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Report No. : KMFC/ WORK STORM INFRA/ PLOT I- 2, DR. VSI
ESTATE/ THIRUVANMIYUR/ T481

Date : 02.11.2018

Project : THE PROPOSED STILT + 4 FLOORS BUILDING
AT PLOT I- 2, DR. VSI ESTATE,
THIRUVANMIYUR, CHENNAI - 600 041

Title : SUBSOIL INVESTIGATION AND
RECOMMENDATIONS FOR SUITABLE TYPE OF
FOUNDATION

Client : WORK STORM INFRA PVT LTD
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INDEX

(Report No. KMFC/ Work Storm Infra/ Plot I- 2, Dr. VSI Estate/ Thiruvannmiyur/ T481,
dt: 02.11.2018)

Sl. No.	Description	Page No.
1	INTRODUCTION	1
2	THICKNESS OF FILLING PROPOSED TO RAISE THE GENERAL GROUND LEVEL OF THE PLOT	1
3	FIELD INVESTIGATION	1 - 2
4	LABORATORY SOIL TESTING	2
5	SUBSOIL CONDITIONS	2 - 3
6	GROUND WATER TABLE	3
7	GUIDELINES FOR FILL MATERIAL AND FOR FILLING TO RAISE THE GENERAL GROUND LEVEL	3 - 4
8	RECOMMENDATIONS FOR SUITABLE TYPE OF FOUNDATION	4 - 8
FIGURES		
1	LAY OUT PLAN SHOWING THE LOCATIONS OF BORE HOLES	9
2 & 3	LOGS OF BORE HOLES	10 - 11
TABLES		
1	RESULTS OF CONE PENETRATION TESTS	12 - 15
2	COMPARISON OF RESULTS OF CONE PENETRATION TESTS AND EQUIVALENT SPT VALUES, AT DIFFERENT DEPTHS (No. OF BLOWS FOR EVERY 300 mm PENETRATION)	16
3	COMPARISON OF SUBSOIL CONDITIONS AND CONE PENETRATION RESISTANCE (EQUIVALENT SPT VALUES) IN THE TWO BORE HOLES	17 - 18
4 & 5	RESULTS OF LABORATORY SOIL TESTING	19 - 20



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Date: 02.11.2018

REPORT ON SUBSOIL INVESTIGATION AND RECOMMENDATIONS FOR SUITABLE TYPE OF FOUNDATION FOR THE PROPOSED STILT + 4 FLOORS BUILDING AT PLOT I- 2, DR. VSI ESTATE, THIRUVANNIYUR, CHENNAI - 600 041

1. INTRODUCTION

Soil investigation bore hole and continuous cone penetration test were made on 27.10.2018 for the proposed Stilt + 4 Floors Building at Plot I- 2, Dr. VSI Estate, Thiruvanniyur, Chennai - 600 041.

Results of the soil investigation and recommendations for suitable type of foundation for the proposed construction are presented in this report.

2. THICKNESS OF FILLING PROPOSED TO RAISE THE GENERAL GROUND LEVEL OF THE PLOT

It is learnt that a filling of about 0.6 m is proposed to raise the general ground level of the Plot.

3. FIELD INVESTIGATION

Two bore holes and two continuous cone penetration tests were made at locations shown in Fig.1, by M/s Geo Consultants, Chennai. The Bore Holes were made using auger and representative soil samples were collected from the Bore Holes at every 0.3 m depth intervals. The Bore Holes were made up to either 6 m depth below the existing ground level (EGL) or up to the depth up to which the soil samples could be collected, whichever is earlier. The diameter of the Bore Holes was 150 mm.

Ground water table was met with, at a depth of 4.5 m in the Bore Holes, during boring. However, Ground water sample could not be collected.



Continuous Cone Penetration Tests (CPT) were conducted near each Bore Hole location. The cone penetration tests consist of driving a 25 mm diameter cone, by a 10 kg drop weight with a free fall of 500 mm. The cone tests were conducted right from EGL, continuously up to either 9 m depth below EGL or up to a hard stratum, whichever is earlier. The number of blows for every 50 mm penetration was recorded. The number of blows for each 300 mm penetration is termed as "Cone Penetration Resistance" (CPR). Correlations developed between the CPR and SPT (Standard Penetration Test) show that the CPR is about 1.8 times the SPT value.

