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PROPOSED CONSTRUCTION OF STILT + 5 FLOORS RESIDENTIAL BUILDING AT URAPAKKAM

Report on Geotechnical Investigation

Client:

M/s. Ruby Builders & Promoters,

Chennai.

MARS SYNERGY GEOTECH Pvt Ltd

An ISO 9001: 2015 Certified Company
NABL Accredited Laboratory

No.145A, 2nd Cross Street, Developed Plots Estate,
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Project No: MSGTPL/SI-4726-R1/20-21

July-2020.

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07th May 2024.

To

M/s. Ruby Builders & Promoters,

Chennai.

Reg: Proposed Construction of Stilt + 5 Floors Residential Building at 142A/1C1, Kilaambakkam Village, Urapakkam, Chengalpattu, Tamil Nadu.

The **Mars Synergy Geotech Pvt Ltd**, Chennai has completed the geotechnical engineering services for the above referenced project.

This geotechnical engineering report presents the results of the subsurface exploration and provides geotechnical recommendations design recommendations for your structure foundation are presented here in final form together with a summary of field and laboratory data.

We appreciate the opportunity to be of service to you on this project. If you have any comments concerning this report, or if we may be of further services, please contact us/mail.

Note:

1. The test results enclosed are only related to the sample tested by us.
2. The Report shall not be reproduced in full or part without written permission from Mars Synergy Geotech Laboratory.
3. All the lab related tested values are as per the standard conditions followed by the lab.
4. *Not under NABL scope and NABL is applicable only to tested results enclosed.
5. Samples are retained for 30 days from sample received date at lab.

Sincerely,

Mars Synergy Geotech Pvt Ltd.

ULR-TC867820100000105F

Report No: **MSGTPL/SI-4726-R1/20-21**

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REPORT ON SOIL INVESTIGATION AND RECOMMENDATIONS FOR THE PROPOSED CONSTRUCTION OF STILT + 5 FLOORS RESIDENTIAL BUILDING AT URAPAKKAM

1.0 INTRODUCTION

M/s. Ruby Builders & Promoter, Chennai are planning to construct Stilt + 5 Floors Residential Building at 142A/1C1, Kilaambakkam Village, Urapakkam, Chengalpattu, Tamil Nadu, INDIA. **M/s. Mars Synergy Geotech Pvt Ltd**, Chennai, carried out this investigation and completed on 09st July 2020 according to the instructions from owner of the project.

The scope of work includes the following:

- Making two numbers of Standard Soil Investigation bore-holes
- Collecting soil samples at regular depth intervals
- Conducting SPTs at every 1.0m/1.50m depth intervals
- Conducting laboratory tests on samples collected
- Submitting report with laboratory test results and recommendations for foundations.

1.1 DESCRIPTION OF STRUCTURE

The proposed structure is Stilt + 5 Floors Residential Building. The exact details of columns are not available at the time of preparation of this report. Assuming an approximate column spacing of 4.0 to 4.5 m c/c considering this the central column load works about 120 to 150 tones for proposed building. These loads are assumed for foundation purpose only and for the structural design, exact loads are to be estimated based on a suitable structural analysis.

1.2 SOIL INVESTIGATION

The field investigation works were carried out using 1 set of Rotary mechanical drilling Rig. The following activities, carried out in chronological sequence, comprised the field work for the project

- Mobilization of rotary drilling rig, water pump, testing tools and accessories.
- Collection of disturbed samples of non-cohesive soils.
- Sampling and logging of the boreholes. Packing, labeling and dispatching the samples to laboratory.
- Field investigation and laboratory tests conducted as per IS-1892 and IS -2720

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1.3 FIELD SAMPLING

Two numbers of standard soil investigation boreholes of 100mm diameter was made at the locations shown in the drawing, **MSGTPL/SI-4726** enclosed. Investigations were conducted 7.0m and 8.0m from existing ground level where SPT is more than 50blows. SPTs were conducted at every 1.0/1.5m depth intervals and samples were collected for identification and testing.

1.4 LABORATORY TESTS

The laboratory-testing scheme is so designed to obtain the design parameters for the foundations. The following parameters are evaluated:

- Type of soil and it's gradation properties
- Atterberg Limits
- Specific Gravity
- Natural Moisture Content (NMC)

All the test results are presented in the tabular forms. Comprehensive field information along with SPT values is presented on separate sheet.

1.5 SOIL PROFILE

Based on visual identification of soil samples and test results (of both field and laboratory tests), the soil profile arrived. Subsoil is made-up of three/four distinctive layers there are

BH-1

(i) Medium dense Clayey SAND up to -1.50m with **SPT's N=16**

(ii) Hard CLAY-1.50m to -5.50m with **SPT's N=>50**

(iii) Soft Disintegrated Rock -5.50m to -7.0m with **SPT's N=>100**

BH-2

(i) Stiff CLAY up to -1.50m with **SPT's N=12**

(ii) Dense to very dense clayey SAND -1.50m to -6.50m with **SPT's N=38- >57**

(iii) Soft Disintegrated Rock -6.50m to -8.0m with **SPT's N=>100**

The soil profile details are presented in the bore-chart.

1.6 GROUND WATER TABLE

At the time of soil investigation (09/07/2020), the ground water table was (-)3.20m encountered within the site location

1.7 DISCUSSION ON FOUNDATION

The proposed structure is a six storied residential building, the column loads are assumed in the absence of structural drawing 120 to 150 tones on central column.

At this proposed building location, two boreholes were investigated up to 8.0m depth, the soil strata are described in section-1.5 of this report.

Soil Design parameters are arrived based on filed and laboratory test results, same as shown below and for foundations same soil parameters are used.

Layer No	Depth (m)		Soil	Avg Field SPT **'N'**	γ' (t/m^3)	Ø (Deg)	C (T/m^2)	α	K
	From	To							
1	0.0	1.50	Medium dense clayey SAND	16	0.8	31	-	-	1.05
2	1.5	5.0	Hard CLAY	>50	1.0	-	25	0.3	-
3	5.0	8.0	Soft Disintegrated Rock	>100	12	-	50	0.3	-

Based on soil strata it is ideal to adopt strip raft at -2.0m depth, alternatively bored cast in-situ pile foundation also suggested for the proposed building. Depending on the structural load foundation can be adopted.

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1.8 RECOMMENDATIONS

Option-1

The proposed building is a six-storied residential building

a. Excavation shall be made up to a depth of 2.50m below the Existing Ground Level (Remove Clay Layer). For all column footings, irrespective of the importance of the column or the loading on the column.

b. After thorough compaction of the bottom of excavation, **a layer of hard core, 300 mm thickness**, shall be placed. The hard-core layer shall be at least 450 mm wider on the four sides of the raft. Specifications for the hard-core layer are given in ***Enclosure-1***.

After thorough filling and compaction as mentioned above (a &b), adopt strip raft.

- Adopt strip raft of 1.25m minimum width at a depth of 2.0m below the E.G.L can be adopted.
- **The Safe bearing capacity is 8.0T/sq.m. can be taken at 2.0m depth with 25mm settlement, similarly at same Depth 15.0Ton/Sq.m can be adopted with 40mm Settlements**
- <u>There should be a beam connecting the columns and resting on the bottom strip raft forming an inverted Tee-Beam.</u>
- These should be interconnecting strip rafts in perpendicular direction.
- Strip raft should rest on 100mm thick 1:4:8 mat laid on 100mm well compacted SAND.
- The settlements are within permissible limits.
- All foundation works should be done in dry conditions only.
- Excavated soil (clay soil) should not use for back filling.
- Guidelines for fill material and filling are given in ***Enclosure 2.***

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Option-2

- ✓ Considering that the proposed structure is a six-storied residential building, pile foundations are recommended up to 8.0m depth from existing Ground level.
- ✓ The pile bore may be terminated at a depth of minimum three times diameter of the pile in to hard strata (where three consecutive SPT 'N' values of more than 50 are obtained in each test at depth intervals of one pile diameter).
- ✓ To satisfy the above criterion the pile length may be about 8.0 m from the existing ground level.
- ✓ The capacities of piles of varying diameters are provided below for the proposed upcoming structure. Pile Capacity (Vertical Uplift/Tension and Lateral) Calculations sheets are attached**.**
- ✓

Pile Termination Depth Below G.L (m)	Pile Dia (mm)	Safe Vertical Capacity (Tones)	Safe Uplift Capacity (Tones)	Safe lateral Capacity with 5mm Deflection (Tones)	
				Free Head	Fixed Head
8	450	69	35	4.3	11.0
8	500	80	40	4.7	12.3
8	600	105	48	5.7	14.8

- ✓ **Use minimum M30 Grade Concrete.**
- ✓ **The above safe loads suggested are only tentative and these must be confirmed by conducting through pile load tests conducted as per I.S-2911 part –IV.**

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2.0 DETERMINATION OF BEARING CAPACITY OF SHALLOW FOUNDATIONS

[Based On IS: 6403-1981]

Strip Width: 1.25m
Length of Strip: 20.0m (Assumed)
Depth of Foundation: 2.0m
Existing Ground level: 0.00M
Ground Water Table level: -0.00M (Due to Heavy Rain Temporary)
Bulk Density (W) of Soil above Footing Base: 1.80
Submerged Density (W') of Soil above Footing Base: 0.80T/Cu.M.
Bulk Density (W) of Soil below Footing Base: 1.80T/Cu.M.
Factor of Safety: 3.0

