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GEOTECHNICAL INVESTIGATION REPORT

PROJECT: Geotechnical investigation for the proposed construction of Stilt+03 Floors RCC Framed Structure at No.33, Buddhar Street, Selaiyur, East Tambaram, Chennai - 600 059.

CLIENT: M/s. Sivaram Homes Pvt. Ltd.,

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_AUG23_CTN_095_EAST TAMBARAM

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INTRODUCTION

This report presents the results of the geotechnical investigations carried out by **GLOBE GEOTECHNIQUES,** for the proposed construction of Stilt+03 Floors RCC Framed Structure at No.33, Buddhar Street, Selaiyur, East Tambaram, Chennai - 600 059.

This work was authorized by **M/s. Sivaram Homes Pvt. Ltd.,** 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 03.40 m and 04.50 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 Floors RCC Framed Structure at No.33, Buddhar Street, Selaiyur, East Tambaram, Chennai - 600 059.

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.

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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 Floors RCC Framed Structure at No.33, Buddhar Street, Selaiyur, East Tambaram, Chennai - 600 059.

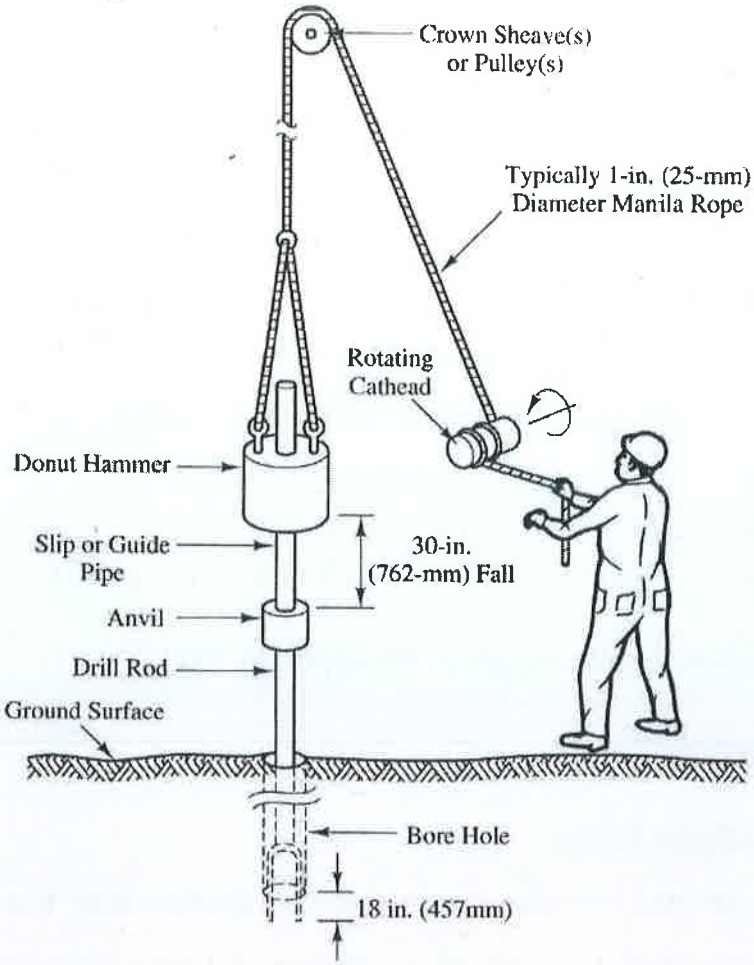
To achieve the above, two (02) bores were drilled at the proposed site up to maximum depth of 03.40 m and 04.50 m at Borehole locations BH-01 and BH-02 respectively. The borehole location was selected by our geotechnical engineer in-charge. Soil samples were collected for visual identification, classification and laboratory testing.

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

INVESTIGATION PROGRAM & TECHNIQUES

After the visual inspection of the site, the subsurface investigation was started on 30th August 2023 and completed on the same day of 30th August 2023.