The results of cone penetration tests are presented in Tables 1 & 2. Table 1 gives the number of blows for every 50 mm penetration in both the tests. Table 2 gives the CPR values in both the tests. The equivalent SPT values are also presented in Table 2.

A comparison of visual identification of soil samples in the two bore holes with the results of the two cone penetration tests is given in Table 3.

The logs of the bore holes are presented in Figs. 2 & 3. The CPR values and the equivalent SPT values are also shown alongside the bore logs. The depth of ground water table is also shown in the Bore logs.

4. LABORATORY SOIL TESTING

The representative soil samples collected from the bore holes were visually identified, and classification and identification tests (Liquid and Plastic Limit tests on clayey soil samples and Grain Size Analysis of sandy and gravelly soil samples) were conducted. The results are presented in Tables 4 & 5.

5. SUBSOIL CONDITIONS

The data presented in Figs. 2 & 3 and Tables 1 to 5 shows the following subsoil conditions.

- (i) The top layer is Medium dense Debris Filling, 0.3 m thickness.
- (ii) At Bore Hole 1 location, a layer of fine to medium sand with a little clay binder occurs from 0.3 m to 1.5 m, the soil being:

Medium dense: From 0.3 m to 0.9 m

Loose: From 0.9 m to 1.1 m

Very loose: From 1.1 m to 1.5 m

- (iii) At Bore Hole 2 location, a layer of stiff sandy clay of medium plasticity occurs from 0.3 m to 0.6 m, followed by a layer of loose clayey sand with gravel occurs from 0.6 m to 1.1 m



- (iv) A layer of sandy clay of high plasticity occurs from 1.5 m to 8.25 m at Bore Hole 1 location, beyond 1.1 m depth, in the remaining investigated depth, at Bore Hole 2 location, the sandy clay being:

Medium stiff: From 1.5 m to 2.1 m at Bore Hole 1 location

Stiff:

From 2.1 m to 3.85 m at Bore Hole 1 location

From 1.1 m to 1.75 m at Bore Hole 2 location

Very stiff:

From 3.85 m to 8.1 m at Bore Hole 1 location

From 1.75 m to 3.65 m, from 4.9 m to 5.05 m & also from 5.3 m to 8.4 m at Bore Hole 2 location

Hard:

From 8.1 m to 8.25 m at Bore Hole 1 location

From 3.65 m to 4.9 m, from 5.05 m to 5.3 m & also from 8.4 m to 9 m at Bore Hole 2 location

- (v) Very Hard Stratum occurs at a depth of 8.25 m at Bore Hole 1 location; did not occur with 9 m depth at Bore Hole 2 location.

6. GROUND WATER TABLE

At the time of soil investigation (27.10.2018), Ground water table was met with, at a depth of 4.5 m in the Bore Holes, during boring.

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

It is extremely important to make sure that the earth filling material shall be relatively inert material & also it shall be well compacted in layers, since the thickness of earth filling will be of the order of 0.6 m.

Before filling, it is important to remove any organic matter or plants, with roots, if present in the Plot, It is also important to compact the sandy soil at the ground level.

Relatively inert material such as clean sand (clean river sand, or M sand, but not Quarry dust), or gravel shall be used for filling to raise the general ground level of the Plot, 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 (Reaffirmed 2011, Second Revision): 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 & 2.2

Table 2.1 Control Tests on Borrow Materials

S. No	Test	Test Method	Minimum desirable frequency
1.	Gradation [@] / Sand-content	IS : 2720 Part IV-1985 (Reaffirmed 2006, Second Revision)	1-2 tests per 8000 m ³ of soil
2.	Plasticity index	IS : 2720 Part V-1985 (Second Revision)	-do-
3.	Standard Proctor Test	IS : 2720 Part VII-1980 (Reaffirmed 2011, Second Revision)	-do-
4.	CBR on a set of 3 specimens **	IS : 2720 Part XVI-1987 (Reaffirmed 2002, Second Revision)	One test per 3000 m ³
5.	Deleterious constituents	IS : 2720 Part XXVII - 1977	As required
6.	Natural moisture content	IS : 2720 Part II – 1973 (Reaffirmed 2010, 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 (Reaffirmed 2010, Second Revision)	2-3 tests per 250 m ³ of loose soil
2.	Dry density of compacted layer	IS : 2720 Part XXVIII-1974 (Reaffirmed 2010, First Revision)	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.

