \text{ Rock Pieces } \geq 10 \text{ cm} / \text{Core run total Length}) \times 100 \%$$

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RQD (%)	Geotechnical Quality
<25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

FOUNDATION RECOMMENDATION:

The foundation system design is an interface between super structure and the sub soil bearing strata characteristics. A sound foundation system should be safe against bearing strata shear response under the super structure load intensity. Similarly, the stability of the foundation system is governed by the bearing strata deformation response under the super structure load intensity.

In addition, as a combined system of super structure and foundation, the overall stability is also governed by the super structure arrangement. Considering the above aspects of foundation design, the suitable type of foundation system with respect to the sub soil conditions encountered at the borehole locations is presented in the subsequent sections.

Based on the borehole information in addition to the nature of the proposed construction of Stilt+05 Residential RCC Framed Structure at Plot No: 5, 6 & 7, S. Nos: 168/20, 168/22 & 168/4A1B1A, Karthikeyapuram 2nd Cross Street & Deivanai Nagar 4th Street, Madipakkam, Chennai- 600091, the following foundation recommendation shall be adopted.

PILE FOUNDATION:

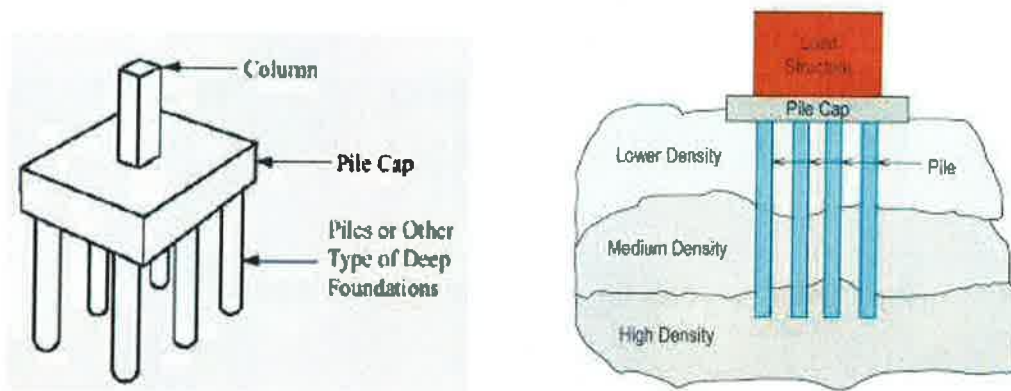
Bored cast in-situ pile (End bearing cum friction) shall be adopted by terminating pile length at 05.50 m from existing ground level.

Diameter of Pile (mm)	Pile Length (m)	Recommended Safe Load Carrying Capacity of Pile (Skin+End), Tonnes	Safe Allowable Pull out Capacity of Piles, Tonnes	Recommended Lateral Load Capacity for 5 mm Deflection, Tonnes	Depth of fixity from borehole level (m)
450	5.50	40	21.14	3.60	2.89
500	5.50	50	23.69	4.50	3.15
600	5.50	70	32.48	6.30	4.02

- *Actual pile capacities* shall be verified by pile load tests.
- **Socketing length shall be taken as 2.5 times Diameter of the pile and Cast-in-situ method & DMC (direct mud circulation method) using tripod rig shall be suggested.**
- During rock socketing process, heavy chiselling of high torque drilling may produce vibrations. These vibrations may cause destabilization of soft rock/soil strata over laying the rock layer. Thus the pile will lose friction component from these layers. Hence greater care should be taken to reduce the vibrations.
- In order to remove fine particles produced during socketing process and other cuttings, the borehole should be thoroughly washed with fresh bentonite slurry just before pouring concrete.


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- *Two/ Three Piles per column shall be designed in order to have lateral stability.*
- Since, the behavior of the pile not only depends upon the soil parameters (theoretical load carrying capacity estimates) but also on the execution skill and care, it is mandatory to construct prototype pile load tests as per the guide lines laid down in IS: 2911-Part IV to confirm the theoretical estimates, before proceeding with the execution work.

