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GLOBE GEOTECHNIQUES

GEOTECHNICAL INVESTIGATION REPORT

PROJECT: Geotechnical investigation for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 13, plot no: 1821 , block no : 42 , Anna Nagar 13th main road, I,H,J,Z,Y - Blocks , survey no : T.S.No : 38,Chennai.

CLIENT: M/s. EK Infra.

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_FEB22_CTN_079_ANNA NAGAR

26/02/2022

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CONTENTS

INTRODUCTION

This report presents the results of the geotechnical investigations carried out by **GLOBE GEOTECHNIQUES,** for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 13, plot no: 1821 , block no : 42 , Anna Nagar 13th main road, I,H,J,Z,Y - Blocks , survey no : T.S.No : 38,Chennai.

This work was authorized by **M/s. EK Infra.** This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

One (01) Standard Penetration Testing bore was drilled at the proposed site up to maximum depth of 27.50 m at Borehole location BH-01 below existing ground level as per the request of the client.

The investigation consists of drilling One (01) borehole, soil sampling, field and laboratory testing and preparation of a Geotechnical Report for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 13, plot no: 1821 , block no : 42 , Anna Nagar 13th main road, I,H,J,Z,Y - Blocks , survey no : T.S.No : 38,Chennai.

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.

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 G+05 Floors RCC Structure at Door no. New no: 13, plot no: 1821 , block no : 42 , Anna Nagar 13th main road, I,H,J,Z,Y - Blocks , survey no : T.S.No : 38,Chennai.

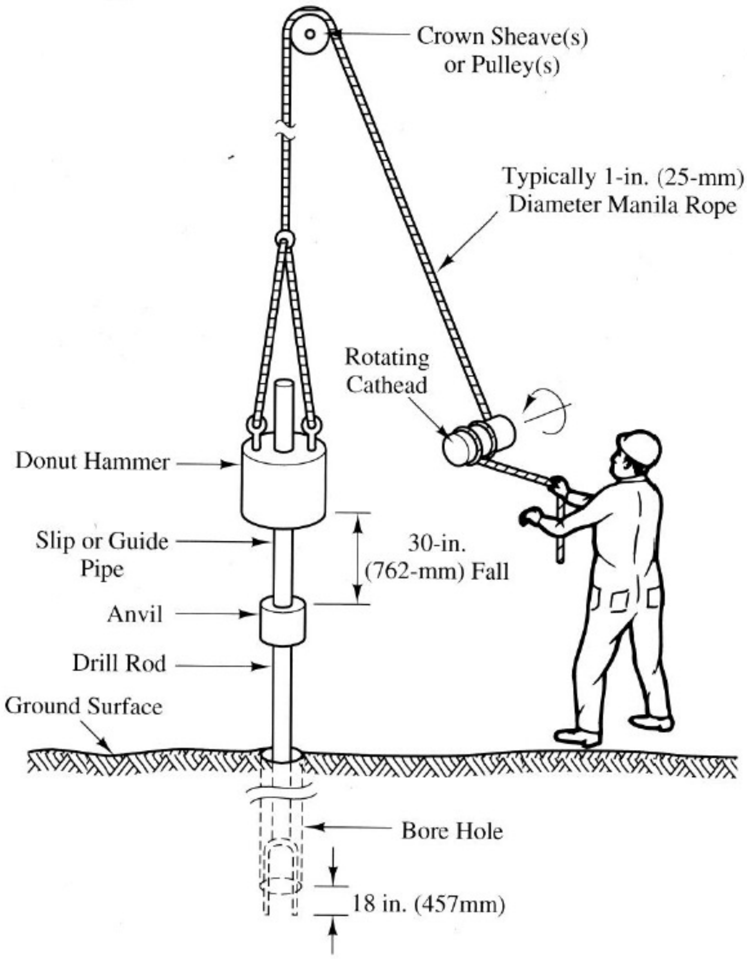
To achieve the above, one (01) bore was drilled at the proposed site up to maximum depth of 27.50 m at Borehole location BH-01. The borehole location was selected by our geotechnical engineer in-charge. Soil samples were collected for visual identification, classification and laboratory testing.

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 23rd February 2022 and completed on the day of 24th February 2022.

One (01) bore was drilled at the proposed site up to maximum depth of 27.50 m at Borehole location BH-01 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.

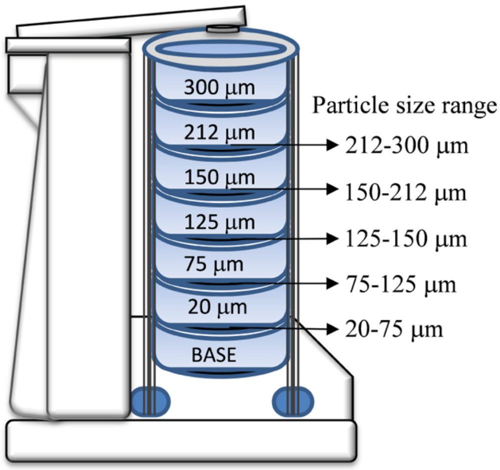
1. Moisture Content
2. Liquid limit (IS: 2720 Part V – 1985)
3. Plastic Limit and Plasticity Index (IS: 2720 Part VI – 1972)
4. Sieve Analysis (IS: 2720 Part IV – 1985)

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.

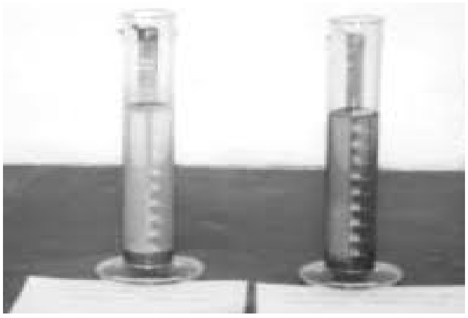


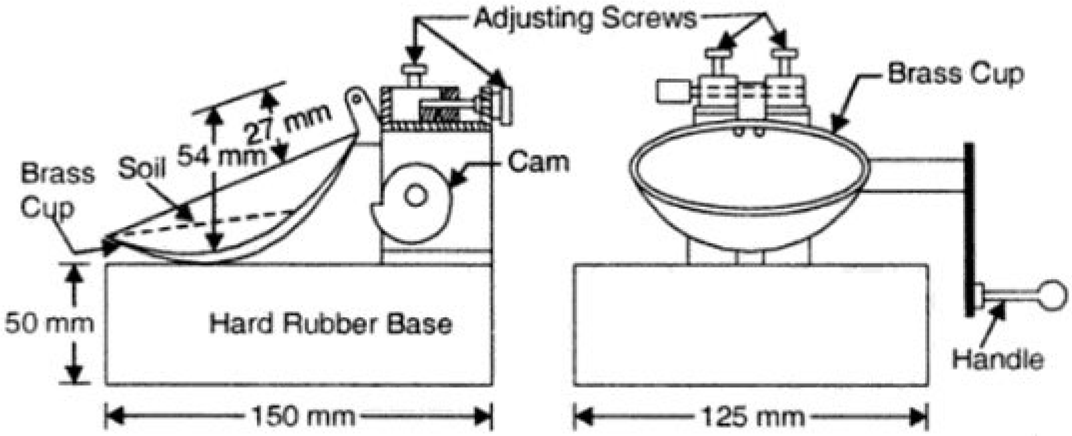
Fine Grained Samples:

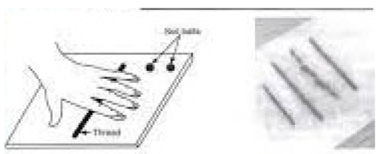
Index Property – Free Swell Tests:

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.







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 – 03.60 m	Brownish Grey Silty Sandy Clay
03.60 m – 08.15 m	Brownish Fine to Medium Sand
08.15 m – 09.75 m	Dark Greyish Silty Sandy Clay
09.75 m – 17.40 m	Dark Greyish Clayey Medium to Fine Sand
17.40 m – 22.50 m	Dark Greyish Clayey Medium to Fine Sand
22.50 m – 24.45 m	Dark Greyish Clayey Medium to Fine Sand
24.45 m – 27.50 m	Dark Greyish Clayey Medium to Fine Sand
Drilling stopped at 27.50 m below EGL	

GROUND WATER

GROUND WATER TABLE	
Borehole Location	**Depth of Ground Water Table**
Borehole I	3.25 m below existing ground level

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:

$q_{nf} = cN_c.s_c.d_c.i_c + \sigma\,(N_q-1)\,s_q.d_q.i_q + 0.5\,B.Y.N_Y.s_Y.d_Y.i_Y W'$

For Local shear failure:

$q_{nf} = 2/3\,cN_c'.s_c.d_c.i_c + \sigma\,(N_q'-1)s_q.d_q.i_q + 0.5\,B.Y.N_Y'.s_Y.d_Y.i_Y W'$

SHAPE FACTORS (IS: 6403-1981)

Shape of base	Shape factors		
	s_c	s_q	s_Y
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: (Σ Rock Pieces ≥10 cm / Core run total Length) x100 %

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 G+05 Floors RCC Structure at Door no. New no: 13, plot no: 1821 , block no : 42 , Anna Nagar 13th main road, I,H,J,Z,Y - Blocks , survey no : T.S.No : 38,Chennai, the following foundation recommendation shall be adopted.

OPTION I: PILE FOUNDATION:

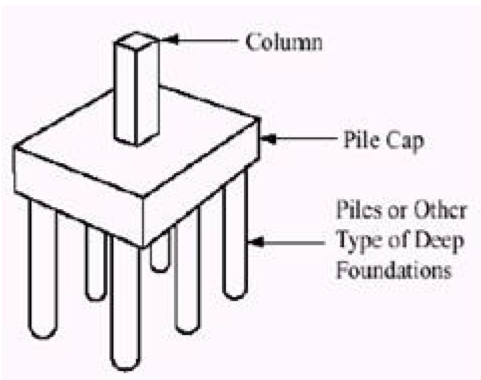
Bored cast in–situ pile (End bearing cum friction) shall be adopted by terminating pile length at 26.00 m from existing ground level.