8. RECOMMENDATIONS FOR SUITABLE TYPE OF FOUNDATION

On the basis of the results of the soil investigation carried out, the following are recommendations for suitable type of foundation for the proposed Stilt + 4 Floors Building at Plot I- 2, Dr. VSI Estate, Thiruvanniyur, Chennai - 600 041.



It is learnt that a filling of about 0.6 m is proposed to raise the general ground level of the Plot.

Considering that the subsoil beyond about 1.5 m depth is sandy clay of high plasticity, two alternative types of foundations, namely, (i) Under-reamed piles or (ii) Bored Cast In situ Concrete Piles are recommended.

8.1 Alternative 1: UNDER-REAMED PILES

- (i) Under-reamed piles, with a single bulb, of 4.5 m length below the existing ground level, including bucket length, are recommended.
- (ii) A minimum shaft diameter of 300 mm (the corresponding bulb diameter will be 750 mm) is recommended for all under-reamed piles.
- (iii) The under-reamed piles shall be installed as per guide lines given in the Indian Standard, Indian Standard, IS: 2911 (Part-III) - 1980, Reaffirmed 2006 & also 2015, "CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS, Part-III UNDER-REAMED PILES", First Revision or latest revision.
- (iv) Care shall be taken to prevent caving of pile bore, before concreting. This can be achieved by either (i) using a casing pipe of at least 2.5 m length or (ii) by using drilling mud, in circulation, as given in clause 6.4 of IS: 2911 (Part-III) - 1980, Reaffirmed 2006 & also 2015, "CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS, Part-III UNDER-REAMED PILES", First Revision or latest revision.
- (v) The safe capacity of the under-reamed piles can be taken equal to 1.25 times the values given in Table-1 of the Indian Standard, IS: 2911 (Part-III) - 1980, Reaffirmed 2006 & also 2015, "CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS, Part-III UNDER-REAMED PILES", First Revision or latest revision. The safe capacity of under-reamed piles of different shaft diameter is reproduced below from Table - 1 of the Indian Standard, along with the recommended safe capacity for this site.

Shaft Diameter	Bulb Diameter	Safe capacity as per IS: 2911 (Part III)	Safe capacity recommended for this site
300 mm	750 mm	16 tonnes	20 tonnes
375mm	937.5 mm	24 tonnes	30 tonnes
400 mm	1000 mm	28 tonnes	35 tonnes
450 mm	1125 mm	35 tonnes	44 tonnes
500 mm	1250 mm	42 tonnes	53 tonnes



- (vi) At least M 30 grade concrete is recommended for the under-reamed piles. All other requirements given in IS: 2911 (Part-III) - 1980, Reaffirmed 2006 & also 2015, "CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS, Part-III UNDER-REAMED PILES", First Revision or latest revision shall be complied with.
- (vii) It is desirable to use a pile group (of at least two piles in the group) under each column, so that any inadvertent eccentricity between the piles and the columns will be taken care by the pile group as axial compression or axial upward force. The minimum spacing in a pile group (centre to centre of
- (viii) piles) shall not be less than one and a half times the bulb diameter, as stipulated in IS: 2911 (Part-III) - 1980, Reaffirmed 2006 & also 2015, "CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS, Part-III UNDER-REAMED PILES", First Revision or latest revision, Clause-5.2.7.2.
- (ix) In case a single pile is adopted for a column, the column shall be grown over the pile, in order to avoid any eccentric loading on the pile.
- (x) It is necessary that an experienced contractor execute the under-reamed piles with proven ability in installing under-reamed piles. It is desirable that at least one initial test pile is installed for the purpose of evaluating the ability of the contractor to install proper under-reamed piles and also to determine the capacity of the pile for vertical load.
- (xi) After the initial test pile is load-tested, and the results analysed, regular piles (working piles) may be installed. At least one working pile shall be load-tested (routine pile load test).
- (xii) The initial pile load test and the routine pile load test shall be carried out as per guidelines given in Indian Standard, IS: 2911 (Part 4) - 2013, Second Revision, CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS, PART 4: LOAD TEST ON PILES.
- (xiii) The initial pile load test shall be carried out up to a "test load" of at least two times the estimated safe load, preferably up to two and a half times the estimated safe load. The routine pile load test on working pile shall be carried out up to either a "test load" of one and a half times the design safe load or up to a settlement of 12 mm whichever occurs first.



