GLOBE GEOTECHNIQUES

GEOTECHNICAL INVESTIGATION REPORT

PROJECT:

Geotechnical investigation for the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, Chennai.

CLIENT:

Mrs. Ammu

Soil Investigation carried out and Report prepared by:

GLOBE GEOTECHNIQUES,

No-17/10, Vinayagapuram III Street,MMDA, Arumpakkam,

Chennai - 600 106.

REPORT NO: GGS_JUNE19_015A_ARUMBAKKAM

GLOBE GEOTECHNIQUES CHENNAI

15/06/2019

No.17/10, Vinayagapuram III Street, MMDA, Arumpakkam, Chennai - 600 106.
Mobile: 9994712791 / 9445315710.
E-mail: globegeotechniques@gmail.com

M.A. GANESH

Promoter

CONTENTS

S.NO.	DESCRIPTION	PAGE NO.
1.	INTRODUCTION	1
2.	OBJECTIVE	2
3.	SCOPE OF WORK	2 - 3
4.	INVESTIGATION PROGRAM & TECHNIQUES	3 - 4
5.	LABORATARY TESTING PROGRAM	4 - 5
6.	DETAILS OF SUBSURFACE SOIL	5
7.	GROUND WATER	5
8.	SAFE BEARING CAPACITY	6
9.	FOUNDATION RECOMMENDATIONS	7 - 10
	Appendix – A **BOREHOLE LOG**	A
	Appendix – B - **LABORATARY TEST RESULTS** -	B
	Appendix – C - **GENERAL COMMENTS**	C

INTRODUCTION

This report presents the results of the geotechnical investigations carried out by **GLOBE GEOTECHNIQUES,** for the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, Chennai.

This work was authorized by **Mrs. Ammu.** This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

Two (02) Standard Penetration Testing bores were drilled at the proposed site up to maximum depth of 20.00 m and 10.50 m at Borehole locations BH-01 and BH-02 respectively below existing ground level as per the request of the client.

The investigation consists of drilling Two (02) boreholes, soil sampling, field and laboratory testing and preparation of a Geotechnical Report for the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, 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 samc on completion of field work. Determine the soil profile at the site by conducting Standard Penetration tests at various depths, with ground water observation.

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

Recommend a suitable foundation system and safe bearing pressure at the founding levels for the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, Chennai.

To achieve the above, Two (02) bores were drilled at the proposed site up to maximum depth of 20.00 m and 10.50 m at Borehole locations BH-01 and BH-02 respectively. The borehole location was selected by our geotechnical engineer in-charge.

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 to 10.87 m	Brownish Silty Sandy Clay
10.87 m to 17.23 m	Blackish Grey Silty Sandy Clay
17.23 m to 20.00 m	Yellowish Brown Slate Rock
Drilling stopped at 20.00 m below EGL	

Borehole II	
Layers	**Description of Soil**
00.00 m to 6.36 m	Brownish Silty Sandy Clay
6.36 m to 10.50 m	Blackish Silty Clay
Drilling stopped at 10.50 m below EGL	

GROUND WATER

GROUND WATER TABLE	
Borehole Location	**Depth of Ground Water Table**
Borehole I	Not Encountered during Field Test
Borehole II	Not Encountered during Field Test

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.

FOUNDATION RECOMMENDATION:

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

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

Based on the borehole information in addition to the nature of the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, Chennai, the following foundation recommendation shall be adopted.

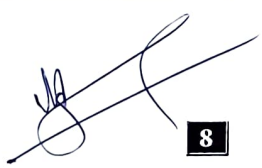
SAFE BEARING CAPACITY OF SOIL

S. NO.	Depth, m	Ultimate Bearing Capcity of Soil, kPa.	Factor of Safety	Safe Bearing Capacity of Soil, kPa	Ultimate Bearing Capcity of Soil, t/sqm	Factor of Safety	Safe Bearing Capacity of Soil, t/sqm.
1	1.50	124.73	2.50	49.89	12.47	2.50	4.99
2	3.00	196.01	2.50	78.40	19.60	2.50	7.84
3	4.50	142.55	2.50	57.02	14.26	2.50	5.70
4	6.00	124.73	2.50	49.89	12.47	2.50	4.99
5	7.50	89.09	2.50	35.64	8.91	2.50	3.56
6	9.00	53.46	2.50	21.38	5.35	2.50	2.14
7	10.50	71.28	2.50	28.51	7.13	2.50	2.85
8	12.00	160.37	2.50	64.15	16.04	2.50	6.41
9	13.50	178.19	2.50	71.28	17.82	2.50	7.13
10	15.00	160.37	2.50	64.15	16.04	2.50	6.41
11	16.50	302.92	2.50	121.17	30.29	2.50	12.12
12	18.00	890.94	2.50	356.38	89.09	2.50	35.64
13	20.00	1781.89	2.50	712.75	178.19	2.50	71.28