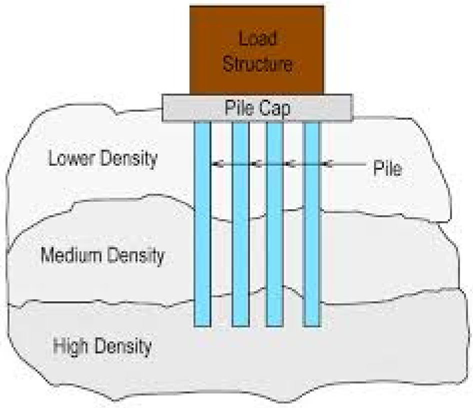
S.NO.	PILE DIAMETER, mm	PILE LENGTH, m	RECOMMENDED SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END), Tonnes	LATERAL LOAD CARRYING CAPACITY OF PILE, Tonnes
1	450 mm dia	26.00	**120**	4.6
2	500 mm dia	26.00	**140**	5.1
3	600 mm dia	26.00	**180**	6.3

Diameter of Pile (mm)	Pile Length (m)	Recommended Safe Load Carrying Capacity of Pile (Skin+End), Tonnes	Recommended Lateral Load Capacity for 5 mm Deflection, Tonnes	Depth of fixity from borehole level (m)
450	26	120	4.60	4.02
500	26	140	5.10	4.47
600	26	180	6.30	5.36

- *Actual pile capacities* shall be verified by pile load tests.

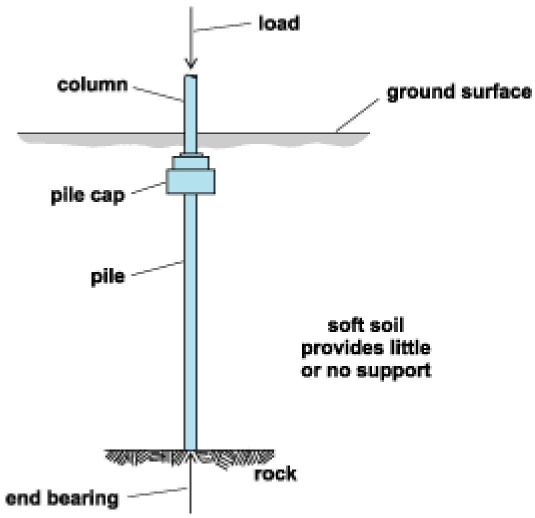
- Since, the behavior of the pile not only depends upon the soil parameters (theoretical load carrying capacity estimates) but also on the execution skill and care, it is mandatory to construct prototype pile load tests as per the guide lines laid down in IS: 2911-Part IV to confirm the theoretical estimates,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





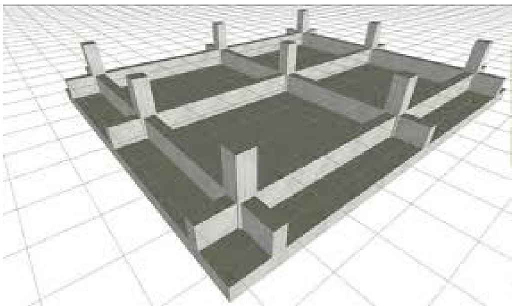
Design and construction of bored cast in situ piles are done in accordance with IS 2911 (part-1/Sec-2) – 2010. The work is basically making a borehole of designed diameter at the designated locations to the required depth, after providing temporary or permanent casing and stabilizing with bentonite slurry;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

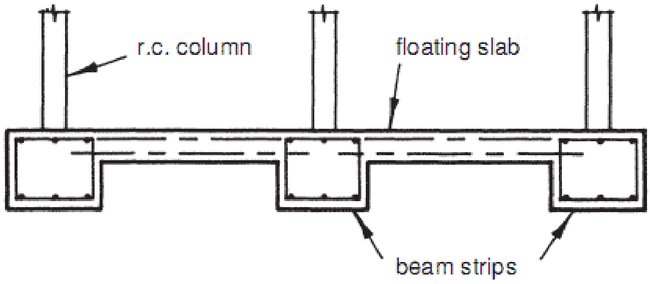
Direct mud circulation method is the less expensive method for doing the boring activity. In this method bentonite slurry is constantly circulated into the bore hole during the boring activity through the bailer pipes, and overflow is collected and redirected to the bentonite slurry tank. The density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



OPTION II: STRIPPED RAFT / RAFT / COMBINED FOOTINGS:

In view of the observed subsoil strata conditions the proposed structure can be supported on Raft footings at a depth of **2.20 m** below existing ground level. Safe bearing pressure of **15 t/m^2** or **1.50 kg/cm^2** (**150 kPa**) can be adopted for the design of foundation. The soil below **2.20 m** level should be compacted to the thickness of **0.5m after filling quarry dust (Non-Cohesive) to the thickness of 200 mm to 250 mm.** Necessary **Dewatering** technique shall be adopted to **lower** the **ground water table** below the proposed **foundation depth** level. Necessary **Ground Improvement techniques** shall be adopted to improve the **bearing capacity and safe stress distribution** of soils**.** Certain additives such as lime, bitumen, fly ash and cement etc. shall be added onto the soil at site to improve its characteristics.





Lime Stabilization

This technique came into picture more than half a century ago. Lime can be used to treat soils in order to improve their workability and load bearing characteristics in a no. of situations. Quicklime delays the reaction time with soil by about 1.25 times the time taken by slaked lime. Use of lime as a stabilizer enhances the long-term permanent strength, stability and stiffness particularly with respect to the action of water and frost especially in fine grained soils and sometimes in in fine grained fractions of granular soils too. Once the soil has been cured using lime, important works such as creating embankments or subgrade of structures can be done with them, hence avoiding the expensive works like excavation and transport. Generally 2-8% of lime may be required for coarse grained soils and 5 to 8% of lime may be required for plastic soils.

Cement Stabilization

Cement has been one of the oldest binder in the soil stabilization technique. Soil reacts with cement and the hard mixture obtained from the reaction of pulverized soil, Portland cement and water is known as soil-cement. This is done at site by using special equipment. The cementing action is said to be the result of chemical reactions of cement with siliceous soil during hydration reaction. Nature of soil content, mixing conditions, compaction, curing and type of admixtures used are some of the factors that affect the properties of soil cement. This technique is used in shallow depth stabilization in the case of highways and embankment material and in the stabilization of weak soils at a greater depth such as soft soils and peaty soils. The recent developments have taken place mainly in the optimization of tools and process for mass production.

Fly Ash Stabilization

Fly ash, being a waste product from the thermal power plants is generally used in a variety of operations. Around 15% of the fly ash is utilized in the manufacturing of bricks and cement and the remaining is stored as slurries in lagoons. Hence despite having lesser cementitious properties than in lime and cement, the abundance of fly ash has made it an increasingly popular alternative during recent years. The fly ash is used potentially as a subgrade stabilizer and in land reclamation.

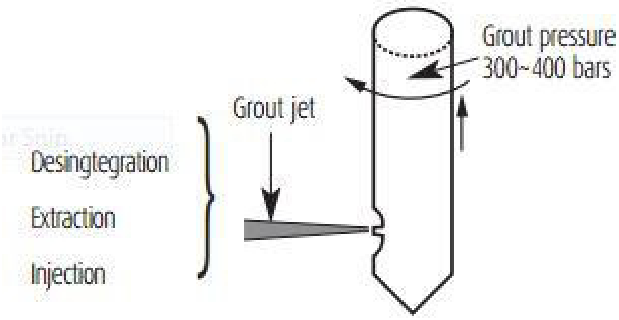
Jet Grouting

This is a costly method for soil stabilization. In this method, External stabilizers are injected into the soil. Jet grouting is used across wide range of soils. In this technique in situ geometries of soilcrete (grouted soil) are created, using a grouting monitor attached to the end of a drill stem. Hydraulic Rotary drill is used to reach the design depth. The jets erode and mix the in situ soil as the drill stem and jet grout monitor are rotated and raised. This method is suitable for stabilizing buried zones of relatively limited extent and is not useful for clayey soils because of their low permeability.

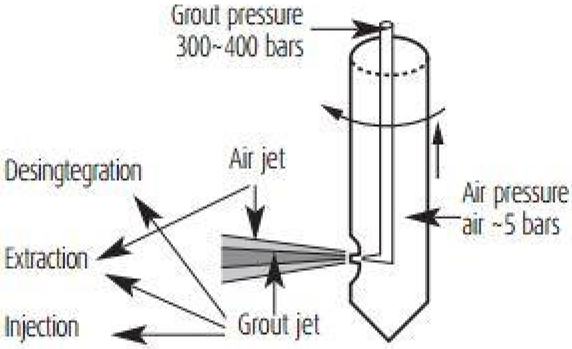
There are three traditional grout systems, namely single, double and triple fluid systems. In a single-fluid jet grouting system (Figure a), a high-velocity cement slurry grout is used for eroding and mixing the soil mass. With this grout, functions such as breaking down of soil matrix, removal of excess material and mixing with soil are easily fulfilled. This method is most commonly used for silts and clays.

Whereas in the double-fluid jet grouting system (Figure b), a two-phase internal fluid system with a coaxial air-jet supply line around the grout-jet supply which increases the erosion efficiency. This system is more effective in cohesive soils than the single-fluid system.