Shape factor	Depth Factor	Inclination Factor
Sc = 0.80	Dc = 1.32	Ic = 1.000

Ultimate Net B.C. = Qult_n = C*Nc*Sc*Dc*Ic
Cohesion (Cu):25.0 Ton/Sq.m

Bearing Capacity Factors
Nc = 5.14

Thus Qult_n =135.69T/Sq.M.
Allowable Bearing Capacity (Qall) = 45.23T/Sq.M. **Say 45T/m^2**

Settlement Calculations as per IS-8009-(Part1) 1998

S=Sc+S$_i$

$$Sc = \lambda \frac{Cc}{1+eo} x H' x \log\left(\frac{Po+\Delta p}{Po}\right)$$

Cc=0.15, **λ**=0.5, **H'**=3.0m, e=NMCxGs=0.25*2.65=0.665

p$_o$=(2.0*1.8)+3.0*1.0=6.6 ton/m^2

Δp=19.3t/m^2

S$_c$= $\frac{0.5x0.15x\ 3.0\ \log\ (6.6+19.3)}{1+0.665}$ $\frac{}{6.6}$ =0.0802m =**80.3mm**

Sc =80.33mm

Correction for Depth= 80.33*0.85=68.20mm **Total settlement is =70mm**

Which is higher than permissible limits, hence settlements are restricted to 25mm and 40mm settlement

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8 Ton/Sqm for 25mm Settlement and 15Ton/Sq.m with 40mm settlement is suggested as per IS 1904-1986

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Enclosure 1

PROCEDURE FOR PREPARATION OF "HARD CORE" LAYER

1. The "hard core" layer shall consist of well graded hard broken stone, 40 mm nominal size (as given in Sl. No.2 below), with voids filled with clean river sand. This is to be done in the following sequence.

   (i) Place a thin layer of clean river sand, 50 mm thick, after thorough compaction of he underlying soil layer. Then place the remaining 250 mm thickness of hard broken stone layer, over the 50 mm thick sand layer. The hard broken stone layer shall be at least 450 mm wider on each of the four sides of the column footing.

   (ii) Place clean river sand, about 50 mm thickness on top of the broken stone layer, and water jetting shall be done almost in a vertical downward direction, over the sand layer in order to force the sand in to the void spaces of the broken stone. The water jetting at any given point shall be continued for a few seconds and then slowly moved laterally to the adjacent points, in order to ensure that the voids in the hard broken stone metal get filled up.

   (iii) When most of the sand goes in to the voids of the broken stone, one more thin layer of clean river sand shall be placed again and using water jetting, force the sand into the voids of the broken stone. The process shall be repeated until no more sand and water get into the void spaces of the broken stone.

   (iv) Look for pockets or areas where water may flow in to the layer. This indicates that there are void spaces below such pockets. Identify such pockets, place more sand (mixed with powder dry shell lime), over the pockets and force the sand into the void space below, using water jet.

   (v) Forcing the sand into the void spaces of the broken stone using water jetting shall be done right up to the edges of the layer.

2. The broken stone used in the hard core layer mentioned above shall be well graded hard broken stone of 40 mm nominal size, conforming to the following gradation (reproduced from IS: 383 – 1970, Specification for coarse and fine aggregates from natural sources for concrete, Table–2).

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IS Sieve Designation	*% Passing*
80 mm	100%
40 mm	95 – 100%
20 mm	30 – 70%
10 mm	10 – 35%
4.75 mm	0 – 5%

Enclosure-2

GUIDELINES FOR FILL MATERIAL AND FOR FILLING TO RAISE THE GENERAL GROUND LEVEL

In case it is proposed to raise the general ground level by filling, relatively inert material such as sand or gravel shall be used for filling. The percentage of fines (grain size less than 0.075 mm) shall not exceed 20%. The liquid limit shall not exceed 30% and the plasticity index shall not exceed 10%. The fill material shall be free from contamination from decomposed organic matter and harmful chemicals.

Filling shall be done in layers of not more than 150 mm thickness, each layer. Each layer shall be well compacted at about the optimum moisture content of the fill soil. Compaction may be monitored by taking field density measurements at the rate of at least one test for every 750 square meters * of area compacted. At least 95% of the maximum dry density obtained in the laboratory Standard Proctor compaction test (as per IS: 2720, Part VII-1980, Methods of test for soils, Determination of water content-dry density relation using light compaction, Second Revision) shall be achieved in the field.

* Reference: Handbook of Quality control for construction of roads and runways, second revision, Indian Roads Congress, Special Publication – 11, Pages 18 & 19, Tables 2.1 & 2.

Table 2.1 Control Tests on Borrow Materials

S. No	*Test*	*Test Method*	*Minimum desirable frequency*
1.	Gradation@ / Sand-content	IS : 2720 Part IV-1965	1-2 tests per 8000 m^3 of soil
2.	Plasticity index	IS : 2720 Part V-1970	-do-
3.	Standard Proctor Test	IS : 2720 Part VII-1965	-do-
4.	CBR on a set of 3 specimens **	IS : 2720 Part XVI-1965	One test per 3000 m^3
5.	Deleterious constituents	IS : 2720 Part XXVII-1968	As required

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6.	Natural moisture content	IS : 2720 Part II – 1973 (Second Revision)	One test per 250 m^3 of soil

@ If specifications call for such tests.

** For purposes of design only, unless otherwise specified.

Table 2.2 Tests for Compaction Control

S. No	***Test***	***Test Method***	***Minimum desirable frequency***
1.	Moisture content just before compaction	IS : 2720 Part II-1973 (Second Revision)	2-3 tests per 250 m^3 of loose soil
2.	Dry density of compacted layer	IS : 2720 Part XXVIII-1966	Generally, one test per 1000 m^2 of compacted area for the body of the embankment, to be increased to one test per 500-1000 m^2 of compacted area for top sub grade layers, i.e., top 500 mm portion of the embankment.

DETAILED STEP BY STEP PROCEDURE FOR FILLING TO RAISE THE GENERAL GROUND LEVEL

1. TYPE OF SOIL TO BE USED

(i) The fill material shall be relatively inert material such as sand or gravel or sandy soil such as clayey sand or sandy clay of low plasticity. The percentage of fines (grain size less than 0.075 mm) shall be less than 20 %. The liquid limit shall be less than 30 %. The plasticity index shall be less than 10 %.

(ii) The fill material shall be free from contamination from materials such as decomposed organic matter or municipal waste or harmful chemicals.

2. TESTS TO BE CONDUCTED ON FILL MATERIAL

The tests to be conducted on fill material are listed in Table-1 below (reproduced from Handbook of Quality control for construction of roads and runways, second revision, Indian Roads Congress, Special Publication – 11, Page 18, Tables 2.1).

The minimum desirable number of tests is also specified in Table-1.

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Table-1 Control Tests on Borrow Materials

S. No	*Test*	*Test Method*	*Minimum desirable frequency*
1.	Gradation@ / Sand-content	IS : 2720 Part IV-1985 Grain-size analysis	1 to 2 tests per 8000 m^3 of soil
2.	Plasticity index	IS : 2720 Part V-1985 Determination of liquid and plastic limit	-do-
3.	Standard Proctor Test	IS : 2720 Part VII-1980 Determination of water content-dry density relation using light compaction	-do-
4.	CBR on a set of 3 specimens **	IS : 2720 Part XVI-1987 Laboratory determination of CBR	One test per 3000 m^3
5.	Deleterious constituents	IS : 2720 Part XXVII-1977 Determination of total soluble sulphates	As required
6.	Natural moisture content	IS : 2720 Part II – 1973 Determination of water content	One test per 250 m^3 of soil

@ If specifications call for such tests.
** For purposes of design only, unless otherwise specified.

3. SPECIFICATIONS FOR FILLING

(i) The filling shall be done in layers of not more than 150 mm thickness, each layer (compacted thickness).

(ii) When spread before compaction, the thickness of each uncompacted layer can be of the order of 200 mm.

(iii) Each layer shall be compacted at about optimum moisture of the fill soil. which is determined from Standard Proctor Test mentioned in Sl. No. 2 above.

(iv) In the case of sand without cohesion, the layer which is spread before compaction shall be watered and then compacted, preferably by vibratory plate or vibratory roller.

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(v) In the case soft clayey sand or sandy clay of low plasticity, rollers such as 10 tonne roller can be used for compaction.

(vi) In the case of (sand without cohesion), relative density shall be determined after compaction. The relative density shall not be less than 65%. Formula for working out the relative density is given in Enclosure-1.

(vii) In case of clayey sand or sandy clay, the density achieved shall be determined using either core cutter method as per IS 2720 (Part XXIX) – 1975, Determination of dry density of soils inplace by the core cutter method or using a sand replacement method as per IS 2720 (Part XXVIII) – 1975, Determination of dry density of soils inplace by the sand replacement method.

(viii) In the case of gravelly soil, either sand replacement method as per IS 2720 (Part XXVIII) – 1975 or Rubber balloon method as per IS 2720 (Part XXXIV) – 1975, Determination of dry density of soils inplace by the Rubber balloon method can be used.