8.2 Alternative 2: BORED CAST IN SITU CONCRETE PILES, END BEARING ON VERY HARD STRATUM

- (i) Bored Cast In situ Concrete Piles, end bearing on Very Hard Stratum are recommended.
- (ii) The pile bore shall be terminated at a depth where an equivalent SPT value of not less than 100 is obtained in the first few piles. At Bore Hole 1 location, very hard stratum occurs at a depth of 8.25 m below the existing ground level. At Bore Hole 2 location, very hard stratum occurs at a depth of more than 9 m below the existing ground level (the actual depth is to be determined at the site, during piling).
- (iii) Correlations developed between dropping of the chisel and the SPT value show that chiseling may be terminated at a depth where 100 blows of drop of 1 tonne chisel with 1.2 m height of fall does not cause a penetration of more than 150 mm. If the chisel weight or height of drop is different, an equivalent energy criterion may be adopted.
- (iv) The safe capacity of bored cast in situ concrete piles, end bearing on weathered rock or very hard stratum, for different pile diameters is give below.

<i>Diameter</i>	<i>Safe capacity of bored cast in situ concrete piles</i>
400 mm	60 tonnes
450 mm	80 tonnes
500 mm	100 tonnes
550 mm	120 tonnes
600 mm	140 tonnes
750 mm	220 tonnes

- (v) At least M 30 grade of concrete shall be used for concrete in the piles. All other requirements given in Indian Standard, IS: 2911 (Part-1 / Section 2), the latest version, shall be complied with.
- (vi) "DMC method (Direct Mud Circulation method) shall be followed for installing the bored cast-in situ concrete piles. Tremie pipe shall be used for concreting.
- (vii) Specifications for the "basic properties of drilling mud (bentonite) given in Appendix-A of Indian Standard, IS: 2911 (Part 1/Sec 2) - 2010, DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS — CODE OF PRACTICE, PART 1: CONCRETE PILES, Section 2: Bored Cast In-situ Concrete Piles (Second Revision) or the latest version shall be followed.
- (viii) Prior to beginning of concreting using tremie-pipe, the pile bore shall be flushed clean, until no soil particles come out of the pile bore from the drilling mud being circulated".



- (ix) It is desirable to use a pile group (a group of at least two piles) under each column, so that any inadvertent eccentricity between the piles and the column will be taken care by the pile group as axial compression or axial upward force.
- (x) In case a single pile is adopted for a column, the column shall be grown over the pile, in order to avoid any eccentric loading on the pile.
- (xi) It is necessary that the piling work is executed by an experienced contractor with proven ability in installing driven cast in situ concrete piles or bored cast-in situ concrete piles, as the case may be. It is recommended that at least one initial test pile is installed for the purpose of evaluating the ability of the contractor and workmanship to install proper driven cast in situ or bored cast-in situ concrete piles and also to determine the capacity of the pile for vertical load.
- (xii) After the initial test pile is load-tested, and the results analysed, regular piles (working piles) may be installed. At least one working pile shall be load-tested (routine pile load test).
- (xiii) The initial pile load test and the routine pile load test shall be carried out as per guidelines given in Indian Standard, IS: 2911 (Part 4) – 2013, Second Revision, **CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS, PART 4: LOAD TEST ON PILES.**
- (xiv) The initial pile load test shall be carried out up to a "test load" of at least two times the estimated safe load, preferably up to two and a half times the estimated safe load. The routine pile load test on working pile shall be carried out up to either a "test load" of one and a half times the design safe load or up to a settlement of 12 mm whichever occurs first.
- (xv) Since ground water samples could not be collected during boring, due to its presence at a large depth of 4.5 m, Chemical composition of ground water is not known. Therefore, to be on the safe side, the following recommendation may be followed for the concrete in the piles.

"Either supersulphated cement or sulphate resisting Portland cement may be used with a minimum cement content of 330 kg/m^3 of concrete and with a maximum water- cement ratio of 0.50

or

Portland pozzolana cement or Portland slag cement may be used with a minimum cement content of 350 kg/m^3 of concrete and with a maximum water-cement ratio of 0.45".