OPTION I: PILE FOUNDATION:

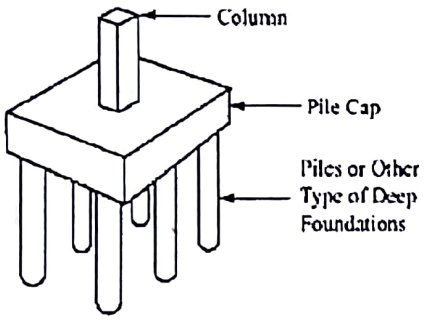
Bored cast in–situ pile (End bearing cum friction) shall be adopted by terminating pile length at 19.00 m from existing ground level.

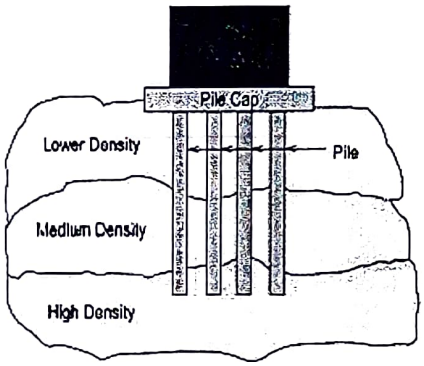
S.NO.	PILE DIAMETER, mm	PILE LENGTH, m	RECOMMENDED SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END), kN	LATERAL LOAD CARRYING CAPACITY OF PILE, kN
1	300 mm dia	19.00	**200.00**	24
2	400 mm dia	19.00	**250.00**	31
3	450 mm dia	19.00	**350.00**	42
4	500 mm dia	19.00	**400.00**	47
5	600 mm dia	19.00	**550.00**	61
6	800 mm dia	19.00	**850.00**	94



- *Actual pile capacities will* range between 25 to 55 tonnes, which shall be verified by pile load tests.

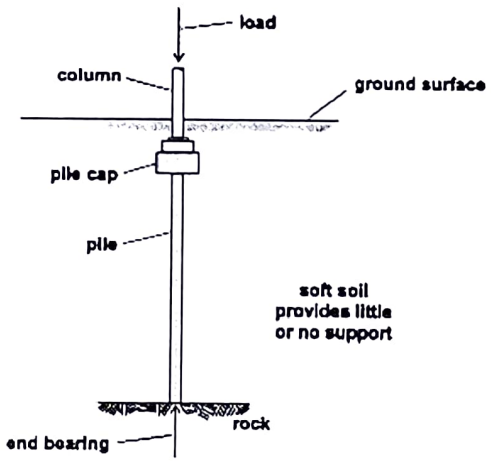
- Since, the behavior of the pile not only depends upon the soil parameters (theoretical load carrying capacity estimates) but also on the execution skill and care, it is mandatory to construct prototype pile load tests as per the guide lines laid down in IS: 2911-Part IV to confirm the theoretical estimates,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



GENERAL: All Structures have to be designed for higher seismic forces (Zone III) due to increased seismic activity in peninsular India in the last decade.

GEOTECHNICAL ENGINEER

G.MANOJ KUMAR M.E.,
Registered Geotechnical Engineer
GTE/15.08.012 - DTCP & GTE/TVLR/01/2019 - DTCP
GLOBE GEOTECHNICAL SERVICES
CHENNAI - 600 101

APPENDIX A

BOREHOLE LOG

nt : Mrs. Ammu

oil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project :Geotechnical investigation for the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, Chennai.