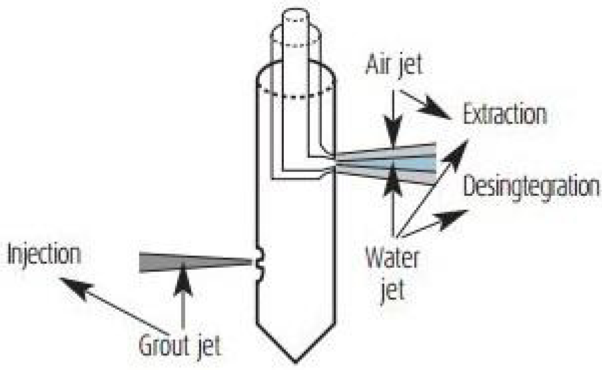
In the triple-fluid jet grouting system (Figure c), water jet is surrounded by an air jet, with a lower grout jet to inject cement slurry at a lower pressure. To erode the soil structure, coaxial air and high-velocity water are used with an additional improvement through partial substitution of the finest soil particles.



(a) Single Jet grouting system



(b) Double Jet grouting system



(c) Triple Jet grouting system

APPENDIX A

BOREHOLE LOG

Client: M/s. EK Infra

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project : Geotechnical investigation for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 13, plot no: 1821 , block no : 42 , Anna Nagar 13th main road, I,H,J,Z,Y - Blocks , survey no : T.S.No : 38,Chennai.

Location: BH-01

Started On : 23/02/2022; Ended On : 24/02/2022 G.W.T: 3.25 m below existing ground level Final Depth: 27.50 m

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details: Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	Relative Density/Consistency	Type of Sample
GL			Brown Clay							
			Brown Clay							
1.00			Brown Clay	1.00	2	3	6	9	Stiff	DS
			Brown Clay							
2.00			Brown Clay	2.00	3	4	4	8	Firm	DS
			Brown Clay							
3.00			Brown Clay	3.00	4	4	6	10	Stiff	DS
3.25	GWT		Brown Clay							
3.60			Brown Clay							
4.50			Brownish Clayey Sand	4.50	6	7	8	15	Medium	DS
			Brownish Clayey Sand							
6.00			Brownish Clayey Sand	6.00	8	9	10	19	Medium	DS
			Brownish Clayey Sand							
7.50			Brownish Clayey Sand	7.50	9	13	15	28	Medium	DS
8.15			Brownish Clayey Sand							
9.00			Blackish Grey Clay	9.00	5	7	7	14	Stiff	DS
9.75			Blackish Grey Clay							
10.50			Greyish Clayey Silty Sand	10.50	6	6	8	14	Medium	DS
			Greyish Clayey Silty Sand							
12.00			Greyish Clayey Silty Sand	12.00	7	7	10	17	Medium	DS
14.00			Greyish Clayey Silty Sand	14.00	8	9	10	19	Medium	DS
			Greyish Clayey Silty Sand							
16.00			Greyish Clayey Silty Sand	16.00	9	12	14	26	Medium	DS
17.40			Greyish Clayey Silty Sand							
18.00			Yellowish Brown Silty Sandy Hard Clay	18.00	10	13	15	28	Very Stiff	DS
20.00			Yellowish Brown Silty Sandy Hard Clay	20.00	11	14	17	31	Hard	DS
22.00			Yellowish Brown Silty Sandy Hard Clay	22.00	14	19	24	43	Hard	DS
22.50			Yellowish Brown Silty Sandy Hard Clay							
24.00			Yellowish Brown Sandy Hard Clay with Gravels	24.00	16	22	28	50	Hard	DS
24.45			Yellowish Brown Sandy Hard Clay with Gravels							
26.00			Yellowish Silty Sandy Shale Clay	26.00	31	50 / 12 cm Bal			Hard	DS
27.50			Yellowish Silty Sandy Shale Clay	27.50	Hammer Rebound				Hard	DS

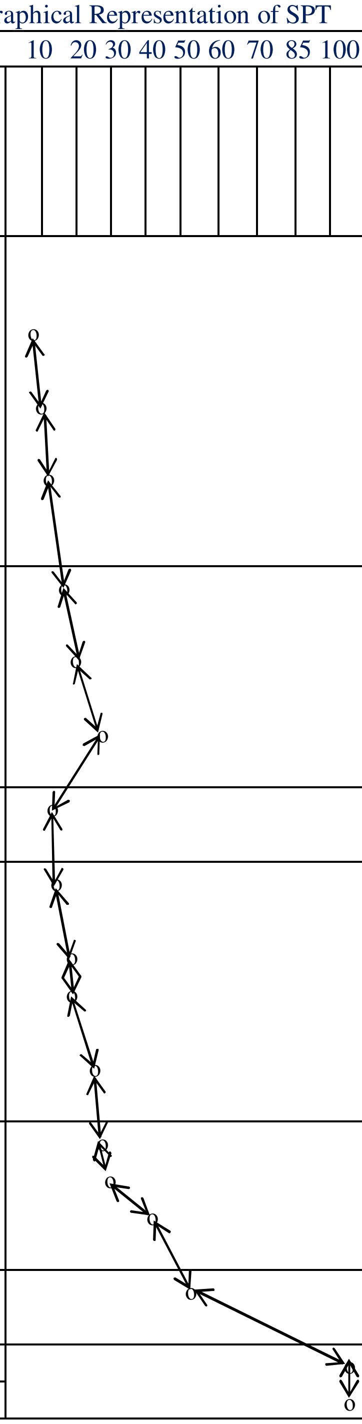


Fig. 2.1 Soil Profile at BH-01 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 27.50 m FROM EXISTING GROUND LEVEL

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.,ע kN/m3**
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 Stength (c), kPa**	**Approx. Rang of Most. Unit Wt.,ע kN/m3**
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%

Table of Laboratory Test Results														
Client: M/s. EK Infra														
Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES														
Project : Geotechnical investigation for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai.														
Bore Hole No	**Depth (m)**		**Type of Soil**	**Grain Size Analaysis (Particle Retained in IS Sieve) %**					**Atterberg Limits**			**IS Classification**	**Natural Moisture Content %**	**Remarks**
	From	**To**		**4.75 mm**	**2.00 mm**	**0.425 mm**	**0.075 mm**	**Fines**	**LL**	**PL**	**PI**			
BH 1	0.00	3.60	Clay	-	-	-	-	-	40.0	20.0	20.0	CI	12.34	
	3.60	8.15	Clayey Sand	0.33	4.58	10.47	37.52	47.10	-	-	-	SC	11.18	
	8.15	9.75	Clay	-	-	-	-	-	42.0	20.0	22.0	CI	13.65	
	9.75	17.40	Clayey Silty Sand	0.52	6.54	7.24	38.65	47.05	-	-	-	SC	12.47	
	17.30	22.50	Silty Sandy Hard Clay	0.24	5.62	7.24	41.15	45.75	39.0	21.0	18.0	CI	10.32	
	22.50	24.45	Sandy Hard Clay with Gravels	12.54	11.18	14.62	22.47	39.19	-	-	-	GP	14.25	
	24.45	27.50	Silty Sandy Shale Clay	-	-	-	-	-	-	-	-	SC	12.15	

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 beat 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.

<u>GENERAL COMMENTS</u>

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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DESIGN OF PILE FOUNDATION (Refer-BH-01)

Refer, IS:2911(Part I/Sec 2)-1979, Reaffirmed 1997

1.0 Type of Installation of Pile **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile(D):	**450.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**26.000**	m
R.L. of Bot. of Pile	-26.00	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.2.1.1 **Layer-I**

Type of Strata:	Clay	
Average SPT of the strata,N:	8	
Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	53.3333	kPa
R.L of top of Strata:	0.00	m
R.L of bottom of Strata:	3.55	m
Average Thickness of Strata,I_c:	3.55	m
Effective overburden pressure over the top of strata,σ_{top}:	0.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	21.30	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	10.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	187.36	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.2 **Layer-II**

Type of Strata:	Sand	
Average SPT of the strata,N:	15	
Bulk Density of the strata,γ:	16	kN/m^3
Angle of Shearing Resistance,ϕ:	31.5	Deg.
R.L of top of Strata:	3.55	m
R.L of bottom of Strata:	8.10	m
Average Thickness of Strata,I_c:	4.55	m
Effective overburden pressure over the top of strata,σ_{top}:	21.30	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	48.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	34.95	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	137.77	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.3 **Layer-III**

Type of Strata:	Clay	
Average SPT of the strata,N:	12	
Bulk Density of the strata,γ:	16	kN/m^3

Undrained Cohesion, Cu:	80	kPa
R.L of top of Strata:	8.10	m
R.L of bottom of Strata:	9.65	m
Average Thickness of Strata,I_c:	1.55	m
Effective overburden pressure over the top of strata,σ_{top}:	48.60	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	57.90	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	53.25	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	122.71	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.4 Layer-IV

Type of Strata:	Sand	
Average SPT of the strata,N:	13	
Bulk Density of the strata,γ:	17	kN/m^3
Angle of Shearing Resistance,ϕ:	30.9	Deg.
R.L of top of Strata:	9.65	m
R.L of bottom of Strata:	17.30	m
Average Thickness of Strata,I_c:	7.65	m
Effective overburden pressure over the top of strata,σ_{top}:	57.90	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	111.45	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	84.68	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	548.07	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.5 Layer-V

Type of Strata:	Clay	
Average SPT of the strata,N:	26	
Bulk Density of the strata,γ:	19	kN/m^3
Undrained Cohesion, Cu:	173.333	kPa
R.L of top of Strata:	17.30	m
R.L of bottom of Strata:	22.60	m
Average Thickness of Strata,I_c:	5.30	m
Effective overburden pressure over the top of strata,σ_{top}:	111.45	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	159.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	135.30	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	909.11	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.6 Layer-VI

Type of Strata:	Clay	

Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	22.60	m
R.L of bottom of Strata:	24.30	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	159.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	176.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	167.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	560.77	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.7 Layer-VII

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	24.30	m
R.L of bottom of Strata:	26.00	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	176.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	193.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	184.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	560.77	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**3026.6**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Clay	
Cross-Sectional Area of pile,Ap:	0.159	m^2
R.L of bottom of pile:	26.00	
Minimum SPT-value of the Bearing Strata	50	
Undrained Cohesion, Cu=(q_u/2):	333.33	kPa
Bearing Capacity Factor(Nc)	9.00	
Ultimate End Bearing Resistance (Qp)	**477.1**	**kN**
(Qp=Ap*Cu*Nc)		