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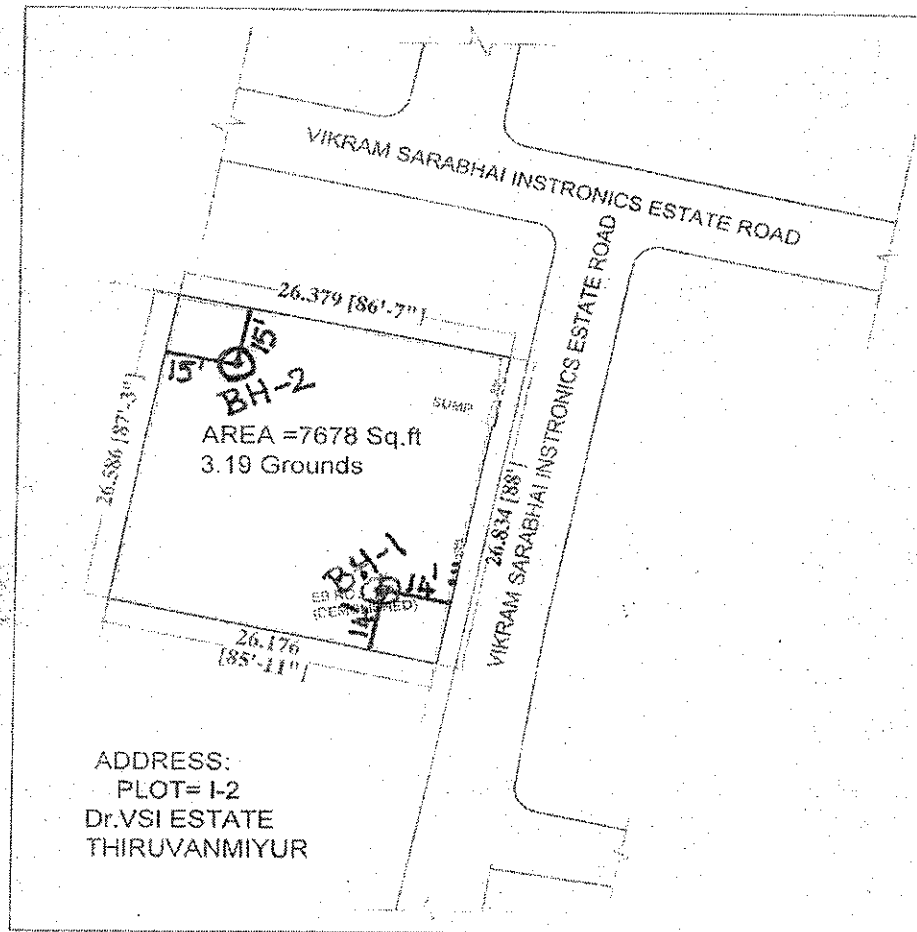