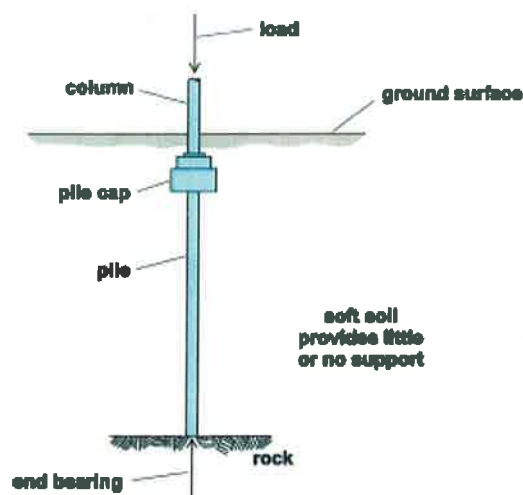


Design and construction of bored cast in situ piles are done in accordance with IS 2911 (part-1/Sec-2) – 2010. The work is basically making a borehole of designed diameter at the designated locations to the required depth, after providing temporary or permanent casing and stabilizing with bentonite slurry; and filling the borehole with concrete after placing reinforcement cage.

The boreholes are drilled using rotary or percussion type drilling rigs, using direct mud circulation (DMC) or reverse mud circulation (RMC) methods. Drilling can also be done using rope operated or hydraulically operated grabbing tools. Concreting is usually done using tremie pipes.

Direct mud circulation method is the less expensive method for doing the boring activity. In this method bentonite slurry is constantly circulated into the bore hole during the boring activity through the bailer pipes, and overflow is

collected and redirected to the bentonite slurry tank. The density of bentonite slurry should be around 1.12. Bentonite has a property of becoming a jelly like substance once left undisturbed for a long time. This jelly acts as plastering on the walls of the bore holes, and thereby preventing the boreholes from caving. Direct mud circulation method is commonly used while boring with bailer and chisel, and reverse mud circulation is adopted for boring using auger. In reverse mud circulation method, the bentonite is directed into the borehole directly, and the return is collected through the drill pipe.




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APPENDIX A

BOREHOLE LOG

Client: Mr.D.Ravikumar & Mr.D.Muthulingam

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project : Geotechnical investigation for the proposed construction of Stilt+05 Residential RCC Framed Structure at Plot No: 5, 6 & 7, S. Nos: 168/20, 168/22 & 168/4A1B1A, Karthikeyapuram 2nd Cross Street & Deivanai Nagar 4th Street, Madipakkam, Chennai- 600091.

Location: BH-01

Started On : 07/10/2022; Ended On : 07/10/2022 G.W.T: Not Encountered during field test Final Depth: 05.00 m

R.L. of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details			Graphical Representation of SPT											Relative Density/Consistency	Type of Sample			
				Depth of SPT below E.G.L. (m)	0-15 cm	15-30 cm	30-45 cm	N-Value														
GL			Filled Up / Made Up Soil Filled Up / Made Up Soil Filled Up / Made Up Soil Filled Up / Made Up Soil Filled Up / Made Up Soil																			
1.20																						
2.00			Greyish Sandy Clay Greyish Sandy Clay Greyish Sandy Clay Greyish Sandy Clay Greyish Sandy Clay Greyish Sandy Clay	2.00	3	3	4	7											Firm	DS		
2.70																						
3.00			Yellowish Grey Clayey Sand with Limestone Yellowish Grey Clayey Sand with Limestone Yellowish Grey Clayey Sand with Limestone Yellowish Grey Clayey Sand with Limestone Yellowish Grey Clayey Sand with Limestone	3.00	7	9	10	19											Medium	DS		
4.20																						
4.50			Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock	4.50	34	50 / 11 cm Bal												Very Dense	DS			
5.00				5.00	Hammer Rebound													Very Dense	DS			
			Soft Rock Soft Rock Soft Rock Soft Rock Soft Rock Soft Rock Soft Rock Soft Rock Soft Rock																			

Fig. 2.1 Soil Profile at BH-01 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 05.00 m FROM EXISTING GROUND LEVEL

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Client: Mr.D.Ravikumar & Mr.D.Muthulingam

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project : Geotechnical investigation for the proposed construction of Stilt+05 Residential RCC Framed Structure at Plot No: 5, 6 & 7, S. Nos: 168/20, 168/22 & 168/4A1B1A, Karthikeyapuram 2nd Cross Street & Deivanai Nagar 4th Street, Madipakkam, Chennai- 600091.