1.3.0	**Ultimate Load Carrying Capacity (Qu=Qp+Qs**	**3503.7**	**kN**
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1401.5**	**kN**
	However, limit Q_{safe} to the structural capacity of pile:	**1200.0**	**kN**

DESIGN OF PILE FOUNDATION (Refer-BH-01)

Refer, IS:2911(Part I/Sec 2)-1979, Reaffirmed 1997

1.0 Type of Installation of Pile **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile(D):	**500.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**26.000**	m
R.L. of Bot. of Pile	-26.00	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.2.1.1 **Layer-I**

Type of Strata:	Clay	
Average SPT of the strata,N:	8	
Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	53.3333	kPa
R.L of top of Strata:	0.00	m
R.L of bottom of Strata:	3.55	m
Average Thickness of Strata,I_c:	3.55	m
Effective overburden pressure over the top of strata,σ_{top}:	0.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	21.30	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	10.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	208.18	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.2 **Layer-II**

Type of Strata:	Sand	
Average SPT of the strata,N:	15	
Bulk Density of the strata,γ:	16	kN/m^3
Angle of Shearing Resistance,ϕ:	31.5	Deg.
R.L of top of Strata:	3.55	m
R.L of bottom of Strata:	8.10	m
Average Thickness of Strata,I_c:	4.55	m
Effective overburden pressure over the top of strata,σ_{top}:	21.30	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	48.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	34.95	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	153.07	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.3 **Layer-III**

Type of Strata:	Clay	
Average SPT of the strata,N:	12	
Bulk Density of the strata,γ:	16	kN/m^3

Undrained Cohesion, Cu:	80	kPa
R.L of top of Strata:	8.10	m
R.L of bottom of Strata:	9.65	m
Average Thickness of Strata,I_c:	1.55	m
Effective overburden pressure over the top of strata,σ_{top}:	48.60	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	57.90	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	53.25	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	136.35	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.4 Layer-IV

Type of Strata:	Sand	
Average SPT of the strata,N:	13	
Bulk Density of the strata,γ:	17	kN/m^3
Angle of Shearing Resistance,ϕ:	30.9	Deg.
R.L of top of Strata:	9.65	m
R.L of bottom of Strata:	17.30	m
Average Thickness of Strata,I_c:	7.65	m
Effective overburden pressure over the top of strata,σ_{top}:	57.90	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	111.45	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	84.68	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	608.96	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.5 Layer-V

Type of Strata:	Clay	
Average SPT of the strata,N:	26	
Bulk Density of the strata,γ:	19	kN/m^3
Undrained Cohesion, Cu:	173.333	kPa
R.L of top of Strata:	17.30	m
R.L of bottom of Strata:	22.60	m
Average Thickness of Strata,I_c:	5.30	m
Effective overburden pressure over the top of strata,σ_{top}:	111.45	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	159.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	135.30	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	1010.13	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.6 Layer-VI

Type of Strata:	Clay	

Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	22.60	m
R.L of bottom of Strata:	24.30	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	159.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	176.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	167.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	623.08	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.7 Layer-VII

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	24.30	m
R.L of bottom of Strata:	26.00	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	176.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	193.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	184.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	623.08	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**3362.9**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Clay	
Cross-Sectional Area of pile,Ap:	0.196	m^2
R.L of bottom of pile:	26.00	
Minimum SPT-value of the Bearing Strata	50	
Undrained Cohesion, Cu=(q_u/2):	333.33	kPa
Bearing Capacity Factor(Nc)	9.00	
Ultimate End Bearing Resistance (Qp)	**589.0**	**kN**
(Qp=Ap*Cu*Nc)		
1.3.0 Ultimate Load Carrying Capacity (Qu=Qp+Qs	**3951.9**	**kN**
Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1580.8**	**kN**
However, limit Q_{safe} to the structural capacity of pile:	**1400.0**	**kN**

DESIGN OF PILE FOUNDATION (Refer-BH-01 - BH-02)

Refer, IS:2911(Part I/Sec 2)-1979, Reaffirmed 1997

1.0 Type of Installation of Pile **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile(D):	**600.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**26.000**	m
R.L. of Bot. of Pile	-26.00	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.2.1.1 **Layer-I**

Type of Strata:	Clay	
Average SPT of the strata,N:	8	
Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	53.3333	kPa
R.L of top of Strata:	0.00	m
R.L of bottom of Strata:	3.55	m
Average Thickness of Strata,I_c:	3.55	m
Effective overburden pressure over the top of strata,σ_{top}:	0.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	21.30	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	10.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	249.82	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.2 **Layer-II**

Type of Strata:	Sand	
Average SPT of the strata,N:	15	
Bulk Density of the strata,γ:	16	kN/m^3
Angle of Shearing Resistance,ϕ:	31.5	Deg.
R.L of top of Strata:	3.55	m
R.L of bottom of Strata:	8.10	m
Average Thickness of Strata,I_c:	4.55	m
Effective overburden pressure over the top of strata,σ_{top}:	21.30	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	48.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	34.95	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	183.69	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.3 **Layer-III**

Type of Strata:	Clay	
Average SPT of the strata,N:	12	
Bulk Density of the strata,γ:	16	kN/m^3

Undrained Cohesion, Cu:	80	kPa
R.L of top of Strata:	8.10	m
R.L of bottom of Strata:	9.65	m
Average Thickness of Strata,I_c:	1.55	m
Effective overburden pressure over the top of strata,σ_{top}:	48.60	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	57.90	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	53.25	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	163.61	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.4 Layer-IV

Type of Strata:	Sand	
Average SPT of the strata,N:	13	
Bulk Density of the strata,γ:	17	kN/m^3
Angle of Shearing Resistance,ϕ:	30.9	Deg.
R.L of top of Strata:	9.65	m
R.L of bottom of Strata:	17.30	m
Average Thickness of Strata,I_c:	7.65	m
Effective overburden pressure over the top of strata,σ_{top}:	57.90	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	111.45	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	84.68	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	730.76	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.5 Layer-V

Type of Strata:	Clay	
Average SPT of the strata,N:	26	
Bulk Density of the strata,γ:	19	kN/m^3
Undrained Cohesion, Cu:	173.333	kPa
R.L of top of Strata:	17.30	m
R.L of bottom of Strata:	22.60	m
Average Thickness of Strata,I_c:	5.30	m
Effective overburden pressure over the top of strata,σ_{top}:	111.45	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	159.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	135.30	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	1212.15	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.6 Layer-VI

Type of Strata:	Clay

Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	22.60	m
R.L of bottom of Strata:	24.30	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	159.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	176.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	167.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	747.70	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.7 Layer-VII

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	24.30	m
R.L of bottom of Strata:	26.00	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	176.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	193.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	184.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	747.70	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**4035.4**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Clay	
Cross-Sectional Area of pile,Ap:	0.283	m^2
R.L of bottom of pile:	26.00	
Minimum SPT-value of the Bearing Strata	50	
Undrained Cohesion, Cu=(q_u/2):	333.33	kPa
Bearing Capacity Factor(Nc)	9.00	
Ultimate End Bearing Resistance (Qp)	**848.2**	**kN**
(Qp=Ap*Cu*Nc)		

1.3.0	**Ultimate Load Carrying Capacity (Qu=Qp+Qs**	**4883.7**	**kN**
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1953.5**	**kN**
	However, limit Q_{safe} to the structural capacity of pile:	**1800.0**	**kN**

Client : M/s. EK Infra

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project :Geotechnical investigation for the proposed construction of G+05 Floors RCC Structure at Door no. New no:

13, plot no: 1821 , block no : 42 , Anna Nagar 13th main road, I,H,J,Z,Y - Blocks , survey no : T.S.No : 38,Chennai.

Pile Load Capacity at 26.00 m terminated Length from Ground Level

S.NO.	PILE DIAMETER (mm)	ULTIMATE LOAD CARRYING CAPACITY OF PILE (SKIN+END) (kN)	SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END) (kN)	RECOMMENDED SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END) (kN)	LATERAL LOAD CARRYING CAPACITY OF PILE (kN)
1	450 mm dia	3504	1401	**1200**	**47**
2	500 mm dia	3952	1581	**1400**	**51**
3	600 mm dia	4884	1953	**1800**	**63**

DESIGN OF OPEN FOUNDATION SYSTEM (Ref. BH-01)

1 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Type of Foundation System:	Open Foundation	
R.L of the top of Borehole (m):	0.00	m
Depth of open excavations below Ground level (Degl):	2.70	m
R.L of the depth of foundation system (m):	-2.70	m
Thickness of CNS:	0.50	m
Effective Depth of Foundation below Ground level (D_f):	2.20	m

1.2 Soil Data :

Type of Bearing Strata :	Clay	
Design SPT-value of the Bearing Strata :	9	
(considered based upon the density of the strata)		
Type of Shear Failure:	General	
Undrained Cohesion, Cu:	60.00	kPa

1.3 Design Parameters:

Bulk Density of Soil above the foundation detph (γ_{bulk})	15.40	kN/m^3
Effective Overburden pressure at foundation level (q)	11.88	kPa
Water Table Correction Factor (w')	0.50	

Bearing Capacity Factors:

N_c = 5.14

N_q = N/A

N_γ = N/A

Shape Factors:

S_c = 1.30

S_q = N/A

S_γ = N/A

Depth Factors :

D_c = 1.00

D_q = N/A

D_γ = 1.00

Inclination Factor:

I_c = 1.00

I_q = N/A

I_γ = N/A

1.4 Ultimate Bearing Capacity (Qu) :

Qu = Cu*Nc*Sc*D_C*I_C+q*(Nq-1)*Sq*Dq*Iq + 0.5*B*γ*Nγ*Sγ*Dγ*Ig*w'

Q_u = 400.92 kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) : 2.50

Qsafe : 160.37 kPa

Recommended Safe Bearing Capacity: 150.00 kPa

1.6 Settlements

Since, the bearing strata are silty sandy clayey soil type, the settlements under the recommended safe bearing pressure 150 kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 150 kPa and average SPT of 9 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 39 mm which is within the permissible limits of 65 mm for Shallow Foundations as per revised I.S:1904.