Fig. 1: PLAN SHOWING BORE HOLE (BH) LOCATION

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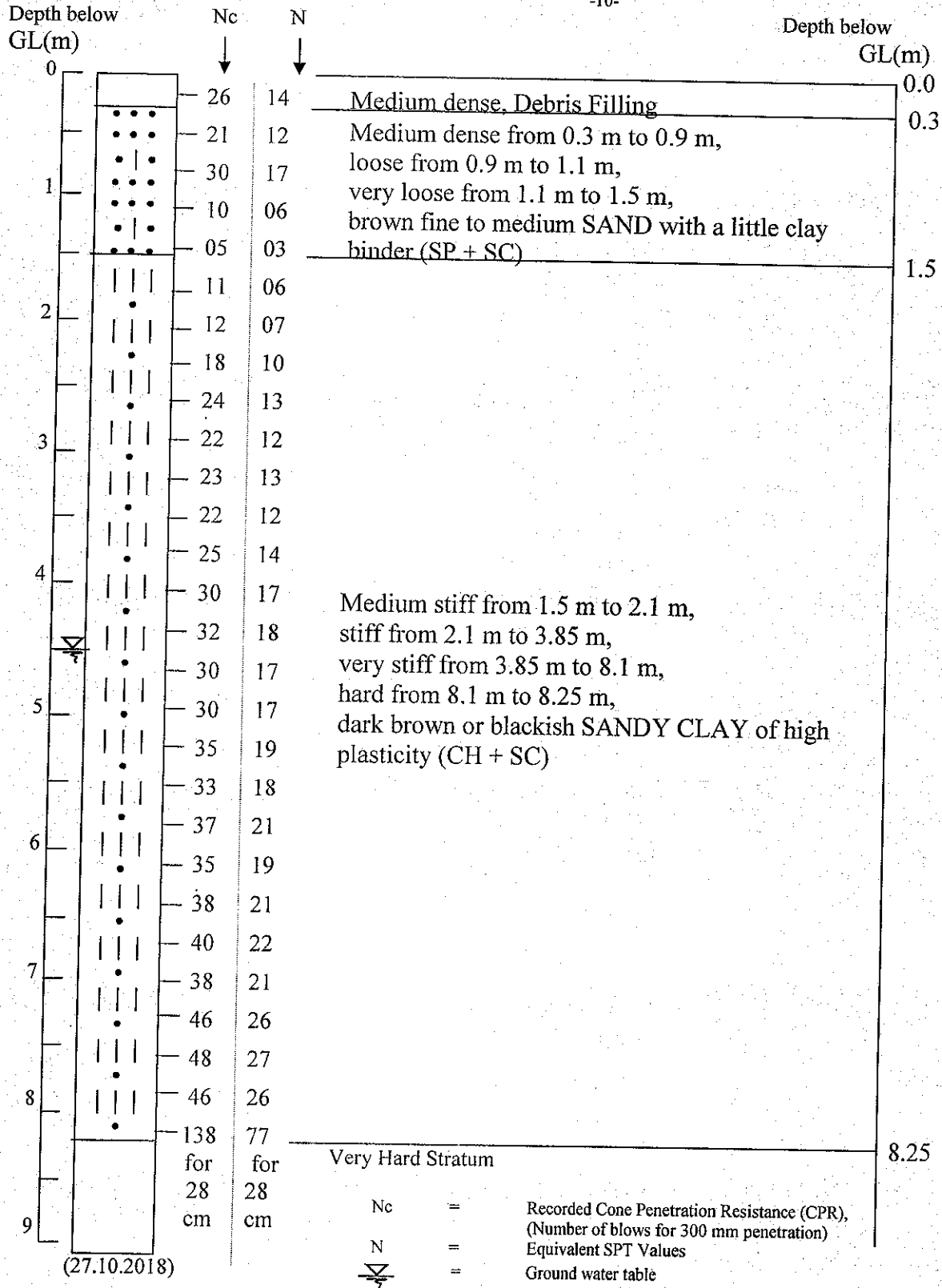
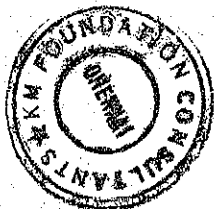