4. COMPACTION MONITORING

The compaction achieved in each compacted layer shall be monitored as per Table-2 reproduced from Handbook of Quality control for construction of roads and runways, second revision, Indian Roads Congress, Special Publication – 11, Page 19, Tables 2.2). The number of test to be conducted shall be as per Table 2.2. The minimum desirable number of tests is also specified in Table-2.

Table 2 Tests for Compaction Control

S. No	*Test*	*Test Method*	*Minimum desirable frequency*
1.	Moisture content just before compaction	IS : 2720 Part II – 1973 Determination of water content	2 to 3 tests per 250 m^3 of loose soil
2.	Dry density of compacted layer	IS 2720 (Part XXIX)–1975, Determination of dry density of soils in place by the core cutter method or IS 2720 (Part XXVIII)–1975, Determination of dry density of soils in place by the sand replacement method	Generally, one test per 1000 m^2 of compacted area for the body of the embankment, to be increased to one test per 500-1000 m^2 of compacted area for top sub grade layers, i.e., top 500 mm portion of the embankment.

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		or IS 2720 (Part XXXIV)–1975, Determination of dry density of soils in place by the Rubber balloon method can be used, as applicable, as mentioned in Sl. No. 3 (vii & viii).	

FORMULA FOR CALCULATING RELATIVE DENSITY (DENSITY INDEX)

(Note: Density Index is the official terminology now being used for Relative Density)

$$\text{Relative density} = \frac{A(B-C)}{B(A-C)}$$

where

A = Maximum dry density obtained in the Laboratory for the sand (grams per cc), as per IS:2720 (Part XIV) – 1983, Determination of density index (relative density) of cohesion less soils.

B = Dry density obtained in the field (grams per cc)

C = Minimum dry density obtained in the Laboratory for the sand (grams per cc), as per IS : 2720 (Part XIV) – 1983, Determination of density index (relative density) of cohesion less soils.

Example:

A = Maximum dry density obtained in the Laboratory for the sand (grams per cc)

= 1.72 (grams per cc)

B = Dry density obtained in the field (grams per cc)

= 1.64 (grams per cc)

C = Minimum dry density obtained in the Laboratory for the sand (grams per cc)

= 1.43 (grams per cc)

$$\text{Relative density} = \frac{1.72\ (1.64-1.43)}{1.64(1.72-1.43)}$$

$$= \frac{1.72\times 0.21}{1.64\times 0.29} \qquad = \frac{0.3612}{0.4756}$$

= 0.7594 or **75.94 %**

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ESTIMATION OF VERTICAL CAPACITY OF PILE

Project No:	4726-R1, Stilt + 5 Floors Residential Building
Location:	Urapakkam
Reference BH's	BH-1 & BH-2

$$Q_u = A_p(\tfrac{1}{2} D\gamma N_\gamma + P_D N_q) + \sum_{i=1}^{n} K_i P_{Di} \tan\delta_i A_{si}$$

$$Q_u = A_p N_c c_p + \sum_{i=1}^{n} \alpha_i c_i A_{si}$$

Dia of Pile		600	mm
Elevation		0	m
Pile Cut off Level		-0.5	m
Pile termination level below G.L		8	m
Total Length of Pile		7.5	m
Factor of safety		**2.5**	
P_D=15*Dia*γ'	=15*0.5mxγ'	52.5	kN/Sq.m

Soil Design Parameters

Sl.No	From (m)	To (m)	Thickness (m)	Soil Type	Avg 'N'	γ' (kN/m³)	C (kN/m²)	α	ϕ (Deg)	K	Pdi (kN/m²)
1	0	1.5	1.5	Medium Dense Cayey SAND	16	8.00	-	-	31	1.05	6.0
2	1.5	5	3.5	Hard CLAY	>50	8.50	250	0.3	-	-	26.9
3	5	8	3	Soft Disintegarted Rock	>100	1.00	500	0.3	-	-	43.3

Pile Calculations As per IS-2911 part-1/Sec-2-2010

Sl.No	From (m)	To (m)	Thickness (m)	Avg 'N'	γ' (kN/m³)	C (kN/m²)	α	ϕ (Deg)	K	Asi	Sf (kN)	Sfi (kN)
1	0.5	1.5	1	16	8.00	-	-	31	1.05	1.88	7.14	7.14
2	1.5	5	3.5	>50	8.50	250	0.3	-	-	6.60	494.80	501.94
3	5	8	3	>100	1.00	500	0.3	-	-	5.65	848.23	1350.17

End Bearing Strata	#REF!										
Dia of Pile(m)	Ap (m²)	γ' (kN/m³)	P_D	ϕ (Deg)	Nq	Ng	Nc	C (kN/m²)	Qp (kN)	Qult (kN)	Qallow (kN)
0.6	0.28274	10	52.5	-	-	-	9	500.0	1272.35	2622.51	**1049.00**

Safe Vertical Capacity of Single Pile	**105**	**Tones**

The ultimate Compressive Strength (considering this as column),

Pu= [0.4fck*Asc+(0.67fy-0.4fck)*Asc]

% of steel	0.4	
Grade of Concrete	25	
fy	415	
Ap	282743.3	mm²
Asc	1130.973	mm²
Pu=	3130591	N
70% of concrete strength	2191414	N
Safe Compressive Strength of Pile	**219**	**Tones**

Which is more than the safe capacity of 105 tones from soil considerations, Hence it is Safe.

ESTIMATION OF UPLIFT CAPACITY OF PILE (TENSION)

FOS=	3	
Qsafe up= Qult/FOS		
Density of Concrete	24	kN/m³
Qult=	1350	kN
Qsafe Up	450	kN
Volume of Pile	2.1	m3
Weight of Pile	51	kN
Pile weight under Buoyant Condition	30	kN

Safe up capacity = Qsafe+Pile weight in buoyant condition
= 480 kN

Safe Uplift Capacity from soil	**45**	**Tones**
Safe uplift capacity from soil + Pile weight	**48**	**Tones**

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Lateral Pile Capacity Calculation

Project Title : 4726-R1, Stilt + 5 Floors Residential Building
Site : Urapakkam
BH: BH-1 &BH-2

As Per IS-2911(Part-1/Sec-2):2010

$$Deflection, y = \frac{H(e+Z_f)^3}{3EI} X10^3 \quad \text{... for free head pile}$$

$$Deflection, y = \frac{H(e+Z_f)^3}{12EI} X10^3 \quad \text{... for fixed head pile}$$

Input

Soil		Hard CLAY	
Diameter of Pile	=	600	mm
Length of Pile Below FGL, (L)	=	8	m
Length of Pile Above FGL, (L1=e)	=	0	m
Grade of Concrete	=	25	
Allowable Deflection, (y)	=	5	mm
Young's modulus of pile material, (E)	=	25000.00	MN/m^2
Moment Inertia of the Pile Cross section (I)	=	0.0064	m^4

For CLAY

k_1=	72	MN/m^2
K=	24	MN/m^3
R=	1.82	m

For SAND

η_h=		MN/m^3
T=	#DIV/0!	m
L_1/T=	#DIV/0!	

Stiffness factor R, in m = $\sqrt[4]{\frac{EI}{KB}}$

L1/R=	0
Lf/R (Free Head)=	1.9
Lf/R (Fixed Head)=	2.2

Stiffness factor T, in m = $\sqrt[5]{\frac{EI}{\eta_h}}$

L_f/T(Free Head)=	1.9
L_f/T(Fixed Head)=	2.2

Output for CLAY Soil

Z_f (Free Head)/ Depth of Fixity =	3.46	m
Z_f (Fixed Head) / Depth of Fixity =	4.01	m

Result

Lateral Load Free Head =	**5.74**	**Tones**
Lateral Load Fixed Head =	**14.79**	**Tones**