GLOBE GEOTECHNIQUES

GEOTECHNICAL INVESTIGATION REPORT

PROJECT: Geotechnical investigation for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai.

CLIENT: M/s. EK Infra.

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_FEB22_CTN_077_ANNA NAGAR

26/02/2022

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CONTENTS

INTRODUCTION

This report presents the results of the geotechnical investigations carried out by **GLOBE GEOTECHNIQUES,** for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai.

This work was authorized by **M/s. EK Infra.** This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

One (01) Standard Penetration Testing bore was drilled at the proposed site up to maximum depth of 28.00 m at Borehole location BH-01 below existing ground level as per the request of the client.

The investigation consists of drilling One (01) borehole, soil sampling, field and laboratory testing and preparation of a Geotechnical Report for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai.

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.

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 G+05 Floors RCC Structure at Door no. New no: 138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai.

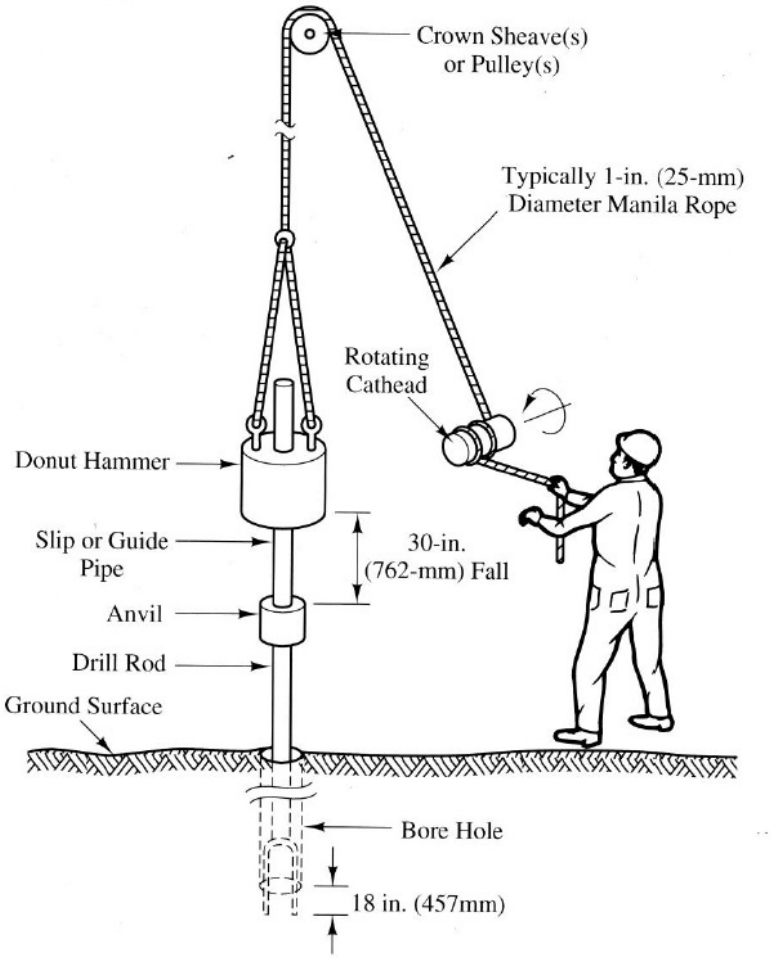
To achieve the above, one (01) bore was drilled at the proposed site up to maximum depth of 28.00 m at Borehole location BH-01. The borehole location was selected by our geotechnical engineer in-charge. Soil samples were collected for visual identification, classification and laboratory testing.

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 21st February 2022 and completed on the day of 22nd February 2022.

One (01) bore was drilled at the proposed site up to maximum depth of 28.00 m at Borehole location BH-01 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.

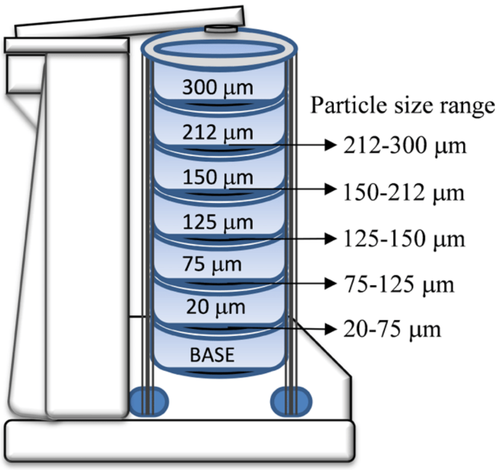
1. Moisture Content
2. Liquid limit (IS: 2720 Part V – 1985)
3. Plastic Limit and Plasticity Index (IS: 2720 Part VI – 1972)
4. Sieve Analysis (IS: 2720 Part IV – 1985)

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.

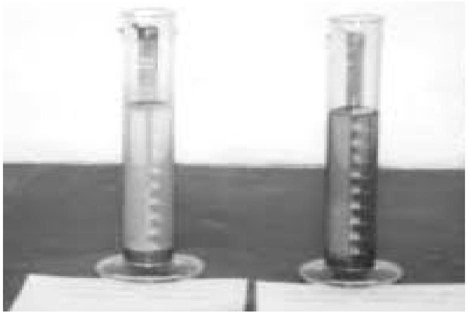


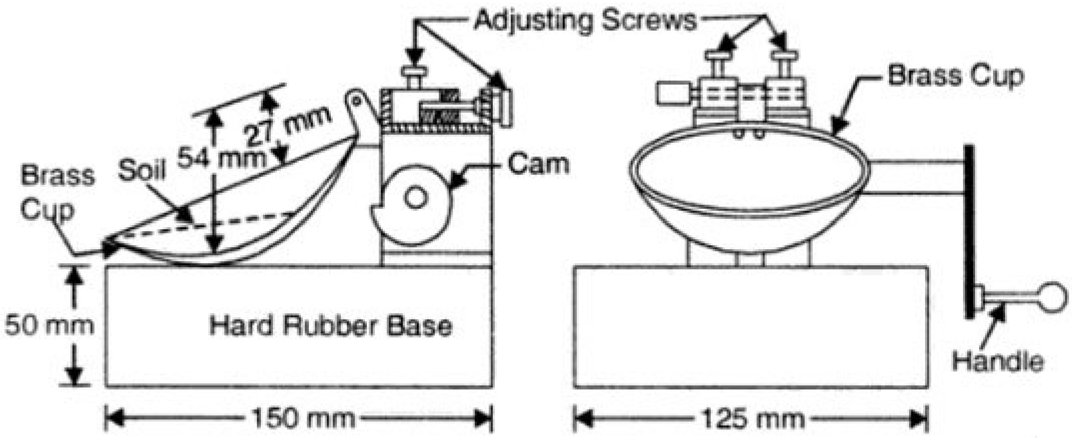
Fine Grained Samples:

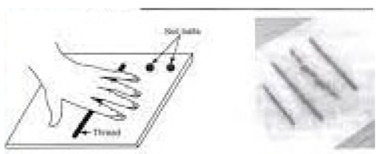
Index Property – Free Swell Tests:

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.







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 – 03.55 m	Brownish Grey Silty Sandy Clay
03.55 m – 08.10 m	Brownish Fine to Medium Sand
08.10 m – 09.65 m	Dark Greyish Silty Sandy Clay
09.65 m – 17.30 m	Dark Greyish Clayey Medium to Fine Sand
17.30 m – 22.60 m	Dark Greyish Clayey Medium to Fine Sand
22.60 m – 24.30 m	Dark Greyish Clayey Medium to Fine Sand
24.30 m – 28.00 m	Dark Greyish Clayey Medium to Fine Sand
Drilling stopped at 28.00 m below EGL	

GROUND WATER

GROUND WATER TABLE	
Borehole Location	**Depth of Ground Water Table**
Borehole I	3.10 m below existing ground level

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:

$q_{nf} = cN_c.s_c.d_c.i_c + \sigma\,(N_q-1)\,s_q.d_q.i_q + 0.5\,B.Y.N_Y.s_Y.d_Y.i_Y W'$

For Local shear failure:

$q_{nf} = 2/3\,cN_c'.s_c.d_c.i_c + \sigma\,(N_q'-1)s_q.d_q.i_q + 0.5\,B.Y.N_Y'.s_Y.d_Y.i_Y W'$

SHAPE FACTORS (IS: 6403-1981)

Shape of base	Shape factors		
	s_c	s_q	s_Y
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: (Σ Rock Pieces ≥10 cm / Core run total Length) x100 %

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 G+05 Floors RCC Structure at Door no. New no: 138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai, the following foundation recommendation shall be adopted.

OPTION I: PILE FOUNDATION:

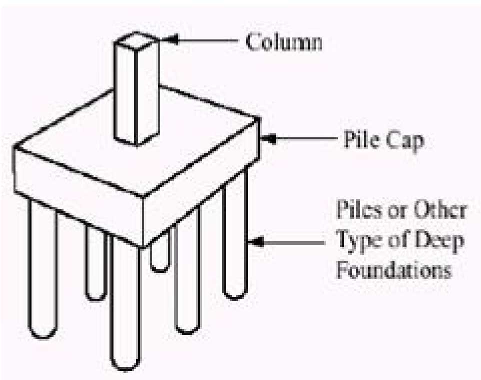
Bored cast in–situ pile (End bearing cum friction) shall be adopted by terminating pile length at 26.00 m from existing ground level.