Location: BH-02

Started On : 07/10/2022; Ended On : 07/10/2022 G.W.T: Not Encountered during field test Final Depth: 04.80 m

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				Graphical Representation of SPT												Relative Density/Consistency	Type of Sample	
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	10 20 30 40 50 60 70 85 100													
GL			Greyish Sandy Clay																			
1.00			Greyish Sandy Clay																			
1.60			Greyish Sandy Clay	1.00	2	2	3	5													Firm	DS
			Greyish Sandy Clay																			
			Greyish Sandy Clay																			
2.00			Yellowish Grey Clayey Sand with Limestone																			
			Yellowish Grey Clayey Sand with Limestone																			
			Yellowish Grey Clayey Sand with Limestone	2.00	6	8	10	18													Medium	DS
			Yellowish Grey Clayey Sand with Limestone																			
			Yellowish Grey Clayey Sand with Limestone																			
2.60			Yellowish Grey Clayey Sand with Limestone																			
3.00			Soft Weathered / Disintegrated Rock																			
			Soft Weathered / Disintegrated Rock	3.00	18	50 / 4 cm Bal															Very Dense	DS
			Soft Weathered / Disintegrated Rock																			
			Soft Weathered / Disintegrated Rock																			
			Soft Weathered / Disintegrated Rock																			
			Soft Weathered / Disintegrated Rock																			
4.50			Soft Weathered / Disintegrated Rock	4.50	50 / 8 cm Balance															Very Dense	DS	
			Soft Weathered / Disintegrated Rock																			
			Soft Weathered / Disintegrated Rock																			
			Soft Weathered / Disintegrated Rock																			
4.80			Soft Weathered / Disintegrated Rock	4.80	Hammer Rebound															Very Dense	DS	
			Soft Rock																			
			Soft Rock																			
			Soft Rock																			
			Soft Rock																			
			Soft Rock																			
			Soft Rock																			

Fig. 2.2 Soil Profile at BH-02 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 04.80 m FROM EXISTING GROUND LEVEL

Client: Mr.D.Ravikumar & Mr.D.Muthulingam

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

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Location: BH-03

Started On : 07/10/2022; Ended On : 07/10/2022 G.W.T: Not Encountered during field test Final Depth: 05.50 m

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details		Graphical Representation of SPT												Relative Density/Consistency	Type of Sample
				Depth of SPT below E.G.L (m)	N-Value	10 20 30 40 50 60 70 85 100													
						0-15 cm	15-30 cm	30-45 cm											
GL			Filled Up / Made Up Soil Filled Up / Made Up Soil Filled Up / Made Up Soil Filled Up / Made Up Soil Filled Up / Made Up Soil																
1.20																			
2.00			Whitish Greyish Clayey Sand with Limestone Whitish Greyish Clayey Sand with Limestone Whitish Greyish Clayey Sand with Limestone Whitish Greyish Clayey Sand with Limestone Whitish Greyish Clayey Sand with Limestone Whitish Greyish Clayey Sand with Limestone Whitish Greyish Clayey Sand with Limestone Whitish Greyish Clayey Sand with Limestone Whitish Greyish Clayey Sand with Limestone	2.00	4	6	6	12									Medium	DS	
3.00																			
3.80				3.00	5	7	8	15									Medium	DS	
4.50			Greyish Clayey Sand with Limestone Greyish Clayey Sand with Limestone Greyish Clayey Sand with Limestone Greyish Clayey Sand with Limestone Greyish Clayey Sand with Limestone	4.50	9	16	22	38									Dense	DS	
5.10																			
5.50			Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock	5.50	Hammer Rebound												Very Dense	DS	
			Soft Rock Soft Rock Soft Rock Soft Rock Soft Rock Soft Rock																