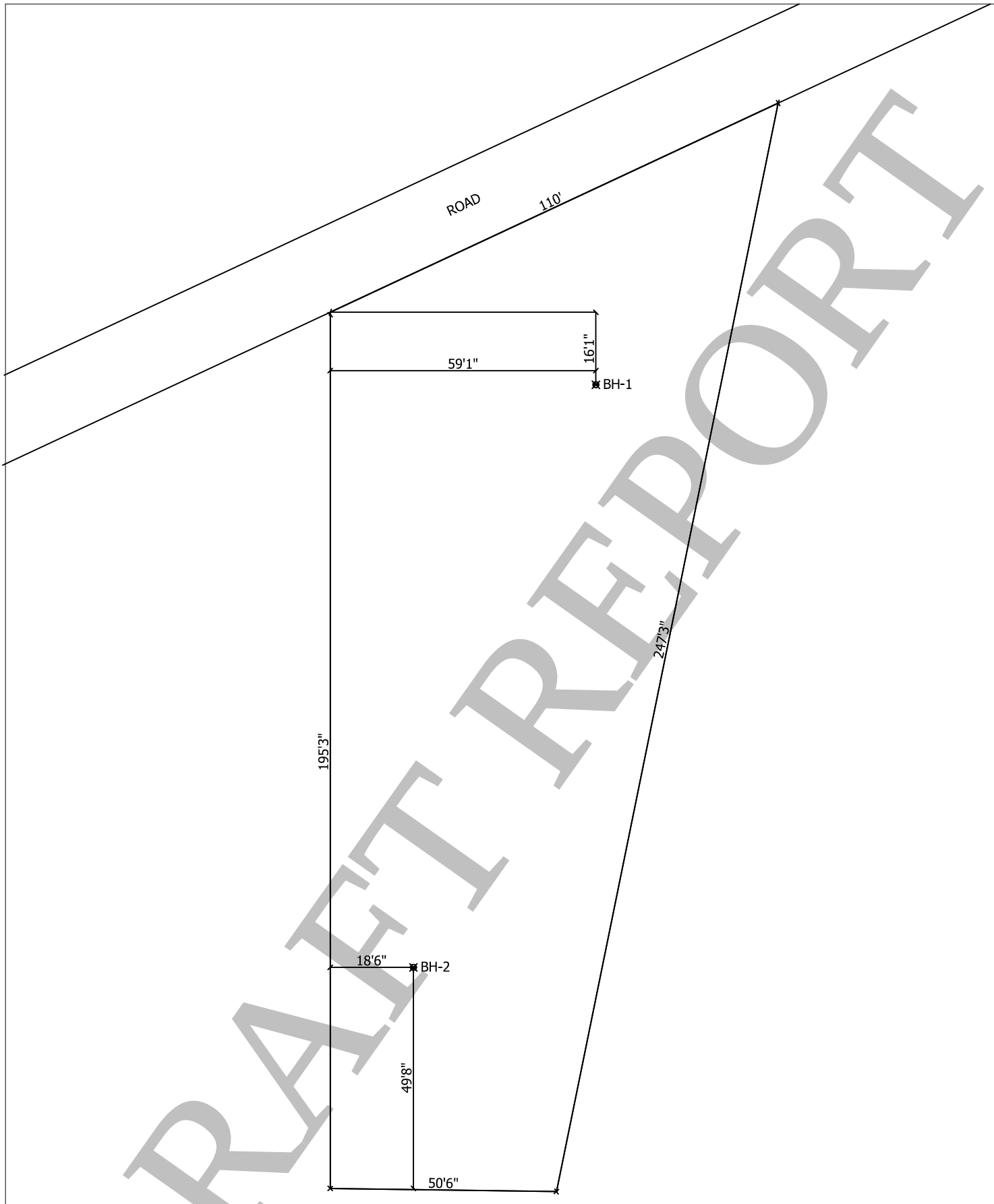
Output for SANDY Soil

Z_F (Free Head) / Depth of Fixity =	#DIV/0!	m
Z_f (Fixed Head) / Depth of Fixity =	#DIV/0!	m

Result

Lateral Load Free Head =	**#####**	**Tones**
Lateral Load Fixed Head =	**#####**	**Tones**

DRAFT REPORT



DRAFT REPORT

TITLE: DRAWING SHOWING THE SOIL INVESTIGATION BORE HOLE LOCATIONS

PROJECT: PROPOSED CONSTRUCTION OF STILT + 5 FLOORS RESIDENTIAL BUILDING AT URAPAKKAM

LEGEND:

BH: BORE HOLE	⊗ -SOIL TEST LOCATION	
ACTIVITY	EXECUTED BY	SCALE: N T S
FOREMEN	RAJA	
DRAFTING	J.B	

MARS SYNERGY GEOTECH Pvt Ltd
(An ISO 9001: 2015 Certified Company)
Engineering Survey & Soil Investigation
#30/25,DROWPATHY AMMAN KOIL MAIN ROAD
VELACHERY,CHENNAI - 600 042.
Mobile: 94440 51563 / 94441 22047

DRAWING NO: MSGTPL/SI-4726-R1/20-21

MS GEOTECH
Geotechnical, Geophysical & Engineering Survey in Offshore & Onshore

BOREHOLE LOG

Project No: MSGTPL/SI-4726-R1/20-21

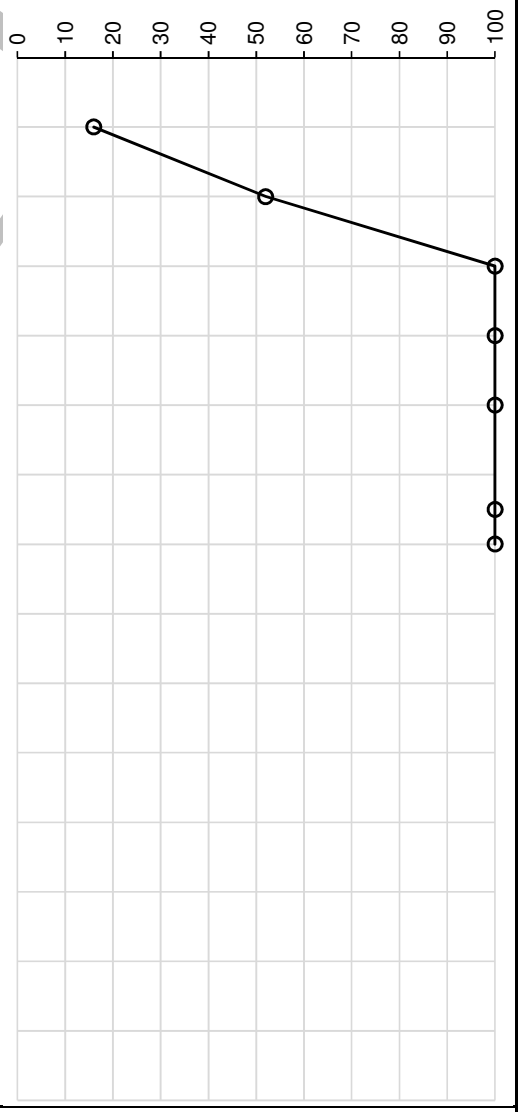
Project: Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

Location	Urapakkam
Ground R.L	Nil
Drilling	Rotary

Borehole No	**BH-1**	
G.W.T (m)	(-)3.20m	
Date of Start	9-Jul-2020	
Date of Complete	9-Jul-2020	
Dia of Bore (mm)	100	Sheet
Termination Depth (m)	7.00	1 of 1

Depth below EGL (m)	Layer Thickness	Soil Layers Description	Soil Symbol	IS-Classification	Type Field Test	Test Depth (m)	SPT Values Record 0 to 45cm			SPT- N- Value
0.0										
0.5	1.0	Medium Dense Light Greyish Clayey SAND		SC						
1.0					SPT	1.0	5	7	9	**16**
1.5										
2.0					SPT	2.0	12	19	33	**52**
2.5										
3.0					SPT	3.0	39	50 Blows for 5Cm		
3.5	4.0	Hard Light Greyish CLAY		CH						
4.0					SPT	4.0	50 Blows for 11Cm			
4.5										
5.0					SPT	5.0	50 Blows for 7Cm			
5.5										
6.0	2.0	Soft Disintegrated Rock		GP						
6.5					SPT	6.5	-	-	-	>100
7.0						7.0	-	-	-	>100
7.5										
8.0										
8.5										
9.0										
9.5										
10.0										
10.5										
11.0										
11.5										
12.0										
12.5										
13.0										
13.5										
14.0										
14.5										
15.0										

Graphical Representation of SPT



Borehole Termination Depth (m) 7.0

EGL- Existing Ground Level
R.L- Reduced Level
GWT- Ground Water Table
SPT- Standard Penetration Test
UDS- Undisturbed Sample
VST- Vane Shear Test
DS- Disturbed Sample
CR- Core Recovery
RQD- Rock Quality Designation

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BOREHOLE LOG

Project No: MSGTPL/SI-4726-R1/20-21

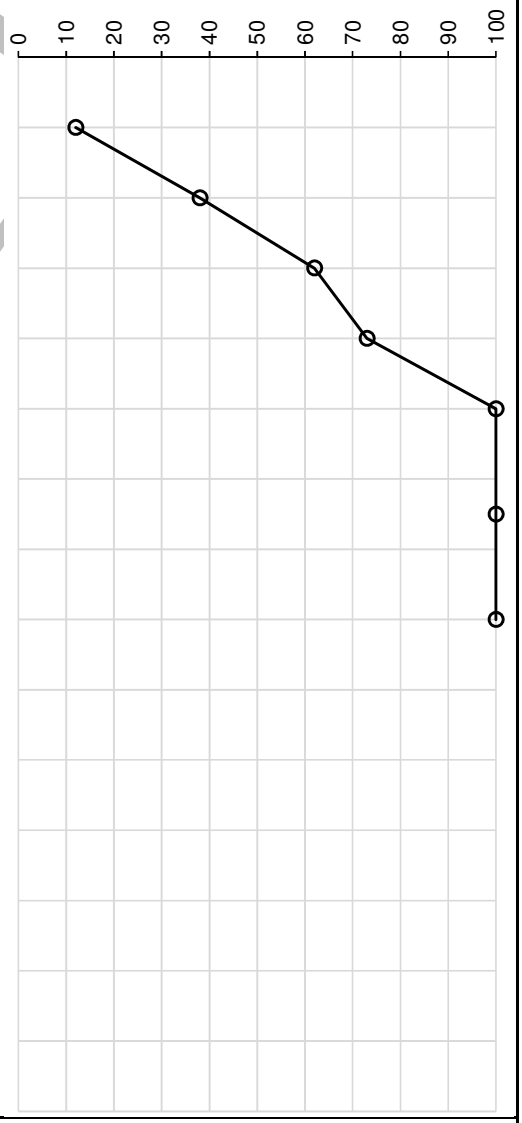
Project: Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