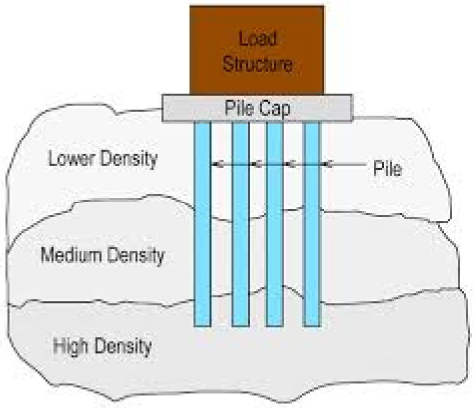
S.NO.	PILE DIAMETER, mm	PILE LENGTH, m	RECOMMENDED SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END), Tonnes	LATERAL LOAD CARRYING CAPACITY OF PILE, Tonnes
1	450 mm dia	26.00	**120**	4.6
2	500 mm dia	26.00	**140**	5.1
3	600 mm dia	26.00	**180**	6.3

Diameter of Pile (mm)	Pile Length (m)	Recommended Safe Load Carrying Capacity of Pile (Skin+End), Tonnes	Recommended Lateral Load Capacity for 5 mm Deflection, Tonnes	Depth of fixity from borehole level (m)
450	26	120	4.60	4.02
500	26	140	5.10	4.47
600	26	180	6.30	5.36

- *Actual pile capacities* shall be verified by pile load tests.

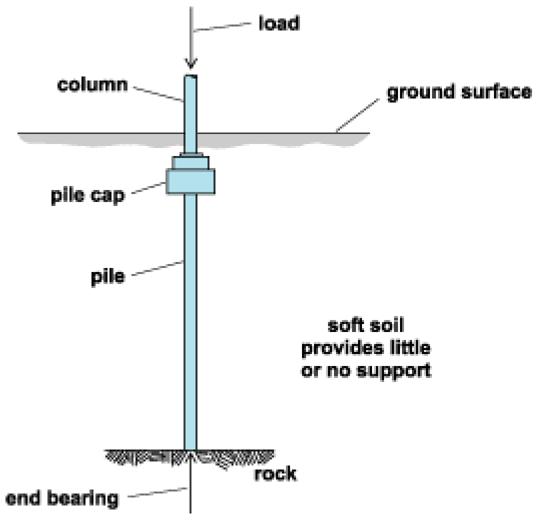
- Since, the behavior of the pile not only depends upon the soil parameters (theoretical load carrying capacity estimates) but also on the execution skill and care, it is mandatory to construct prototype pile load tests as per the guide lines laid down in IS: 2911-Part IV to confirm the theoretical estimates,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





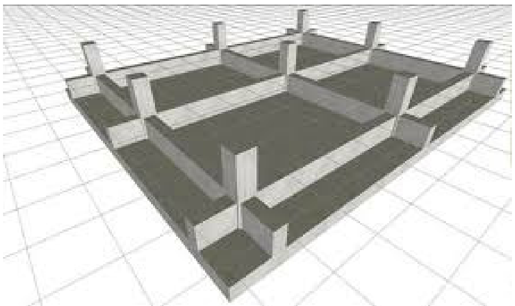
Design and construction of bored cast in situ piles are done in accordance with IS 2911 (part-1/Sec-2) – 2010. The work is basically making a borehole of designed diameter at the designated locations to the required depth, after providing temporary or permanent casing and stabilizing with bentonite slurry;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

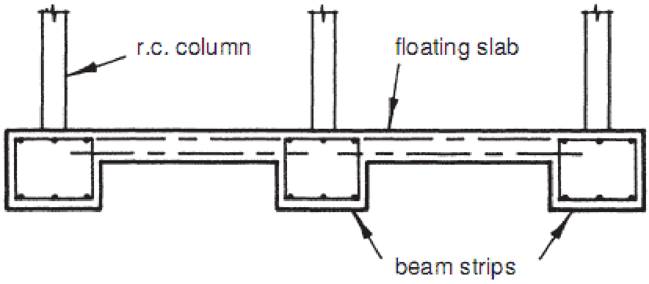
Direct mud circulation method is the less expensive method for doing the boring activity. In this method bentonite slurry is constantly circulated into the bore hole during the boring activity through the bailer pipes, and overflow is collected and redirected to the bentonite slurry tank. The density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



OPTION II: STRIPPED RAFT / RAFT / COMBINED FOOTINGS:

In view of the observed subsoil strata conditions the proposed structure can be supported on Raft footings at a depth of **2.20 m** below existing ground level. Safe bearing pressure of **15 t/m^2** or **1.50 kg/cm^2** (**150 kPa**) can be adopted for the design of foundation. The soil below **2.20 m** level should be compacted to the thickness of **0.5m after filling quarry dust (Non-Cohesive) to the thickness of 200 mm to 250 mm.** Necessary **Dewatering** technique shall be adopted to **lower** the **ground water table** below the proposed **foundation depth** level. Necessary **Ground Improvement techniques** shall be adopted to improve the **bearing capacity and safe stress distribution** of soils**.** Certain additives such as lime, bitumen, fly ash and cement etc. shall be added onto the soil at site to improve its characteristics.





Lime Stabilization

This technique came into picture more than half a century ago. Lime can be used to treat soils in order to improve their workability and load bearing characteristics in a no. of situations. Quicklime delays the reaction time with soil by about 1.25 times the time taken by slaked lime. Use of lime as a stabilizer enhances the long-term permanent strength, stability and stiffness particularly with respect to the action of water and frost especially in fine grained soils and sometimes in in fine grained fractions of granular soils too. Once the soil has been cured using lime, important works such as creating embankments or subgrade of structures can be done with them, hence avoiding the expensive works like excavation and transport. Generally 2-8% of lime may be required for coarse grained soils and 5 to 8% of lime may be required for plastic soils.

Cement Stabilization

Cement has been one of the oldest binder in the soil stabilization technique. Soil reacts with cement and the hard mixture obtained from the reaction of pulverized soil, Portland cement and water is known as soil-cement. This is done at site by using special equipment. The cementing action is said to be the result of chemical reactions of cement with siliceous soil during hydration reaction. Nature of soil content, mixing conditions, compaction, curing and type of admixtures used are some of the factors that affect the properties of soil cement. This technique is used in shallow depth stabilization in the case of highways and embankment material and in the stabilization of weak soils at a greater depth such as soft soils and peaty soils. The recent developments have taken place mainly in the optimization of tools and process for mass production.

Fly Ash Stabilization

Fly ash, being a waste product from the thermal power plants is generally used in a variety of operations. Around 15% of the fly ash is utilized in the manufacturing of bricks and cement and the remaining is stored as slurries in lagoons. Hence despite having lesser cementitious properties than in lime and cement, the abundance of fly ash has made it an increasingly popular alternative during recent years. The fly ash is used potentially as a subgrade stabilizer and in land reclamation.

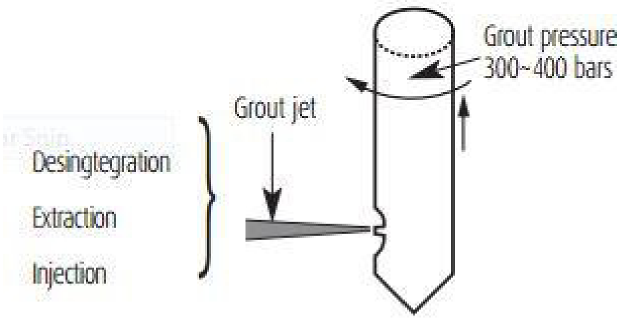
Jet Grouting

This is a costly method for soil stabilization. In this method, External stabilizers are injected into the soil. Jet grouting is used across wide range of soils. In this technique in situ geometries of soilcrete (grouted soil) are created, using a grouting monitor attached to the end of a drill stem. Hydraulic Rotary drill is used to reach the design depth. The jets erode and mix the in situ soil as the drill stem and jet grout monitor are rotated and raised. This method is suitable for stabilizing buried zones of relatively limited extent and is not useful for clayey soils because of their low permeability.

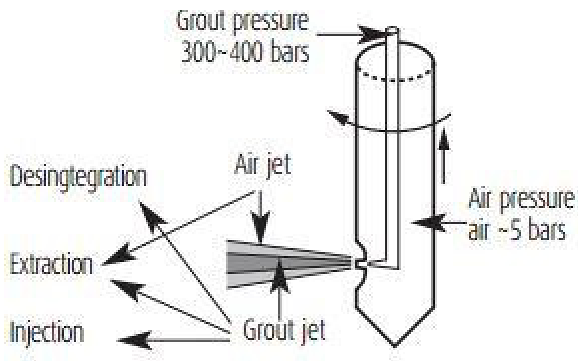
There are three traditional grout systems, namely single, double and triple fluid systems. In a single-fluid jet grouting system (Figure a), a high-velocity cement slurry grout is used for eroding and mixing the soil mass. With this grout, functions such as breaking down of soil matrix, removal of excess material and mixing with soil are easily fulfilled. This method is most commonly used for silts and clays.

Whereas in the double-fluid jet grouting system (Figure b), a two-phase internal fluid system with a coaxial air-jet supply line around the grout-jet supply which increases the erosion efficiency. This system is more effective in cohesive soils than the single-fluid system.

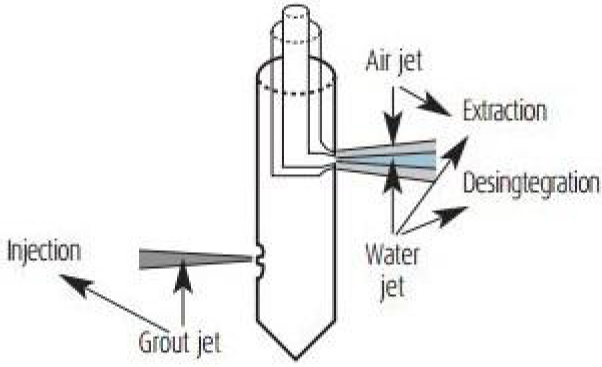
In the triple-fluid jet grouting system (Figure c), water jet is surrounded by an air jet, with a lower grout jet to inject cement slurry at a lower pressure. To erode the soil structure, coaxial air and high-velocity water are used with an additional improvement through partial substitution of the finest soil particles.