Fig. 2.3 Soil Profile at BH-03 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 05.50 m FROM EXISTING GROUND LEVEL

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APPENDIX B
LABORATORY TEST
RESULTS

TABLE – 1
Correlations of SPT N values with Common properties of soils

A) Granular Soil

S.NO.	Standard Penetration No., SPT N	Description	Relative Density, Dr %	Approx. Angle of Internal Friction, Φ°	Approx. Rang of Most. Unit Wt., γ kN/m ³
1	< 4	Very Loose	< 20	< 29	11 to 16
2	04 to 10	Loose	20 to 40	29 to 30	14 to 18
3	10 to 30	Medium	40 to 60	30 to 36	17 to 20
4	30 to 50	Dense	60 to 80	36 to 41	17 to 22
5	> 50	Very Dense	> 80	> 41	20 to 29

B) Cohesive Soil

S.NO.	Standard Penetration No., SPT N	Description	Unconfined Compressive Strength(q_u), kPa	Cohesive Strength (c), kPa	Approx. Rang of Most. Unit Wt., γ kN/m ³
1	< 02	Very Soft	0 to 25	0 to 12.50	14.40 to 16.00
2	02 to 04	Soft	25 to 50	12.50 to 25	16.00 to 17.74
3	04 to 08	Firm	50 to 100	25 to 50	17.60 to 19.20
4	08 to 15	Stiff	100 to 200	50 to 100	19.20 to 20.80
5	15 to 30	Very Stiff	200 to 400	100 to 200	20.80 to 22.40
6	> 30	Hard	> 400	> 200	> 20.00

Note: These values are most appropriate values in general. However, the soil properties vary between sites to site and hence it shall be used only for guidance

ABBREVIATION :

W_N	Natural Moisture content (%)
W_L	Liquid limit (%)
W_P	Plasticity Limit (%)
I_P	Plasticity Index (%)
F.S.I.	Free Swell Index (%)
IS	Indian Standard Classification
CL	Low Compressibility Clay of with $WL < 35\%$
CI	Intermediate Compressibility Clay of with $35\% < WL < 50\%$
CH	High Compressibility Clay of with $> 50\%$

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Table of Laboratory Test Results

Client: Mr.D.Ravikumar & Mr.D.Muthulingam

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

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APPENDIX C

GENERAL COMMENTS

GENERAL INSTRUCTIONS (FOR SHALLOW FOUNDATIONS)

STRUCTURAL FILL

It shall be made of compacted coarse gravel material and placed in layers of 50cm thickness with a minimum compaction of 95% of maximum dry density.

FOUNDATION CONSIDERATIONS

A PCC (Plain Cement Concrete) layer of 10cm thickness is recommended below the foundations.

Any over excavation in the foundation trenches should be re-filled by plain concrete and any disturbed and loose materials found in the foundation trenches should be removed before placement of P.C.C.

EXCAVATION

Excavation through the overburden soil can be carried out by conventional equipment such as dozers and Poclain Excavators.

BACKFILLING AND COMPACTION

Backfilling materials shall be granular with durable particles free of deleterious matter, meeting the gradation requirement. It shall not contain stones larger than 80 mm; more than 35% fines passing # 200 sieves and is free of any deleterious foreign matter. Backfilling materials shall be placed in horizontal layers not exceeding 25 cm thickness and each layer shall be compacted to atleast 95% of the maximum dry density. If there is any over excavations in the foundation trenches, which should be refilled with either structural fill or lean concrete and all the loose and disturbed materials, should be cleared from the foundation trenches.