Location: BH-01

Started On : 04/06/2019; Ended On : 04/06/2019 G.W.T: Not Encountered during Field Test Final Depth: 20.00 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	Graphical Representation of SPT (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
GL			Brownish Silty Sandy Clay								
1.50			Brownish Silty Sandy Clay	1.50	3	3	4	7		Firm	DS
			Brownish Silty Sandy Clay								
3.00			Brownish Silty Sandy Clay	3.00	4	5	6	11		Stiff	DS
			Brownish Silty Sandy Clay								
4.50			Brownish Silty Sandy Clay	4.50	3	4	4	8		Firm	DS
			Brownish Silty Sandy Clay								
6.00			Brownish Silty Sandy Clay	6.00	3	4	3	7		Firm	DS
			Brownish Silty Sandy Clay								
7.50			Brownish Silty Sandy Clay	7.50	1	3	2	5		Firm	DS
			Brownish Silty Sandy Clay								
9.00			Brownish Silty Sandy Clay	9.00	0	1	2	3		Soft	DS
			Brownish Silty Sandy Clay								
10.50			Brownish Silty Sandy Clay	10.50	2	2	2	4		Soft	DS
10.87 m			Brownish Silty Sandy Clay								
			Blackish Grey Silty Sandy Clay								
12.00			Blackish Grey Silty Sandy Clay	12.00	3	4	5	9		Stiff	DS
			Blackish Grey Silty Sandy Clay								
			Blackish Grey Silty Sandy Clay								
13.50			Blackish Grey Silty Sandy Clay	13.50	4	4	6	10		Stiff	DS
			Blackish Grey Silty Sandy Clay								
			Blackish Grey Silty Sandy Clay								
15.00			Blackish Grey Silty Sandy Clay	15.00	4	5	4	9		Stiff	DS
			Blackish Grey Silty Sandy Clay								
			Blackish Grey Silty Sandy Clay								
16.50			Blackish Grey Silty Sandy Clay	16.50	5	7	10	17		Very Stiff	DS
17.23 m			Blackish Grey Silty Sandy Clay								
			Yellowish Brown Slate Rock								
18.00			(Weathered / Disintegrated Rock)	18.00	27	50 / 6 cm Bal				Hard	DS
			Yellowish Brown Slate Rock								
			(Weathered / Disintegrated Rock)								
20.00 m			Yellowish Brown Slate Rock	20.00	50 / 15 cm Balance					Hard	DS

Fig. 2.1 Soil Profile at BH-01 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 20.00 m FROM EXISTING GROUND LEVEL

nt : Mrs. Ammu

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project :Geotechnical investigation for the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, Chennai.

Location: BH-02

Started On : 04/06/2019; Ended On : 05/06/2019 G.W.T: Not Encountered during Field Test Final Depth: 10.50 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	Graphical Representation of SPT (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
GL			Brownish Silty Sandy Clay								
			Brownish Silty Sandy Clay								
			Brownish Silty Sandy Clay								
1.50			Brownish Silty Sandy Clay	1.50	3	3	3	6		Firm	DS
			Brownish Silty Sandy Clay								
			Brownish Silty Sandy Clay								
			Brownish Silty Sandy Clay								
3.00			Brownish Silty Sandy Clay	3.00	2	3	5	8		Firm	DS
			Brownish Silty Sandy Clay								
			Brownish Silty Sandy Clay								
			Brownish Silty Sandy Clay								
4.50			Brownish Silty Sandy Clay	4.50	4	3	4	7		Firm	DS
			Brownish Silty Sandy Clay								
			Brownish Silty Sandy Clay								
			Brownish Silty Sandy Clay								
6.00			Brownish Silty Sandy Clay	6.00	2	3	3	6		Firm	DS
6.36 m			Brownish Silty Sandy Clay								
			Blackish Silty Clay								
			Blackish Silty Clay								
7.50			Blackish Silty Clay	7.50	2	2	3	5		Firm	DS
			Blackish Silty Clay								
			Blackish Silty Clay								
			Blackish Silty Clay								
9.00			Blackish Silty Clay	9.00	1	2	1	3		Soft	DS
			Blackish Silty Clay								
			Blackish Silty Clay								
			Blackish Silty Clay								
10.50 m			Blackish Silty Clay	10.50	0	1	1	2		Very Soft	DS

Fig. 2.2 Soil Profile at BH-02 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 10.50 m FROM EXISTING GROUND LEVEL

GEOTECHNICAL ENGINEER

APPENDIX B

LABORATORY TEST RESULTS

Client : Mrs. Ammu

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project :Geotechnical investigation for the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, Chennai.