Fig. 2: LOG OF BORE HOLE 1

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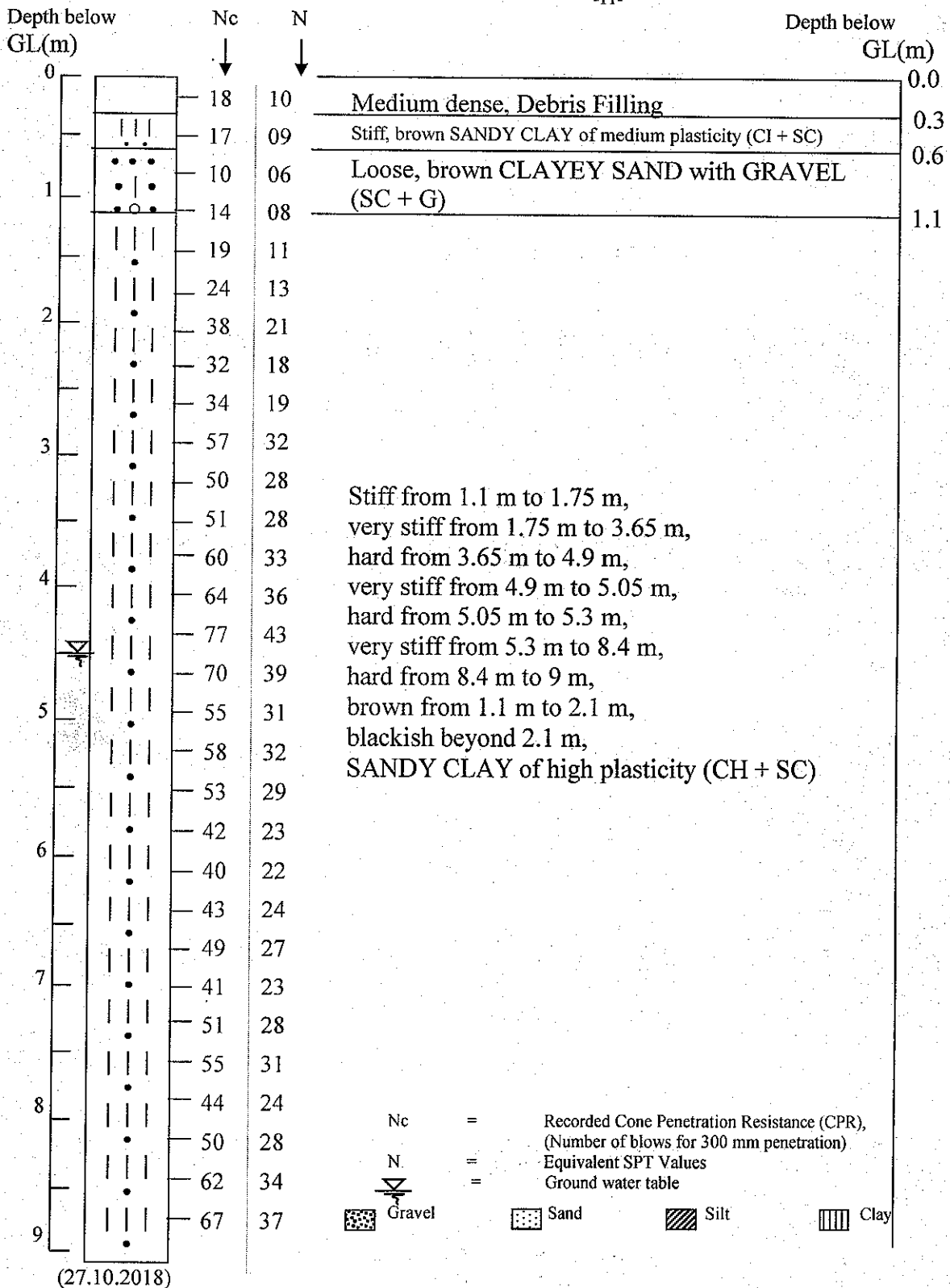


Fig. 3: LOG OF BORE HOLE 2

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Table 1: RESULTS OF CONE PENETRATION TESTS
(No. OF BLOWS FOR EVERY 50 mm PENETRATION)

Project: The proposed Stilt + 4 Floors Building at Plot I- 2, Dr. VSI Estate, Thiruvannmiyur,
Chennai - 600 041

Depth (m)	CPT-1	CPT-2
0.00-0.05	3	2
0.05-0.10	5	2
0.10-0.15	6	3
0.15-0.20	5	3
0.20-0.25	4	4
0.25-0.30	3	4
0.30-0.35	3	4
0.35-0.40	2	3
0.40-0.45	2	3
0.45-0.50	3	2
0.50-0.55	5	2
0.55-0.60	6	3
0.60-0.65	6	2
0.65-0.70	5	2
0.70-0.75	6	2
0.75-0.80	5	2
0.80-0.85	5	1
0.85-0.90	3	1
0.90-0.95	2	2
0.95-1.00	2	1
1.00-1.05	2	2
1.05-1.10	2	2
1.10-1.15	1	4
1.15-1.20	1	3
1.20-1.25	0	3
1.25-1.30	1	4
1.30-1.35	1	3
1.35-1.40	1	3
1.40-1.45	1	3
1.45-1.50	1	3
1.50-1.55	2	3
1.55-1.60	2	4
1.60-1.65	1	5
1.65-1.70	2	4
1.70-1.75	2	2
1.75-1.80	2	6
1.80-1.85	2	7
1.85-1.90	2	7
1.90-1.95	2	6
1.95-2.00	2	6
2.00-2.05	2	6
2.05-2.10	2	6



Table 1Contd...