Two (02) bores were drilled at the proposed site up to maximum depth of 03.40 m and 04.50 m at Borehole locations BH-01 and BH-02 respectively selected by the geotechnical engineer in-charge. Rotary drilling was performed using water as drilling fluid in the sub soil with casing pipe to stabilize the boreholes up to the required depth. Field testing and sampling were conducted in accordance with IS: 2131-1981.



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

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

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LABORATORY TESTING PROGRAM

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

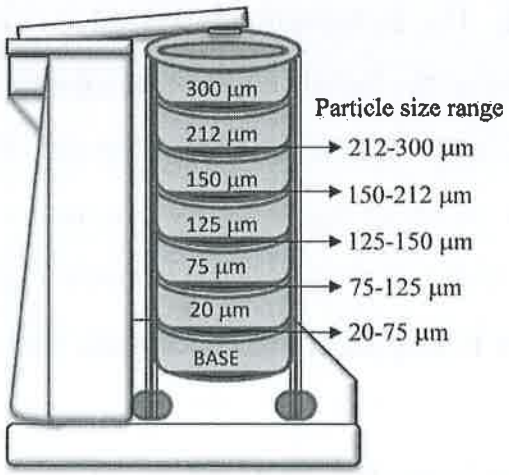
1. Moisture Content
2. Liquid limit (IS: 2720 Part V – 1985)
3. Plastic Limit and Plasticity Index
(IS: 2720 Part VI – 1972)
4. Sieve Analysis (IS: 2720 Part IV – 1985)

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

Coarse Grained Samples:

Grain size Analysis Tests:

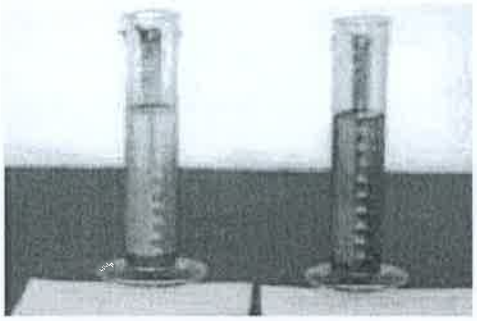
On the coarse-grained samples, grain size distribution tests were conducted as per I.S.2720 (Part 4)-1985, to know the gradation characteristics and to classify them. These results are presented in Tables.

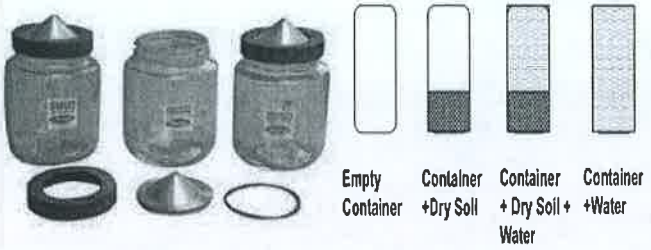


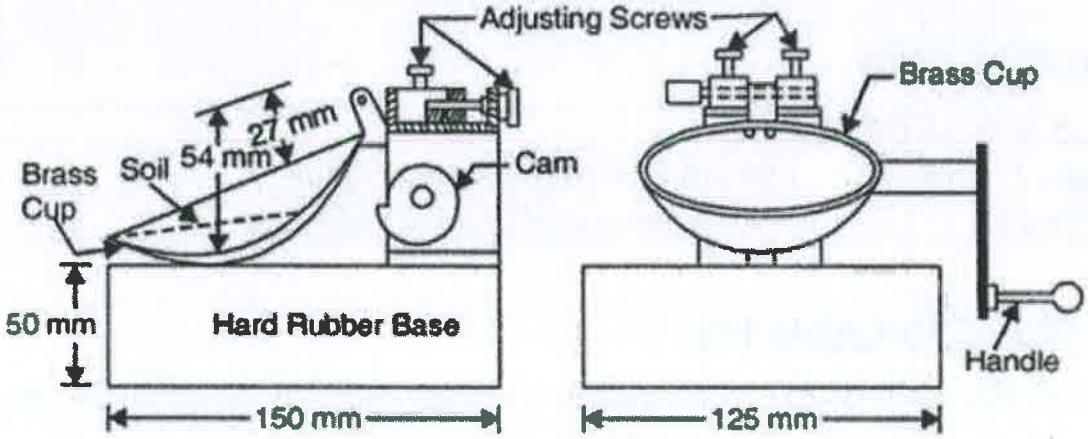
Fine Grained Samples:

Index Property – Free Swell Tests:

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









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SUBSURFACE SOIL DESCRIPTION

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

Borehole I	
Layers	**Description of Soil**
00.00 m - 01.60 m	Reddish Brown Clayey Sand with Gravels
01.60 m – 02.70 m	Yellowish Brown Clayey Sand with SDR
02.70 m – 03.40 m	Soft Weathered / Disintegrated Rock
Below 03.40 m	Hard Rock
Drilling stopped at 03.40 m below EGL	

Borehole II	
Layers	**Description of Soil**
00.00 m - 01.75 m	Reddish Brown Clayey Sand with Gravels
01.75 m – 02.60 m	Yellowish Brown Clayey Sand with SDR
02.60 m – 03.40 m	Soft Weathered / Disintegrated Rock
Below 03.40 m	Hard Rock
Drilling stopped at 03.40 m below EGL	

GROUND WATER

GROUND WATER TABLE	
Borehole Location	**Depth of Ground Water Table**
Borehole I-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:

$q_{nf} = cN_c.s_c.d_c.i_c + (N_q-1)\, s_q.d_q.i_q + 0.5\, B.\, .N\, .s\, .d\, .i\, W'$

For Local shear failure:

$q_{nf} = 2/3\, cN_c'.s_c.d_c.i_c + (N_q'-1)s_q.d_q.i_q + 0.5\, B.\, .N\, '.s\, .d\, .i\, W'$

SHAPE FACTORS (IS: 6403-1981)

Shape of base	Shape factors		
	Sc	Sq	S
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: (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

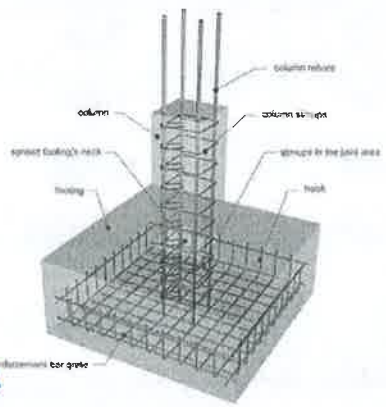
system should be safe against bearing strata shear response under the super structure load intensity. Similarly, the stability of the foundation system is governed by the bearing strata deformation response under the super structure load intensity.

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 Stilt+03 Floors RCC Framed Structure at No.33, Buddhar Street, Selaiyur, East Tambaram, Chennai - 600 059, the following foundation recommendation shall be adopted.

ISOLATED FOUNDATION / COMBINED FOOTINGS:

In view of the observed subsoil strata conditions the proposed structure can be supported on **Isolated/Combined footings** at a depth of **2.00 m** below existing ground level. Safe bearing pressure of **30 t/m2** or **3.00 kg/cm2 (300 kPa)** can be adopted for the design of foundation.



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APPENDIX A

BOREHOLE LOG

Client : M/s. Sivaram Homes Pvt. Ltd.,
Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES
Project : Geotechnical investigation for the proposed construction of Stilt+03 Floors RCC Framed Structure at No.33, Buddhar Street, Selaiyur, East Tambaram, Chennai - 600 059.
Location : BH - 01
Started On : 30/08/2023; Ended On : 30/08/2023 G.W.T: Not Encountered During Field Test Final Depth: 03.40 m