(a) Single Jet grouting system



(b) Double Jet grouting system



(c) Triple Jet grouting system

APPENDIX A

BOREHOLE LOG

Client: M/s. EK Infra

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project : Geotechnical investigation for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai.

Location: BH-01

Started On : 21/02/2022; Ended On : 22/02/2022 G.W.T: 3.10 m below existing ground level Final Depth: 28.00 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			Brown Clay							
			Brown Clay							
1.00			Brown Clay	1.00	3	4	4	8	Firm	DS
			Brown Clay							
2.00			Brown Clay	2.00	3	4	5	9	Stiff	DS
			Brown Clay							
3.00			Brown Clay	3.00	4	5	6	11	Stiff	DS
3.10	GWT		Brown Clay							
3.55			Brown Clay							
4.50			Brownish Clayey Sand	4.50	5	6	9	15	Medium	DS
			Brownish Clayey Sand							
6.00			Brownish Clayey Sand	6.00	7	8	11	19	Medium	DS
			Brownish Clayey Sand							
7.50			Brownish Clayey Sand	7.50	8	12	14	26	Medium	DS
8.10			Brownish Clayey Sand							
9.00			Blackish Grey Clay	9.00	6	6	6	12	Stiff	DS
9.65			Blackish Grey Clay							
10.50			Greyish Clayey Silty Sand	10.50	5	6	7	13	Medium	DS
			Greyish Clayey Silty Sand							
12.00			Greyish Clayey Silty Sand	12.00	6	8	9	17	Medium	DS
14.00			Greyish Clayey Silty Sand	14.00	6	8	9	17	Medium	DS
14.55			Greyish Clayey Silty Sand							
16.00			Greyish Clayey Silty Sand	16.00	8	11	13	24	Medium	DS
17.30			Greyish Clayey Silty Sand							
18.00			Yellowish Brown Silty Sandy Hard Clay	18.00	8	12	14	26	Very Stiff	DS
20.00			Yellowish Brown Silty Sandy Hard Clay	20.00	8	13	16	29	Very Stiff	DS
22.00			Yellowish Brown Silty Sandy Hard Clay	22.00	13	18	23	41	Very Stiff	DS
22.60			Yellowish Brown Silty Sandy Hard Clay							
24.00			Yellowish Brown Sandy Hard Clay with Gravels	24.00	17	23	30	53	Hard	DS
24.30			Yellowish Brown Sandy Hard Clay with Gravels							
26.00			Yellowish Silty Sandy Shale Clay	26.00	37	50 / 14 cm Bal			Hard	DS
28.00			Yellowish Silty Sandy Shale Clay	28.00	Hammer Rebound				Hard	DS

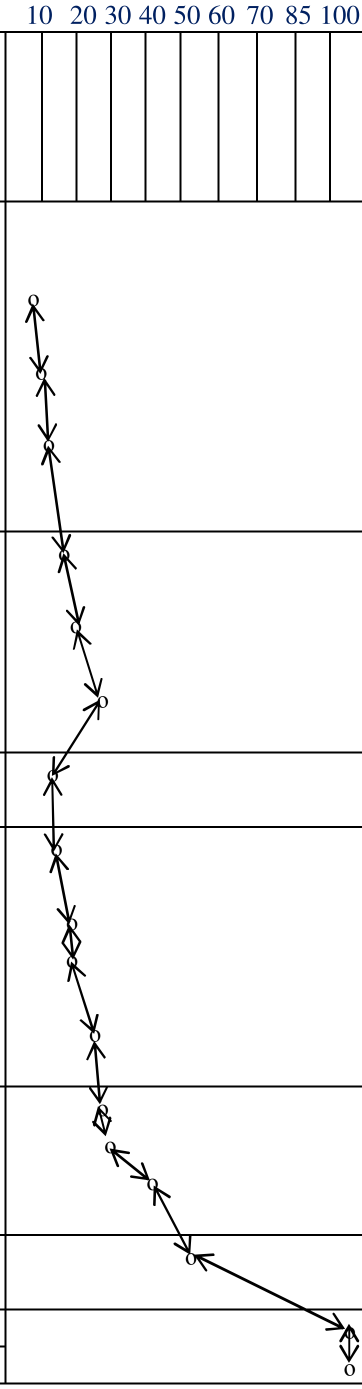


Fig. 2.1 Soil Profile at BH-01 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 28.00 m FROM EXISTING GROUND LEVEL

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.,ע kN/m3
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 Stength (c), kPa	Approx. Rang of Most. Unit Wt.,ע kN/m3
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%

Table of Laboratory Test Results														
Client: M/s. EK Infra														
Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES														
Project : Geotechnical investigation for the proposed construction of G+05 Floors RCC Structure at Door no. New no: 138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai.														
Bore Hole No	**Depth (m)**		**Type of Soil**	**Grain Size Analaysis (Particle Retained in IS Sieve) %**					**Atterberg Limits**			**IS Classification**	**Natural Moisture Content %**	**Remarks**
	From	**To**		**4.75 mm**	**2.00 mm**	**0.425 mm**	**0.075 mm**	**Fines**	**LL**	**PL**	**PI**			
BH 1	0.00	3.10	Clay	-	-	-	-	-	41.0	21.0	20.0	CI	11.15	
	3.10	8.55	Clayey Sand	0.24	6.79	11.22	37.65	44.10	-	-	-	SC	12.65	
	8.55	9.65	Clay	-	-	-	-	-	43.0	21.0	22.0	CI	10.47	
	9.65	17.30	Clayey Silty Sand	0.49	7.22	6.54	38.93	46.82	-	-	-	SC	14.36	
	17.30	22.60	Silty Sandy Hard Clay	0.12	3.54	6.17	33.2	56.97	38.0	18.0	20.0	CI	9.37	
	22.60	24.30	Sandy Hard Clay with Gravels	12.32	11.15	10.32	21.56	44.65	-	-	-	GP	15.24	
	24.30	28.00	Silty Sandy Shale Clay	4.21	12.32	18.27	11.15	54.05	-	-	-	SC	10.34	

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 beat 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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DESIGN OF PILE FOUNDATION (Refer-BH-01)

Refer, IS:2911(Part I/Sec 2)-1979, Reaffirmed 1997

1.0 Type of Installation of Pile **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile(D):	**450.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**26.000**	m
R.L. of Bot. of Pile	-26.00	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.2.1.1 **Layer-I**

Type of Strata:	Clay	
Average SPT of the strata,N:	8	
Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	53.3333	kPa
R.L of top of Strata:	0.00	m
R.L of bottom of Strata:	3.55	m
Average Thickness of Strata,I_c:	3.55	m
Effective overburden pressure over the top of strata,σ_{top}:	0.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	21.30	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	10.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	187.36	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.2 **Layer-II**

Type of Strata:	Sand	
Average SPT of the strata,N:	15	
Bulk Density of the strata,γ:	16	kN/m^3
Angle of Shearing Resistance,ϕ:	31.5	Deg.
R.L of top of Strata:	3.55	m
R.L of bottom of Strata:	8.10	m
Average Thickness of Strata,I_c:	4.55	m
Effective overburden pressure over the top of strata,σ_{top}:	21.30	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	48.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	34.95	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	137.77	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.3 **Layer-III**

Type of Strata:	Clay	
Average SPT of the strata,N:	12	

Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	80	kPa
R.L of top of Strata:	8.10	m
R.L of bottom of Strata:	9.65	m
Average Thickness of Strata,I_c:	1.55	m
Effective overburden pressure over the top of strata,σ_{top}:	48.60	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	57.90	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	53.25	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	122.71	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.4 Layer-IV

Type of Strata:	Sand	
Average SPT of the strata,N:	13	
Bulk Density of the strata,γ:	17	kN/m^3
Angle of Shearing Resistance,ϕ:	30.9	Deg.
R.L of top of Strata:	9.65	m
R.L of bottom of Strata:	17.30	m
Average Thickness of Strata,I_c:	7.65	m
Effective overburden pressure over the top of strata,σ_{top}:	57.90	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	111.45	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	84.68	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	548.07	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.5 Layer-V

Type of Strata:	Clay	
Average SPT of the strata,N:	26	
Bulk Density of the strata,γ:	19	kN/m^3
Undrained Cohesion, Cu:	173.333	kPa
R.L of top of Strata:	17.30	m
R.L of bottom of Strata:	22.60	m
Average Thickness of Strata,I_c:	5.30	m
Effective overburden pressure over the top of strata,σ_{top}:	111.45	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	159.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	135.30	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	909.11	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.6 Layer-VI

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	22.60	m
R.L of bottom of Strata:	24.30	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	159.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	176.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	167.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	560.77	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.7 Layer-VII

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	24.30	m
R.L of bottom of Strata:	26.00	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	176.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	193.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	184.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	560.77	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**3026.6**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Clay	
Cross-Sectional Area of pile,Ap:	0.159	m^2
R.L of bottom of pile:	26.00	
Minimum SPT-value of the Bearing Strata	50	
Undrained Cohesion, Cu=(q_u/2):	333.33	kPa
Bearing Capacity Factor(Nc)	9.00	
Ultimate End Bearing Resistance (Qp)	**477.1**	**kN**
(Qp=Ap*Cu*Nc)		

1.3.0	**Ultimate Load Carrying Capacity (Qu=Qp+Qs**	**3503.7**	**kN**
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1401.5**	**kN**
	However, limit Q_{safe} to the structural capacity of pile:	**1200.0**	**kN**

DESIGN OF PILE FOUNDATION (Refer-BH-01)

Refer, IS:2911(Part I/Sec 2)-1979, Reaffirmed 1997

1.0 Type of Installation of Pile **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile(D):	**500.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**26.000**	m
R.L. of Bot. of Pile	-26.00	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.2.1.1 **Layer-I**