Location	Urapakkam
Ground R.L	Nil
Drilling	Rotary

Borehole No	**BH-2**	
G.W.T (m)	(-)3.20m	
Date of Start	9-Jul-2020	
Date of Complete	9-Jul-2020	
Dia of Bore (mm)	100	Sheet
Termination Depth (m)	8.00	1 of 1

Depth below EGL (m)	Layer Thickness	Soil Layers Description	Soil Symbol	IS-Classification	Type Field Test	Test Depth (m)	SPT Values Record 0 to 45cm			**SPT- N- Value**
0.0										
0.5	1.0	Stiff Brownish CLAY		CH						
1.0					SPT	1.0	5	6	6	**12**
1.5										
2.0					SPT	2.0	10	16	22	**38**
2.5										
3.0					SPT	3.0	19	24	38	**62**
3.5	4.0	Medium Dense Brownish & Light Greyish Clayey SAND		SC						
4.0					SPT	4.0	26	31	42	**73**
4.5										
5.0					SPT	5.0	28	46	50 Blows for 11Cm	
5.5										
6.0	1.5	Brownish Gravel		GP						
6.5					SPT	6.5	50 Blows for 9Cm			
7.0										
7.5	1.5	Soft Disintegrated Rock		GP						
8.0					SPT	8.0	-	-	-	>100
8.5										
9.0										
9.5										
10.0										
10.5										
11.0										
11.5										
12.0										
12.5										
13.0										
13.5										
14.0										
14.5										
15.0										

Graphical Representation of SPT



Borehole Termination Depth (m) 8.0

EGL- Existing Ground Level
R.L- Reduced Level
GWT- Ground Water Table

SPT- Standard Penetration Test
UDS- Undisturbed Sample
VST- Vane Shear Test

DS- Disturbed Sample
CR- Core Recovery
RQD- Rock Quality Designation

DRAFT REPORT

Project No: MSGTPL/SI-4726-R1/20-21

Project : Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

BH No 1 | **Ground Water Level:(-)3.20m** | **Termination Depth:7.0m**

SUMMARY OF TEST RESULTS

N' Value	Layer Thickness	Depth (m)	Soil Description	IS Classification	Index Properties (%)						Specific Gravity	Grain Size Analysis (%)				
					NMC	W_L	W_P	I_P	Ic	FreeSwell		Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay
	1.0	0.00	Medium Dense Light Greyish Clayey SAND	SC												
16		1.00			15						2.65	1	3	24	28	44
52		2.00			20	54	25	29	1.17	12.00	2.62					
>100	4.0	3.00	Hard Light Greyish CLAY	CH	21	53	23	30	1.07	11.54						
>100		4.00			26	53	21	32	0.84	8.33						
>100		5.00			22						2.61					
>100	2.0	6.50	Soft Disintegrated Rock	GP												
>100		7.00														

DRAFT REPORT

Project No: MSGTPL/SI-4726-R1/20-21

Project : Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

BH No 2 | **Ground Water Level:(-)3.20m** | **Termination Depth:8.0m**

SUMMARY OF TEST RESULTS

N' Value	Layer Thickness	Depth (m)	Soil Description	IS Classification	Index Properties (%)						Specific Gravity	Grain Size Analysis (%)				
					NMC	W_L	W_P	I_P	Ic	FreeSwell		Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay
	1.0	0.00	Stiff Brownish CLAY	CH												
12		1.00			21	59	23	37	1.03		2.62					
	4.0		Dense to Very Dense Brownish & Light Greyish Clayey SAND	SC												
38		2.00			16							3	1	11	55	30
62		3.00			16						2.61	8	1	9	52	30
73		4.00			15							9	1	10	42	38
>100		5.00			10						2.61	0	0	11	64	25
	1.5		Brownish Gravel	GP												
>100		6.50			15											
	1.5		Soft Disintegrated Rock	GP												
>100		8.00														

DRAFT REPORT

Project No: MSGTPL/SI-4726-R1/20-21
Project :Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

Method: IS-2720 P-2

Natural Moisture Content Data Sheet

BH.No/ Pit no	1		1		1		1		1			
Depth (m)	1.0		2.0		3.0		4.0		5.0			
Tare No	64	155	165	195	123	113	11	227	146	87		
Wt of Tare (gr)	29.15	29.77	29.95	29.75	29.28	29.49	29.02	29.64	28.70	29.52		
Tare + Soil (gr)	59.39	61.16	59.24	56.56	56.06	53.48	48.22	49.61	55.64	55.43		
Tare+Dry soil (gr)	55.51	57.11	54.45	52.11	51.46	49.29	44.20	45.51	50.85	50.80		
Wt of Water (gr)	3.88	4.05	4.79	4.45	4.60	4.19	4.02	4.10	4.79	4.63		
Wt Dry soil (gr)	26.36	27.34	24.50	22.36	22.18	19.80	15.18	15.87	22.15	21.28		
Water Content (%)	14.72	14.81	19.55	19.90	20.74	21.16	26.48	25.83	21.63	21.76		
Average Water Content (%)	15		20		21		26		22			

DRAFT REPORT

Project No: MSGTPL/SI-4726-R1/20-21
Project :Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

Method: IS-2720 P-2

Natural Moisture Content Data Sheet

BH.No/ Pit no	2		2		2		2		2			
Depth (m)	2.0		3.0		4.0		5.0		6.5			
Tare No	210	276	26	248	268	25	136	145	239	164		
Wt of Tare (gr)	30.32	29.46	29.12	28.75	29.79	30.41	29.56	29.63	29.54	29.43		
Tare + Soil (gr)	52.19	58.09	58.32	56.45	61.77	54.65	50.16	59.27	58.84	64.83		
Tare+Dry soil (gr)	49.14	54.05	54.34	52.59	57.53	51.42	48.35	56.58	55.12	60.13		
Wt of Water (gr)	3.05	4.04	3.98	3.86	4.24	3.23	1.81	2.69	3.72	4.70		
Wt Dry soil (gr)	18.82	24.59	25.22	23.84	27.74	21.01	18.79	26.95	25.58	30.70		
Water Content (%)	16.21	16.43	15.78	16.19	15.28	15.37	9.63	9.98	14.54	15.31		
Average Water Content (%)	16		16		15		10		15			

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SPECIFIC GRAVITY TEST

Project No:MSGTPL/SI-4726-R1/20-21

Project :Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

BH.No	1
Depth(m)	1.0

Pycnometer number			6	35
Weight of bottle	w_1	g	34.5200	34.5300
Weight of bottle + soil	w_2	g	47.6500	47.4300
Weight of bottle + soil + water	w_3	g	95.4000	95.7800
Weight of bottle full of water	w_4	g	87.2300	87.7500
Weight of soil	w_2-w_1	g	13.1300	12.9000
Specific gravity	$\frac{w2-w1}{(w4-w1)-(w3-w2)}$		2.64718	2.64887
Average value G_s			2.65	

BH.No	1
Depth(m)	2.0

Pycnometer number			30	71
Weight of bottle	w_1	g	34.6600	36.3400
Weight of bottle + soil	w_2	g	46.8600	46.2000
Weight of bottle + soil + water	w_3	g	92.8600	93.7200
Weight of bottle full of water	w_4	g	85.3100	87.6200
Weight of soil	w_2-w_1	g	12.2000	9.8600
Specific gravity	$\frac{w2-w1}{(w4-w1)-(w3-w2)}$		2.62366	2.62234
Average value G_s			2.62	

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SPECIFIC GRAVITY TEST

Project No:MSGTPL/SI-4726-R1/20-21

Project :Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

BH.No	1
Depth(m)	5.0

Pycnometer number			60	85
Weight of bottle	w_1	g	33.9600	34.8400
Weight of bottle + soil	w_2	g	45.6900	45.6000
Weight of bottle + soil + water	w_3	g	93.4400	93.1200
Weight of bottle full of water	w_4	g	86.2000	86.4800
Weight of soil	w_2-w_1	g	11.7300	10.7600
Specific gravity	$\frac{w2-w1}{(w4-w1)-(w3-w2)}$		2.61247	2.61165
Average value G_s			2.61	

BH.No	2
Depth(m)	1.0

Pycnometer number			36	77
Weight of bottle	w_1	g	34.3300	34.2400
Weight of bottle + soil	w_2	g	45.7700	45.8800
Weight of bottle + soil + water	w_3	g	94.6300	93.5500
Weight of bottle full of water	w_4	g	87.5500	86.3500
Weight of soil	w_2-w_1	g	11.4400	11.6400
Specific gravity	$\frac{w2-w1}{(w4-w1)-(w3-w2)}$		2.62385	2.62162
Average value G_s			2.62	