GENERAL INSTRUCTIONS (FOR DEEP FOUNDATIONS)

Pile foundations shall be designed in such a way that the load from the structure can be transmitted to the sub-surface with adequate factor of safety against shear failure of sub-surface and without causing such settlement (differential or total), which may result in structural damage and/or functional

distress under permanent/transient loading. The pile shaft should have adequate structural capacity to withstand all loads (vertical, axial or otherwise) and moments which are to be transmitted to the subsoil and shall be designed according to IS 456.

MATERIALS AND STRESSES

CEMENT:

The cement used shall be any of the following:

- a) 33 Grade ordinary Portland cement conforming to IS 269,
- b) 43 Grade ordinary Portland cement conforming to IS 8112,
- c) 53 Grade ordinary Portland cement conforming to IS 12269,
- d) Rapid hardening Portland cement conforming to IS 8041,
- e) Portland slag cement conforming to IS 455,
- f) Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part 1),
- g) Portland pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2),
- h) Hydrophobic cement conforming to IS 8043,
- i) Low heat Portland cement conforming to IS 12600, and
- j) Sulphate resisting Portland cement conforming to IS 12330.

STEEL REINFORCEMENT STEEL SHALL BE ANY OF THE FOLLOWING:

- a) Mild steel and medium tensile steel bars conforming to IS 432 (Part 1), b) High strength deformed steel bars conforming to IS 1786, and c) Structural steel conforming to IS 2062.

CONCRETE:

Consistency of concrete to be used for driven cast in-situ piles shall be consistent with the method of installation of piles. Concrete shall be so designed or chosen as to have a homogeneous mix having a slump/workability consistent with the method of concreting under the given conditions of pile installation. The average compressive stress under working load should not exceed 25 percent of the specified works cube strength at 28 days calculated on the total cross-sectional area of the pile. Where the casing of the pile is

permanent, of adequate thickness and of suitable shape, the allowable compressive stress may be increased.

For the concrete, water and aggregates specifications laid down in IS 456 shall be followed in general. The slump should be 150 to 180 mm at the time of pouring. The minimum grade of concrete to be used for piling shall be M 25. For sub aqueous concrete, the requirements specified in IS 456 shall be followed. The minimum cement content shall be 400 kg/m^3 . However, with proper mix design and use of proper admixtures the cement content may be reduced but in no case the cement content shall be less than 350 kg/m^3 .

Piles shall be installed as accurately as possible according to the design and drawings either vertically or to the specified batter. Greater care should be exercised in respect of installation of single piles or piles in two pile groups. As a guide, for vertical piles, an angular deviation of 1.5 percent and for raker piles, a deviation of 4 percent should not be exceeded. Piles should not deviate more than 75 mm or $D/6$ whichever is less (75 mm or $D/10$ whichever is more in case of piles having diameter more than 600 mm) from their designed positions at the working level. In the case of single pile under a column the positional deviation should not be more than 50 mm or $D/6$ whichever is less (100 mm in case of piles having diameter more than 600 mm). Greater tolerance may be prescribed for piles cast over water and for raking piles. For piles to be cut-off at a substantial depth below the working level, the design shall provide for the worst combination of the above tolerances in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by redesign of the pile cap or pile ties, the piles shall be replaced or supplemented by additional piles.

GENERAL COMMENTS

The recommendations for foundation design and construction are based on the information obtained from borehole drilled at location. When foundation

construction is underway, the recommendations of this report should be checked through field inspection, to validate the information for use during the construction stage. Any variation in underground Conditions revealed by the borehole should be brought to our attention.

For GLOBE GEOTECHNIQUES



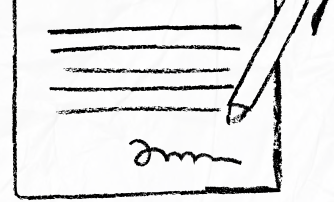
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Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.



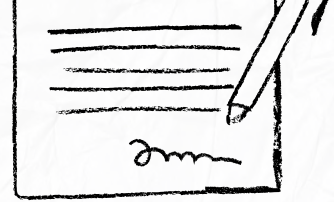
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Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator



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