Type of Strata:	Clay	
Average SPT of the strata,N:	8	
Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	53.3333	kPa
R.L of top of Strata:	0.00	m
R.L of bottom of Strata:	3.55	m
Average Thickness of Strata,I_c:	3.55	m
Effective overburden pressure over the top of strata,σ_{top}:	0.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	21.30	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	10.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	208.18	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.2 **Layer-II**

Type of Strata:	Sand	
Average SPT of the strata,N:	15	
Bulk Density of the strata,γ:	16	kN/m^3
Angle of Shearing Resistance,ϕ:	31.5	Deg.
R.L of top of Strata:	3.55	m
R.L of bottom of Strata:	8.10	m
Average Thickness of Strata,I_c:	4.55	m
Effective overburden pressure over the top of strata,σ_{top}:	21.30	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	48.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	34.95	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	153.07	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.3 **Layer-III**

Type of Strata:	Clay	
Average SPT of the strata,N:	12	

Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	80	kPa
R.L of top of Strata:	8.10	m
R.L of bottom of Strata:	9.65	m
Average Thickness of Strata,I_c:	1.55	m
Effective overburden pressure over the top of strata,σ_{top}:	48.60	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	57.90	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	53.25	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	136.35	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.4 Layer-IV

Type of Strata:	Sand	
Average SPT of the strata,N:	13	
Bulk Density of the strata,γ:	17	kN/m^3
Angle of Shearing Resistance,ϕ:	30.9	Deg.
R.L of top of Strata:	9.65	m
R.L of bottom of Strata:	17.30	m
Average Thickness of Strata,I_c:	7.65	m
Effective overburden pressure over the top of strata,σ_{top}:	57.90	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	111.45	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	84.68	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	608.96	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.5 Layer-V

Type of Strata:	Clay	
Average SPT of the strata,N:	26	
Bulk Density of the strata,γ:	19	kN/m^3
Undrained Cohesion, Cu:	173.333	kPa
R.L of top of Strata:	17.30	m
R.L of bottom of Strata:	22.60	m
Average Thickness of Strata,I_c:	5.30	m
Effective overburden pressure over the top of strata,σ_{top}:	111.45	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	159.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	135.30	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	1010.13	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.6 Layer-VI

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	22.60	m
R.L of bottom of Strata:	24.30	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	159.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	176.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	167.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	623.08	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.7 Layer-VII

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	24.30	m
R.L of bottom of Strata:	26.00	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	176.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	193.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	184.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	623.08	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**3362.9**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Clay	
Cross-Sectional Area of pile,Ap:	0.196	m^2
R.L of bottom of pile:	26.00	
Minimum SPT-value of the Bearing Strata	50	
Undrained Cohesion, Cu=(q_u/2):	333.33	kPa
Bearing Capacity Factor(Nc)	9.00	
Ultimate End Bearing Resistance (Qp)	**589.0**	**kN**
(Qp=Ap*Cu*Nc)		

1.3.0	**Ultimate Load Carrying Capacity (Qu=Qp+Qs**	**3951.9**	**kN**
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1580.8**	**kN**
	However, limit Q_{safe} to the structural capacity of pile:	**1400.0**	**kN**

DESIGN OF PILE FOUNDATION (Refer-BH-01 - BH-02)

Refer, IS:2911(Part I/Sec 2)-1979, Reaffirmed 1997

1.0 Type of Installation of Pile **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile(D):	**600.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**26.000**	m
R.L. of Bot. of Pile	-26.00	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.2.1.1 **Layer-I**

Type of Strata:	Clay	
Average SPT of the strata,N:	8	
Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	53.3333	kPa
R.L of top of Strata:	0.00	m
R.L of bottom of Strata:	3.55	m
Average Thickness of Strata,I_c:	3.55	m
Effective overburden pressure over the top of strata,σ_{top}:	0.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	21.30	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	10.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	249.82	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.2 **Layer-II**

Type of Strata:	Sand	
Average SPT of the strata,N:	15	
Bulk Density of the strata,γ:	16	kN/m^3
Angle of Shearing Resistance,ϕ:	31.5	Deg.
R.L of top of Strata:	3.55	m
R.L of bottom of Strata:	8.10	m
Average Thickness of Strata,I_c:	4.55	m
Effective overburden pressure over the top of strata,σ_{top}:	21.30	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	48.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	34.95	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	183.69	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.3 **Layer-III**

Type of Strata:	Clay	
Average SPT of the strata,N:	12	

Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	80	kPa
R.L of top of Strata:	8.10	m
R.L of bottom of Strata:	9.65	m
Average Thickness of Strata,I_c:	1.55	m
Effective overburden pressure over the top of strata,σ_{top}:	48.60	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	57.90	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	53.25	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	163.61	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.4 Layer-IV

Type of Strata:	Sand	
Average SPT of the strata,N:	13	
Bulk Density of the strata,γ:	17	kN/m^3
Angle of Shearing Resistance,ϕ:	30.9	Deg.
R.L of top of Strata:	9.65	m
R.L of bottom of Strata:	17.30	m
Average Thickness of Strata,I_c:	7.65	m
Effective overburden pressure over the top of strata,σ_{top}:	57.90	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	111.45	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	84.68	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	730.76	kN
(q_s:σ*k*tanϕ*pi()*d*Ic)		

1.2.1.5 Layer-V

Type of Strata:	Clay	
Average SPT of the strata,N:	26	
Bulk Density of the strata,γ:	19	kN/m^3
Undrained Cohesion, Cu:	173.333	kPa
R.L of top of Strata:	17.30	m
R.L of bottom of Strata:	22.60	m
Average Thickness of Strata,I_c:	5.30	m
Effective overburden pressure over the top of strata,σ_{top}:	111.45	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	159.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	135.30	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	1212.15	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.6 Layer-VI

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	22.60	m
R.L of bottom of Strata:	24.30	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	159.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	176.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	167.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	747.70	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.7 Layer-VII

Type of Strata:	Clay	
Average SPT of the strata,N:	50	
Bulk Density of the strata,γ:	20	kN/m^3
Undrained Cohesion, Cu:	333.333	kPa
R.L of top of Strata:	24.30	m
R.L of bottom of Strata:	26.00	m
Average Thickness of Strata,I_c:	1.70	m
Effective overburden pressure over the top of strata,σ_{top}:	176.15	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	193.15	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	184.65	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	747.70	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**4035.4**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Clay	
Cross-Sectional Area of pile,Ap:	0.283	m^2
R.L of bottom of pile:	26.00	
Minimum SPT-value of the Bearing Strata	50	
Undrained Cohesion, Cu=(q_u/2):	333.33	kPa
Bearing Capacity Factor(Nc)	9.00	
Ultimate End Bearing Resistance (Qp)	**848.2**	**kN**
(Qp=Ap*Cu*Nc)		

1.3.0	**Ultimate Load Carrying Capacity (Qu=Qp+Qs**	**4883.7**	**kN**
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1953.5**	**kN**
	However, limit Q_{safe} to the structural capacity of pile:	**1800.0**	**kN**

Client : M/s. EK Infra

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project :Geotechnical investigation for the proposed construction of G+05 Floors RCC Structure at Door no. New no:

138, Plot No: 1820 , Block No.42 , Anna Nagar 13th Main Road, I,H,J,Z,Y - Blocks , Survey No : T.S.No : 39, Chennai.

Pile Load Capacity at 26.00 m terminated Length from Ground Level

S.NO.	PILE DIAMETER (mm)	ULTIMATE LOAD CARRYING CAPACITY OF PILE (SKIN+END) (kN)	SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END) (kN)	RECOMMENDED SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END) (kN)	LATERAL LOAD CARRYING CAPACITY OF PILE (kN)
1	450 mm dia	3504	1401	**1200**	**47**
2	500 mm dia	3952	1581	**1400**	**51**
3	600 mm dia	4884	1953	**1800**	**63**

DESIGN OF OPEN FOUNDATION SYSTEM (Ref. BH-01)

1 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Type of Foundation System:	Open Foundation	
R.L of the top of Borehole (m):	0.00	m
Depth of open excavations below Ground level (Degl):	2.70	m
R.L of the depth of foundation system (m):	-2.70	m
Thickness of CNS:	0.50	m
Effective Depth of Foundation below Ground level (D_f):	2.20	m

1.2 Soil Data :

Type of Bearing Strata :	Clay	
Design SPT-value of the Bearing Strata :	9	
(considered based upon the density of the strata)		
Type of Shear Failure:	General	
Undrained Cohesion, Cu:	60.00	kPa

1.3 Design Parameters:

Bulk Density of Soil above the foundation detph (γ_{bulk})	15.40	kN/m^3
Effective Overburden pressure at foundation level (q)	11.88	kPa
Water Table Correction Factor (w')	0.50	

Bearing Capacity Factors:

N_c = 5.14

N_q = N/A

N_γ = N/A

Shape Factors:

S_c = 1.30

S_q = N/A

S_γ = N/A

Depth Factors :

D_c = 1.00

D_q = N/A

$D_\gamma = 1.00$

Inclination Factor:

$I_c = 1.00$

$I_q =$ N/A

$I_\gamma =$ N/A

1.4 Ultimate Bearing Capacity (Qu) :

$Qu = Cu*Nc*Sc*D_C*I_C+q*(Nq-1)*Sq*Dq*Iq + 0.5*B*\gamma*N\gamma*S\gamma*D\gamma*Ig*w'$

$Q_u =$ 400.92 kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) : 2.50

Qsafe : 160.37 kPa

Recommended Safe Bearing Capacity: 150.00 kPa

1.6 Settlements

Since, the bearing strata are silty sandy clayey soil type, the settlements under the recommended safe bearing pressure 150 kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 150 kPa and average SPT of 9 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 39 mm which is within the permissible limits of 65 mm for Shallow Foundations as per revised I.S:1904.

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