DRAFT REPORT

SPECIFIC GRAVITY TEST

Project No:MSGTPL/SI-4726-R1/20-21

Project :Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

BH.No	2
Depth(m)	3.0

Pycnometer number			82	41
Weight of bottle	w_1	g	33.2000	39.4200
Weight of bottle + soil	w_2	g	46.4500	49.9200
Weight of bottle + soil + water	w_3	g	94.3900	99.5000
Weight of bottle full of water	w_4	g	86.2100	93.0200
Weight of soil	w_2-w_1	g	13.2500	10.5000
Specific gravity	$\frac{w2-w1}{(w4-w1)-(w3-w2)}$		2.61341	2.61194
Average value G_s			2.61	

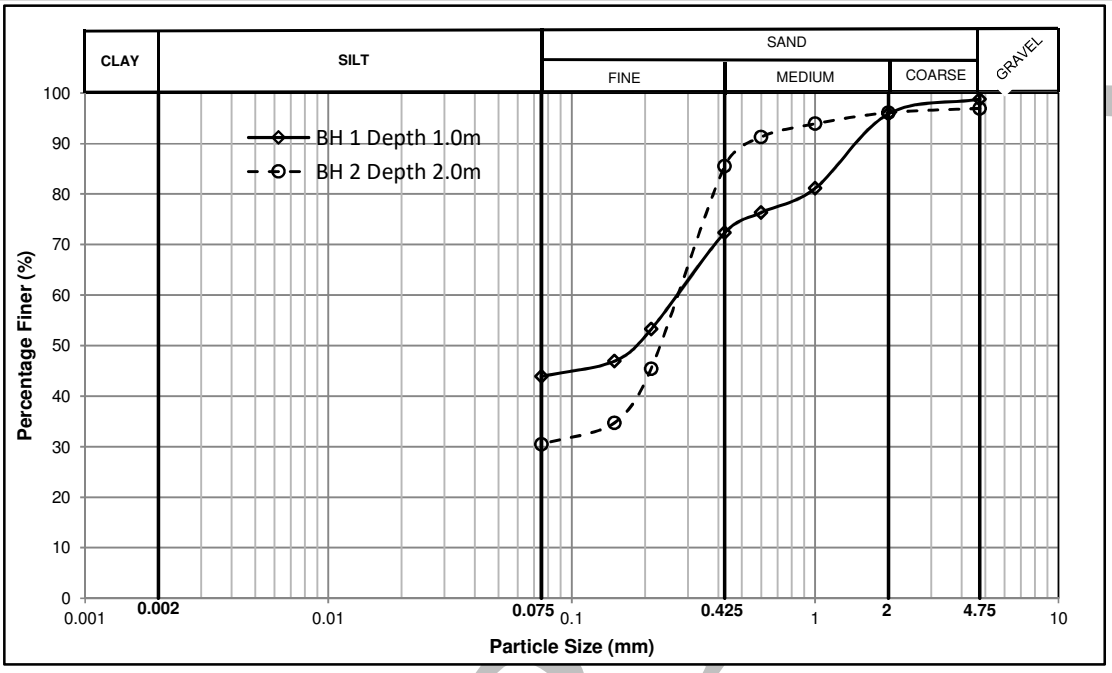
BH.No	2
Depth(m)	5.0

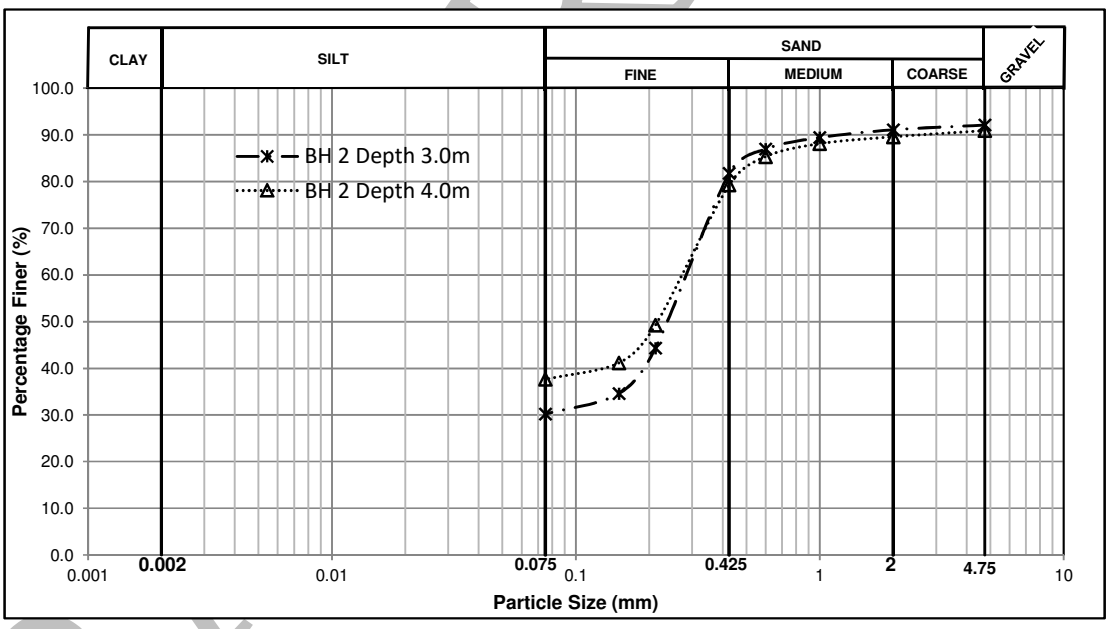
Pycnometer number			23	40
Weight of bottle	w_1	g	28.6600	35.2100
Weight of bottle + soil	w_2	g	40.5400	48.5600
Weight of bottle + soil + water	w_3	g	87.2800	94.6200
Weight of bottle full of water	w_4	g	79.9500	86.3800
Weight of soil	w_2-w_1	g	11.8800	13.3500
Specific gravity	$\frac{w2-w1}{(w4-w1)-(w3-w2)}$		2.61099	2.61252
Average value G_s			2.61	

Project No: MSGTPL/SI-4726-R1/20-21

Project :Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

GRAIN SIZE ANALYSIS





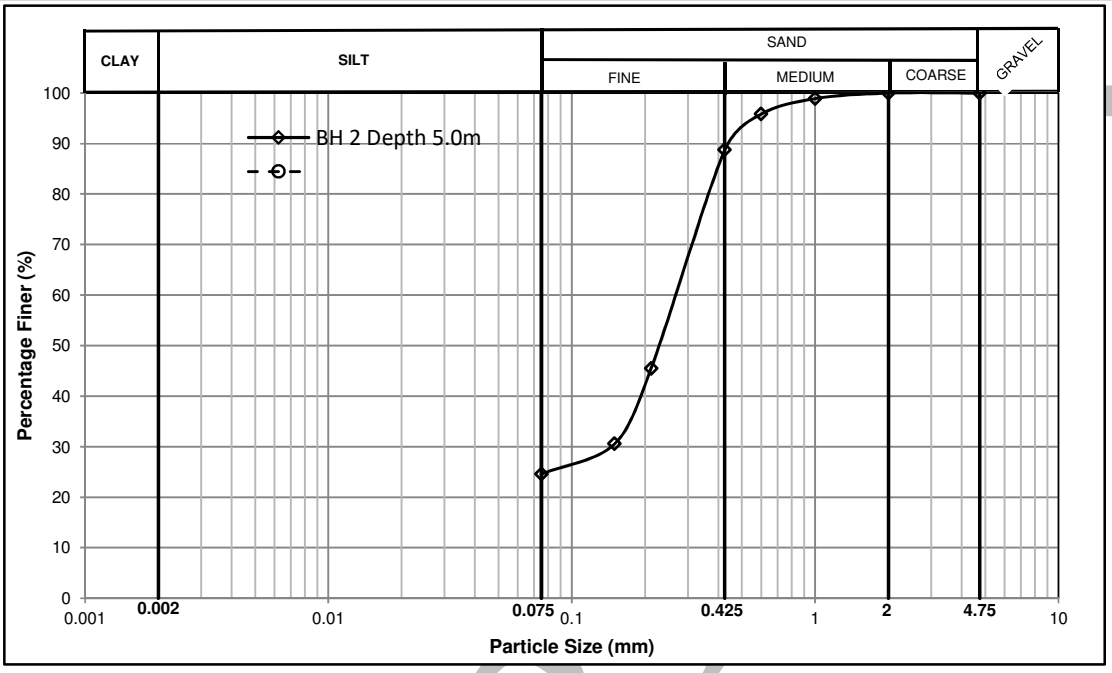
BH-No	Depth	Gravel	SAND (%)			SILT& CLAY	D_{10}	D_{30}	D_{60}	Cu	Cc
	(m)	(%)	Coarse	Medium	Fine	(%)	(mm)	(mm)	(mm)		
1	1.0m	1	3	24	28	44			0.287		
2	2.0m	3	1	11	55	30			0.289		
2	3.0m	8	1	9	52	30	0.000		-0.259		
2	4.0m	9	1	10	42	38			0.288		