			Engineering Description of Soil	SPT - Details					Graphical Representation of SPT (10 20 30 40 50 60 70 85 100)		
GL			Reddish Brown Clayey Sand with Gravels Reddish Brown Clayey Sand with Gravels Reddish Brown Clayey Sand with Gravels Reddish Brown Clayey Sand with Gravels Reddish Brown Clayey Sand with	1.00	4	6	8	14		Medium	DS
1.00											
1.60											
			Yellowish Brown Clayey Sand with SDR Yellowish Brown Clayey Sand with SDR Yellowish Brown Clayey Sand with SDR Yellowish Brown Clayey Sand with SDR Yellowish Brown Clayey Sand with SDR	2.00	15	29	50 / 2 cm			Very Dense	DS
2.00											
			Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock Soft Weathered / Disintegrated Rock	3.00	39	50 / 14 cm Bal				Very Dense	DS
3.00					Hammer Rebound						
			Hard Rock Hard Rock Hard Rock Hard Rock Hard Rock Hard Rock Hard Rock Hard Rock Hard Rock Hard Rock Hard Rock								

Fig. 2.1 Soil Profile at BH-01 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 03.40 m FROM EXISTING GROUND LEVEL

Client : M/s. Sivaram Homes Pvt. Ltd.,
Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES
Project : Geotechnical investigation for the proposed construction of Stilt+03 Floors RCC Framed Structure at No.33, Buddhar Street, Selaiyur, East Tambaram, Chennai - 600 059.
Location : BH - 02
Started On : 30/08/2023; Ended On : 30/08/2023 G.W.T: Not Encountered During Field Test Final Depth: 04.50 m

			Engineering Description of Soil	SPT - Details				Graphical Representation of SPT 10 20 30 40 50 60 70 85 100		
GL			Reddish Brown Clayey Sand with Gravels Reddish Brown Clayey Sand with Gravels							
1.00			Reddish Brown Clayey Sand with Gravels Reddish Brown Clayey Sand with Gravels	1.00	4	7	9	16	Medium	DS
1.75			Reddish Brown Clayey Sand with							
			Yellowish Brown Clayey Sand with SDR							
			Yellowish Brown Clayey Sand with SDR	2.00	43	50 / 18 cm Bal			Very Dense	DS
2.00			Yellowish Brown Clayey Sand with SDR							
			Yellowish Brown Clayey Sand with SDR							
			Yellowish Brown Clayey Sand with SDR							
			Soft Weathered / Disintegrated Rock							
3.00			Soft Weathered / Disintegrated Rock	3.00	50 / 11 cm Balance				Very Dense	DS
			Soft Weathered / Disintegrated Rock							
			Soft Weathered / Disintegrated Rock							
			Soft Weathered / Disintegrated Rock							
			Soft Weathered / Disintegrated Rock							
4.50			Soft Weathered / Disintegrated Rock	4.50	Hammer Rebound				Very Dense	DS
			Hard Rock							
			Hard Rock							
			Hard Rock							
			Hard Rock							
			Hard Rock							
			Hard Rock							
			Hard Rock							
			Hard Rock							
			Hard Rock							
			Hard Rock							

Fig. 2.2 Soil Profile at BH-02 Location

BORE HOLE IS TERMINATED AT THE DEPTH OF 04.50 m FROM EXISTING GROUND LEVEL

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APPENDIX B

LABORATORY TEST RESULTS

TABLE – 1

Correlations of SPT N values with Common properties of soils

A) Granular Soil

S.NO.	Standard Penetration No., SPT N	Description	Relative Density, Dr %	Approx. Angle of Internal Friction,	Approx. Rang of Most. Unit Wt., 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., 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. Sivaram Homes Pvt. Ltd.,

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project : Geotechnical investigation for the proposed construction of Stilt+03 Floors RCC Framed Structure at No.33, Buddhar Street, Selaiyur, East Tambaram, Chennai - 600 059.