BORED CAST IN SITU PILE - LENGTH 20.00 m

S.NO.	PILE DIAMETER, kN	ULTIMATE SKIN RESISTANCE , kN	ULTIMATE END BEARING RESISTANCE, kN	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
1	300 mm dia	**668.53**	158.34	826.87	598.16	**200.00**
2	400 mm dia	**891.37**	281.49	1172.86	825.69	**250.00**
3	450 mm dia	**1002.80**	356.26	1359.05	944.74	**350.00**
4	500 mm dia	**1114.22**	439.82	1554.04	1067.30	**400.00**
5	600 mm dia	**1337.06**	633.35	1970.41	1322.99	**550.00**
6	800 mm dia	**1782.75**	1125.95	2908.70	1876.58	**850.00**

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.

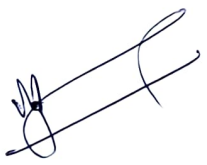
Any over excavation in the foundation trenches should be re-filled by plain concrete and any disturbed and loose materials found in the foundation trenches should be removed before placement of P.C.C.

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

G.MANOJ KUMAR, B.E (CIVIL), M.E (GEO-TECH) (PhD)
Mobile: 9445315710 / 9994712791.
E-mail: globegeotechniques@gmail.com

G.MANOJ KUMAR M.E.,
Registered Geotechnical Engineer
GTE/19/03/012 - CMDA & GTE/TVLR/01/2019 - DTCP
GLOBE GEOTECHNIQUES
9445315710, 9994712791

GLOBE GEOTECHNIQUES CHENNAI

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):	**300.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**19.000**	m
R.L. of Bot. of Pile	19.00	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	
Avcrage SPT of thc 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:	19.00	m
Average Thickness of Strata,I_c:	19.00	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}:	114.00	kN/m^2
Effective overburden pressurc at thc middlc of the strata,σ_{middle}:	57.00	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	668.53	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**668.5**	kN

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Weathered Rock	
Cross-Sectional Area of pile,Ap:	0.071	m^2
R.L of bottom of pile:	19.00	
Minimum SPT-value of the Bearing Strata	50	
Angle of Shearing Resistance(ASR)	41.00	Degrees
Bearing Capacity Factor(Nq)	70.00	
Effecitve Over Burden Pressure at the bottom of pile (q)	32.00	kPa
(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)		
Ultimate End Bearing Resistance (Qp)	**158.3**	kN
(Qp=Ap*q*Nq)		

1.3.0	**Ultimate Load Carrying Capacity ($Qu=Qp+q_p$)**	**826.9**	kN
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**598.2**	kN
	However, limit Q_{safe} to the structural capacity of pile:	**200.0**	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):	**400.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**19.000**	m
R.L. of Bot. of Pile	19.00	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:	19.00	m
Average Thickness of Strata,I_c:	19.00	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}:	114.00	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	57.00	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	891.37	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**891.4**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Weathered Rock	
Cross-Sectional Area of pile,Ap:	0.126	m^2
R.L of bottom of pile:	19.00	
Minimum SPT-value of the Bearing Strata	50	
Angle of Shearing Resistance(ASR)	41.00	Degrees
Bearing Capacity Factor(Nq)	70.00	
Effecitve Over Burden Pressure at the bottom of pile (q)	32.00	kPa
(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)		
Ultimate End Bearing Resistance (Qp)	**281.5**	**kN**
(Qp=Ap*q*Nq)		

1.3.0 **Ultimate Load Carrying Capacity (Qu=Qp+q_p)**	**1172.9**	**kN**
Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**825.7**	**kN**
However, limit Q_{safe} to the structural capacity of pile:	**250.0**	**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):	**450.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**19.000**	m
R.L. of Bot. of Pile	19.00	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:	1.70	m
Average Thickness of Strata,I_c:	19.00	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}:	114.00	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	57.00	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	1002.80	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**1002.8**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Weathered Rock	
Cross-Sectional Area of pile,Ap:	0.159	m^2
R.L of bottom of pile:	19.00	
Minimum SPT-value of the Bearing Strata	50	
Angle of Shearing Resistance(ASR)	41.00	Degrees
Bearing Capacity Factor(Nq)	70.00	
Effecitve Over Burden Pressure at the bottom of pile (q)	32.00	kPa
(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)		
Ultimate End Bearing Resistance (Qp)	**356.3**	**kN**
(Qp=Ap*q*Nq)		