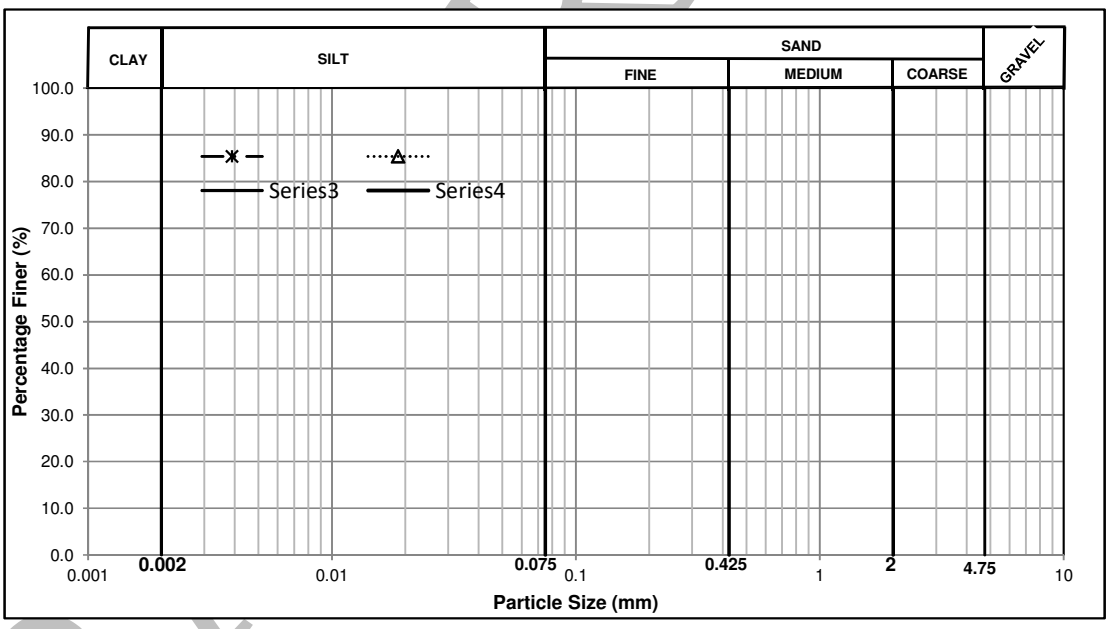
DRAFT

Project No: MSGTPL/SI-4726-R1/20-21

Project :Proposed Construction of Stilt + 5 Floors Residential Building at Urapakkam

GRAIN SIZE ANALYSIS





BH-No	Depth	Gravel	SAND (%)			SILT& CLAY	D_{10}	D_{30}	D_{60}	Cu	Cc
	(m)	(%)	Coarse	Medium	Fine	(%)	(mm)	(mm)	(mm)		
2	5.0m	0	0	11	64	25		0.143	0.283		

DRAFT

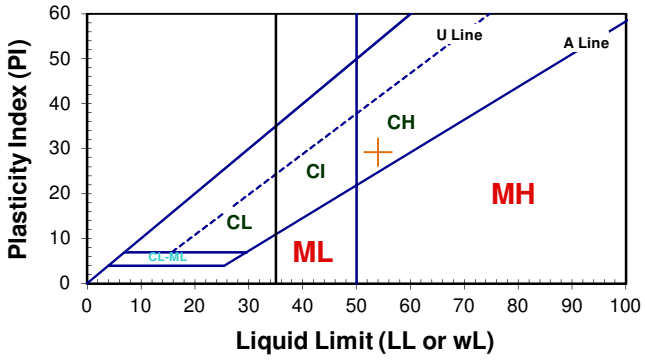
ATTERBERG LIMITS DATA SHEET

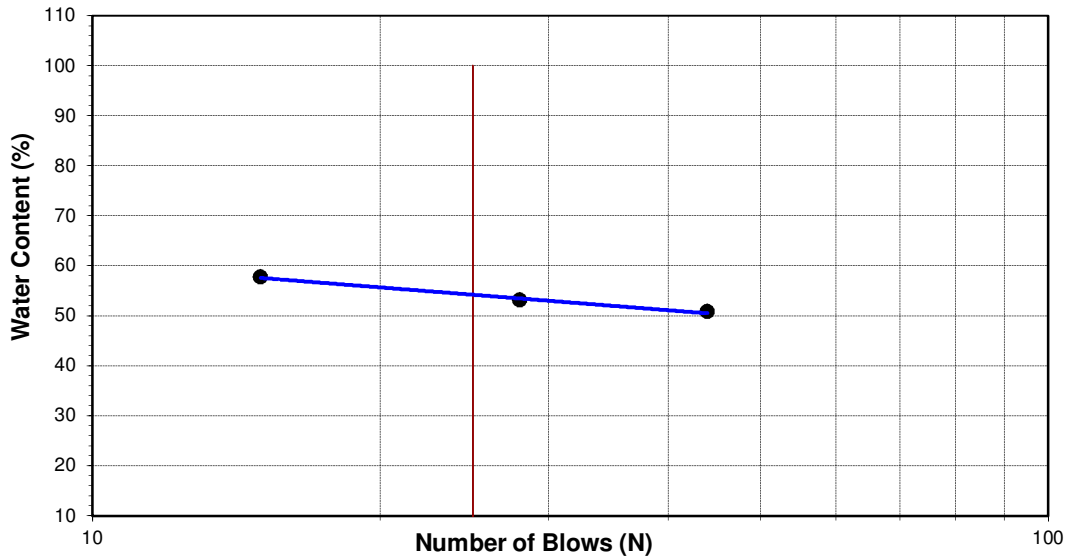
IS-2720-Part-5

Project :	Construction of Stilt + 5 Floors Residential Building
Location:	Urapakkam
Boring No:	BH-1
Sample Depth:	2.0m
Project No:	**MSGTPL/SI-4726/20-21**

TEST			LIQUID LIMIT				PLASTIC LIMIT			
Variable	NO		1	2	3		1	2		
	Var.	Units								
Number of Blows	N	blows	15	28	44					
Tare Number	---	---	1	284	141		80			
Weight of Empty Tare	M_C	(g)	30.61	29.66	30.44		29.9			
Wt of Tare + Soil (Wet)	M_{CMS}	(g)	52.76	51.69	64.6		45.39			
Wt of Tare + Soil (Dry)	M_{CDS}	(g)	44.65	44.05	53.10		42.34			
Weight of Soil	M_S	(g)	14.04	14.39	22.66		12.44			
Weight of Water	M_W	(g)	8.11	7.64	11.50		3.05			
Water Content	*w*	(%)	**57.8**	**53.1**	**50.8**		**24.5**			

Liquid Limit (LL or w_L) (%)	**54**
Plastic Limit (PL or w_P) (%)	**25**
Plasticity Index (PI) (%)	**29**
Soil Classification	**CH**





TEST REPORT

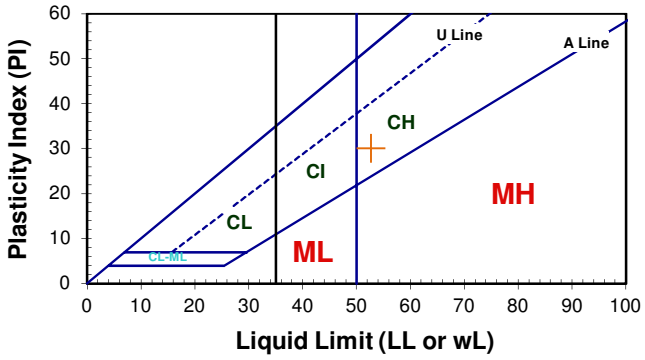
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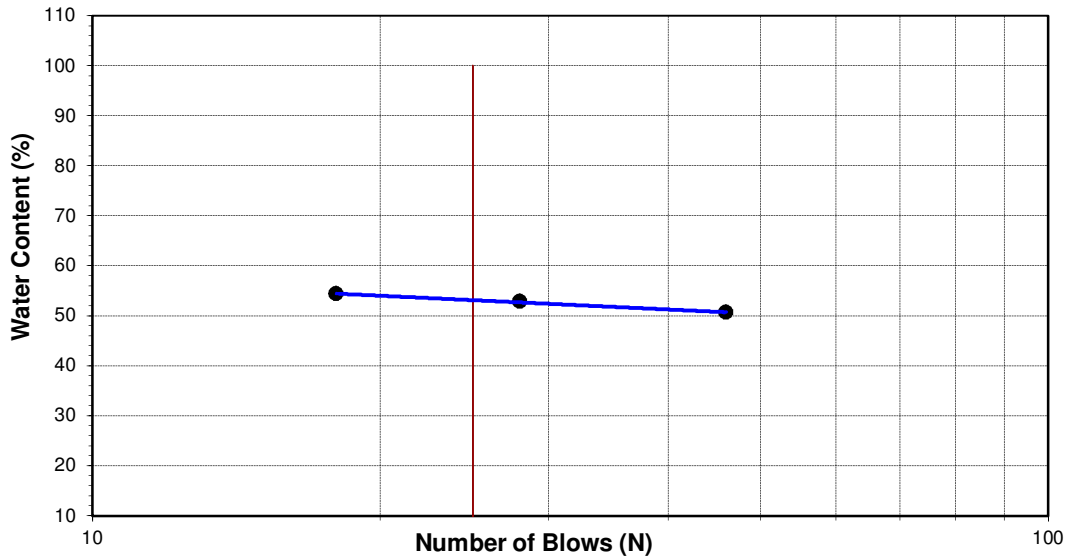
IS-2720-Part-5