Bore Hole No	Depth (m)		Type of Soil	Grain Size Analaysis (Particle Retained in IS Sieve) %					Atterberg Limits				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	1.60	Clayey Sand with Gravels	12.15	10.52	15.25	19.62	42.46	-	-	-	GC	-	
	1.60	2.70	Clayey Sand with SDR	TCR=0%		RQD=0%		Rock Quality = Highly Weathered / Disintegrated Rock						
	2.70	3.40	SDR	TCR=0%		RQD=0%		Rock Quality = Highly Weathered / Disintegrated Rock						
	Below 3.40		HR	-	-	-	-	-	-	-	-	-	-	
BH 2	0.00	1.75	Clayey Sand with Gravels	11.69	12.64	16.14	17.58	41.95	-	-	-	GC	-	
	1.75	2.60	Clayey Sand with SDR	TCR=0%		RQD=0%		Rock Quality = Highly Weathered / Disintegrated Rock						
	2.60	4.50	SDR	TCR=0%		RQD=0%		Rock Quality = Highly Weathered / Disintegrated Rock						
	Below 4.50		HR	-	-	-	-	-	-	-	-	-	-	

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DESIGN OF OPEN FOUNDATION SYSTEM (Ref. BH-01 - BH-02)

1 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Type of Foundation System: Open
R.L of the top of Borehole (m): 0.00 m
Effective Depth of Foundation below natural ground level (D_f): 2.00 m
Design Width of Foundation (B): 1.00 m
Thickness of Foundation (T) : 0.20 m

1.2 Soil Data :

Type of Bearing Strata : Disintegrated Particles
Design SPT-value of the Bearing Strata : 25
(considered based upon the density of the strata)
Type of Shear Failure: General
Angle of Shearing Resistance - Limited to a Maximum of: 34.50 Deg.

1.3 Design Parameters:

Bulk Density of Soil above the foundation detph (γ_{bulk}) 17.00 kN/m3
Effective Overburden pressure at foundation level (q) 14.00 kPa
Water Table Correction Factor (w') 0.50

Bearing Capacity Factors:

$N_c = N/A\ N_q$
$= 31.81\ N_\gamma$
$= 45.47$

Shape Factors:

S_c = N/A
S_q = 1.69
$S_\gamma = 0.60$

Depth Factors :

D_c = N/A
$D_q = 1.00$

$D_\gamma = 1.00$

Inclination Factor:

I_c = N/A I_q
= 1.00 $I_©$
= 1.00

1.4 Ultimate Bearing Capacity (Qu) :

Qu = Cu*Nc*Sc*Dc*Ic+q*(Nq-1)*Sq*Dq*Iq + 0.5*B*©*N©*S©*D©*Ig*w'

Q_u = 867.35 kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) : 2.50

Qsafe : 346.94 kPa

Recommended Safe Bearing Capacity: 300.00 kPa

1.6 Settlements

Since, the bearing strata are coarse-grained type, the settlements under the allowable safe bearing pressure 300 kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 300 kPa and average SPT of 25 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 16 mm which is within the permissible limits of 50 mm for isolated column footings as per I.S:1904.

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APPENDIX C

GENERAL COMMENTS

GENERAL INSTRUCTIONS (FOR SHALLOW FOUNDATIONS)

STRUCTURAL FILL

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

FOUNDATION CONSIDERATIONS

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

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

EXCAVATION

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

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

GENERAL INSTRUCTIONS (FOR DEEP FOUNDATIONS)

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

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

MATERIALS AND STRESSES

CEMENT:

The cement used shall be any of the following:

a) 33 Grade ordinary Portland cement conforming to IS 269,

b) 43 Grade ordinary Portland cement conforming to IS 8112,

c) 53 Grade ordinary Portland cement conforming to IS 12269,

d) Rapid hardening Portland cement conforming to IS 8041,

e) Portland slag cement conforming to IS 455,

f) Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part 1),

g) Portland pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2),

h) Hydrophobic cement conforming to IS 8043,

i) Low 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/m3. 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/m3.

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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Zoning & Land Use Analysis

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

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