1.3.0	**Ultimate Load Carrying Capacity (Qu=Qp+q_p)**	**1359.1**	**kN**
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**944.7**	**kN**
	However, limit Q_{safe} to the structural capacity of pile:	**350.0**	**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):	**500.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**19.000**	m
R.L. of Bot. of Pile	19.00	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:	1.70	m
Average Thickness of Strata,I_c:	19.00	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}:	114.00	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	57.00	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	1114.22	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**1114.2**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Weathered Rock	
Cross-Sectional Area of pile,Ap:	0.196	m^2
R.L of bottom of pile:	19.00	
Minimum SPT-value of the Bearing Strata	50	
Angle of Shearing Resistance(ASR)	41.00	Degrees
Bearing Capacity Factor(Nq)	70.00	
Effecitve Over Burden Pressure at the bottom of pile (q)	32.00	kPa
(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)		
Ultimate End Bearing Resistance (Qp)	**439.8**	**kN**
(Qp=Ap*q*Nq)		

1.3.0 Ultimate Load Carrying Capacity (Qu=Qp+q_p)	**1554.0**	**kN**
Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1067.3**	**kN**
However, limit Q_{safe} to the structural capacity of pile:	**400.0**	**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) :	**19.000**	m
R.L. of Bot. of Pile	19.00	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:	1.70	m
Average Thickness of Strata,I_c:	19.00	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}:	114.00	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	57.00	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	1337.06	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**1337.1**	kN

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Weathered Rock	
Cross-Sectional Area of pile,Ap:	0.283	m^2
R.L of bottom of pile:	19.00	
Minimum SPT-value of the Bearing Strata	50	
Angle of Shearing Resistance(ASR)	41.00	Degrees
Bearing Capacity Factor(Nq)	70.00	
Effecitve Over Burden Pressure at the bottom of pile (q)	32.00	kPa
(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)		
Ultimate End Bearing Resistance (Qp)	**633.3**	kN
(Qp=Ap*q*Nq)		

1.3.0 Ultimate Load Carrying Capacity (Qu=Qp+q_p)	**1970.4**	kN
Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1323.0**	kN
However, limit Q_{safe} to the structural capacity of pile:	**550.0**	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):	**800.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**19.000**	m
R.L. of Bot. of Pile	19.00	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:	1.70	m
Average Thickness of Strata,I_c:	19.00	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}:	114.00	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	57.00	kN/m^2
Adhesion Factor, α:	0.70	
Skin Resistance of the pile,q_s:	1782.75	kN
(q_s:α*Cu*pi()*d*Ic)		
Ultimate Skin Resistance,q_s:	**1782.7**	**kN**

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Weathered Rock	
Cross-Sectional Area of pile,Ap:	0.503	m^2
R.L of bottom of pile:	19.00	
Minimum SPT-value of the Bearing Strata	50	
Angle of Shearing Resistance(ASR)	41.00	Degrees
Bearing Capacity Factor(Nq)	70.00	
Effecitve Over Burden Pressure at the bottom of pile (q)	32.00	kPa
(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)		
Ultimate End Bearing Resistance (Qp)	**1125.9**	**kN**
(Qp=Ap*q*Nq)		

1.3.0	**Ultimate Load Carrying Capacity (Qu=Qp+q_p)**	**2908.7**	**kN**
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1876.6**	**kN**
	However, limit Q_{safe} to the structural capacity of pile:	**850.0**	**kN**

Client : Mrs. Ammu

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project :Geotechnical investigation for the proposed Construction of Stilt+03 Commercial- Hall type Structure at PC 51, Razzak Garden Street, Arumbakkam, Chennai.

BORED CAST IN SITU PILE - LENGTH 20.00 m

S.NO.	PILE DIAMETER, kN	ULTIMATE SKIN RESISTANCE , kN	ULTIMATE END BEARING RESISTANCE, kN	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
1	300 mm dia	668.53	158.34	826.87	598.16	200.00
2	400 mm dia	891.37	281.49	1172.86	825.69	250.00
3	450 mm dia	1002.80	356.26	1359.05	944.74	350.00
4	500 mm dia	1114.22	439.82	1554.04	1067.30	400.00
5	600 mm dia	1337.06	633.35	1970.41	1322.99	550.00
6	800 mm dia	1782.75	1125.95	2908.70	1876.58	850.00