Project :	Construction of Stilt + 5 Floors Residential Building
Location:	Urapakkam
Boring No:	BH-1
Sample Depth:	3.0m
Project No:	**MSGTPL/SI-4726/20-21**

TEST			LIQUID LIMIT				PLASTIC LIMIT			
Variable	NO		1	2	3		1	2		
	Var.	Units								
Number of Blows	N	blows	18	28	46					
Tare Number	---	---	65	274	70		75			
Weight of Empty Tare	M_C	(g)	30.64	29.54	27.69		28.41			
Wt of Tare + Soil (Wet)	M_{CMS}	(g)	63.62	62.18	52.66		40.65			
Wt of Tare + Soil (Dry)	M_{CDS}	(g)	52.00	50.90	44.26		38.4			
Weight of Soil	M_S	(g)	21.36	21.36	16.57		9.99			
Weight of Water	M_W	(g)	11.62	11.28	8.40		2.25			
Water Content	*w*	(%)	**54.4**	**52.8**	**50.7**		**22.5**			

Liquid Limit (LL or w_L) (%)	**53**
Plastic Limit (PL or w_P) (%)	**23**
Plasticity Index (PI) (%)	**30**
Soil Classification	**CH**





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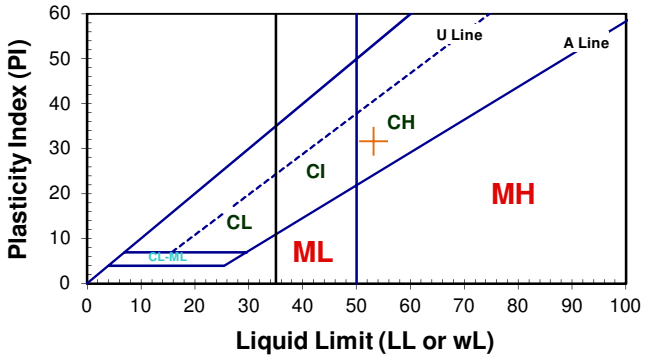
ATTERBERG LIMITS DATA SHEET

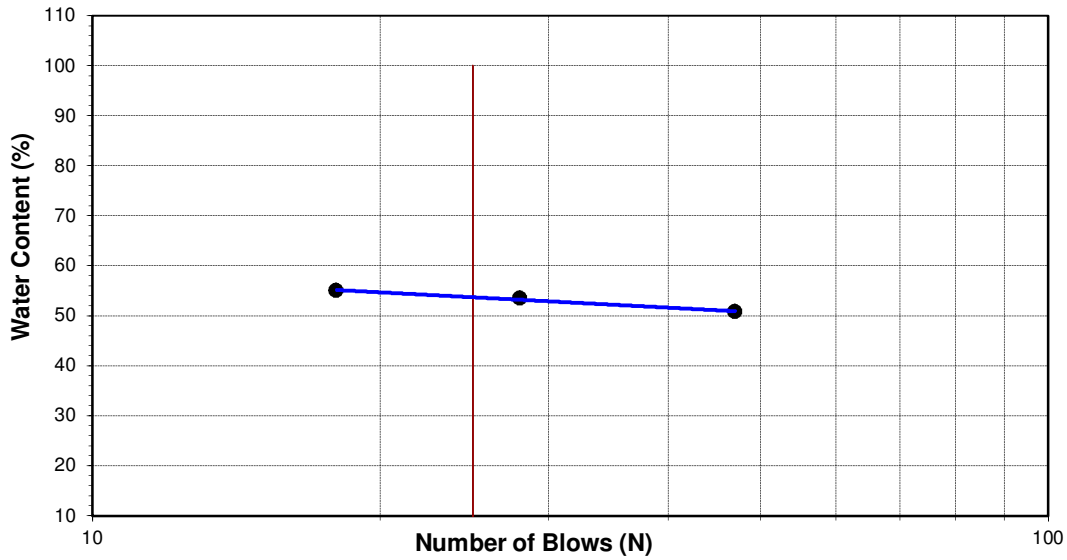
IS-2720-Part-5

Project :	Construction of Stilt + 5 Floors Residential Building
Location:	Urapakkam
Boring No:	BH-1
Sample Depth:	4.0m
Project No:	**MSGTPL/SI-4726/20-21**

TEST			LIQUID LIMIT				PLASTIC LIMIT			
Variable	NO		1	2	3		1	2		
	Var.	Units								
Number of Blows	N	blows	18	28	47					
Tare Number	---	---	109	169	192		34			
Weight of Empty Tare	M_C	(g)	29.34	30.87	30.34		29.75			
Wt of Tare + Soil (Wet)	M_{CMS}	(g)	56.26	53.78	54.28		48.26			
Wt of Tare + Soil (Dry)	M_{CDS}	(g)	46.70	45.80	46.21		45			
Weight of Soil	M_S	(g)	17.36	14.93	15.87		15.25			
Weight of Water	M_W	(g)	9.56	7.98	8.07		3.26			
Water Content	*w*	(%)	**55.1**	**53.4**	**50.9**		**21.4**			

Liquid Limit (LL or w_L) (%)	**53**
Plastic Limit (PL or w_P) (%)	**21**
Plasticity Index (PI) (%)	**32**
Soil Classification	**CH**





FOR TEST REPORT

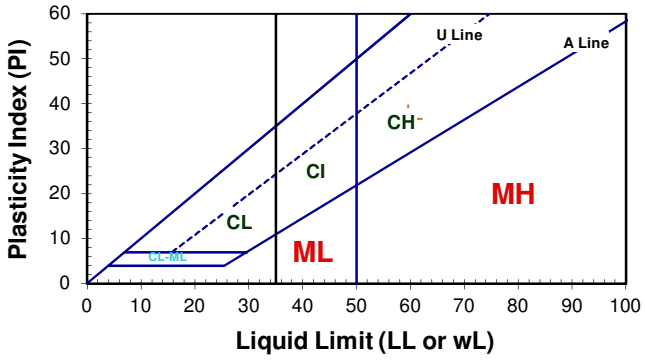
ATTERBERG LIMITS DATA SHEET

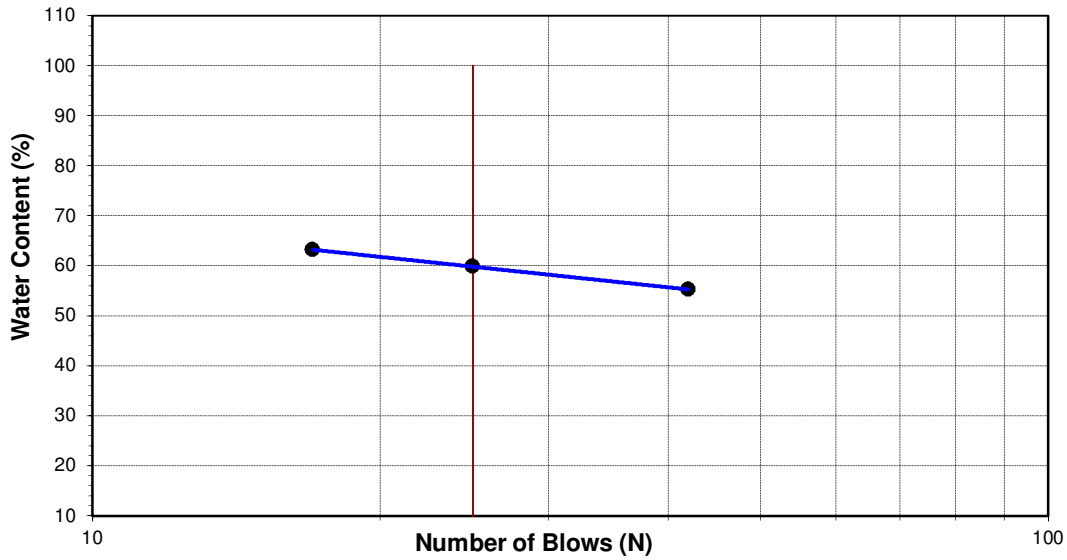
IS-2720-Part-5

Project :	Construction of Stilt + 5 Floors Residential Building
Location:	Urapakkam
Boring No:	BH-2
Sample Depth:	1.0m
Project No:	**MSGTPL/SI-4726/20-21**

TEST			LIQUID LIMIT				PLASTIC LIMIT			
Variable	NO		1	2	3		1	2		
	Var.	Units								
Number of Blows	N	blows	17	25	42					
Tare Number	---	---	3	120	182		73			
Weight of Empty Tare	M_C	(g)	28.52	29.17	30.66		28.91			
Wt of Tare + Soil (Wet)	M_{CMS}	(g)	54.88	52.8	54.76		50.75			
Wt of Tare + Soil (Dry)	M_{CDS}	(g)	44.67	43.95	46.18		46.71			
Weight of Soil	M_S	(g)	16.15	14.78	15.52		17.80			
Weight of Water	M_W	(g)	10.21	8.85	8.58		4.04			
Water Content	*w*	(%)	**63.2**	**59.9**	**55.3**		**22.7**			

Liquid Limit (LL or w_L) (%)	**59**
Plastic Limit (PL or w_P) (%)	**23**
Plasticity Index (PI) (%)	**37**
Soil Classification	**CH**





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our services doesn't just end there

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Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

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

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empowering your real estate decisions with smart tools

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Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

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Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

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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