Depth (m)	CPT-1	CPT-2
2.10-2.15	3	5
2.15-2.20	3	6
2.20-2.25	3	6
2.25-2.30	3	6
2.30-2.35	3	4
2.35-2.40	3	5
2.40-2.45	4	5
2.45-2.50	4	6
2.50-2.55	4	5
2.55-2.60	4	6
2.60-2.65	4	6
2.65-2.70	4	6
2.70-2.75	4	8
2.75-2.80	3	10
2.80-2.85	4	10
2.85-2.90	3	10
2.90-2.95	4	9
2.95-3.00	4	10
3.00-3.05	3	8
3.05-3.10	4	7
3.10-3.15	4	7
3.15-3.20	4	9
3.20-3.25	4	10
3.25-3.30	4	9
3.30-3.35	4	8
3.35-3.40	3	11
3.40-3.45	4	7
3.45-3.50	4	8
3.50-3.55	3	9
3.55-3.60	4	8
3.60-3.65	3	7
3.65-3.70	4	10
3.70-3.75	5	11
3.75-3.80	4	12
3.80-3.85	4	10
3.85-3.90	5	10
3.90-3.95	5	10
3.95-4.00	5	11
4.00-4.05	5	11
4.05-4.10	5	11
4.10-4.15	5	11
4.15-4.20	5	10
4.20-4.25	4	13
4.25-4.30	6	13
4.30-4.35	6	14
4.35-4.40	5	11
4.40-4.45	6	15
4.45-4.50	5	11



Table 1Contd...

Depth (m)	CPT-1	CPT-2
4.50-4.55	5	13
4.55-4.60	5	12
4.60-4.65	5	11
4.65-4.70	5	13
4.70-4.75	5	11
4.75-4.80	5	10
4.80-4.85	5	9
4.85-4.90	5	11
4.90-4.95	5	7
4.95-5.00	4	9
5.00-5.05	5	8
5.05-5.10	6	11
5.10-5.15	6	11
5.15-5.20	6	10
5.20-5.25	5	9
5.25-5.30	6	11
5.30-5.35	6	8
5.35-5.40	6	9
5.40-5.45	6	9
5.45-5.50	5	7
5.50-5.55	5	8
5.55-5.60	6	11
5.60-5.65	5	9
5.65-5.70	6	9
5.70-5.75	6	6
5.75-5.80	6	7
5.80-5.85	7	7
5.85-5.90	6	7
5.90-5.95	6	7
5.95-6.00	6	8
6.00-6.05	6	7
6.05-6.10	5	7
6.10-6.15	6	6
6.15-6.20	6	7
6.20-6.25	6	6
6.25-6.30	6	7
6.30-6.35	7	7
6.35-6.40	6	8
6.40-6.45	6	7
6.45-6.50	6	8
6.50-6.55	6	7
6.55-6.60	7	6
6.60-6.65	7	7
6.65-6.70	7	10
6.70-6.75	7	9
6.75-6.80	6	7
6.80-6.85	7	8
6.85-6.90	6	8



Table 1Contd...

Depth (m)	CPT-1	CPT-2
6.90-6.95	7	7
6.95-7.00	6	7
7.00-7.05	7	6
7.05-7.10	6	7
7.10-7.15	6	7
7.15-7.20	6	7
7.20-7.25	7	8
7.25-7.30	8	8
7.30-7.35	8	11
7.35-7.40	7	8
7.40-7.45	8	7
7.45-7.50	8	9
7.50-7.55	8	7
7.55-7.60	8	9
7.60-7.65	9	10
7.65-7.70	7	10
7.70-7.75	8	10
7.75-7.80	8	9
7.80-7.85	9	8
7.85-7.90	8	7
7.90-7.95	8	8
7.95-8.00	7	7
8.00-8.05	7	6
8.05-8.10	7	8
8.10-8.15	13	9
8.15-8.20	18	7
8.20-8.25	22	8
8.25-8.30	28*	9
8.30-8.35	32*	8
8.35-8.40	25 for 3 cm*	9
8.40-8.45		10
8.45-8.50		9
8.50-8.55		11
8.55-8.60		10
8.60-8.65		11
8.65-8.70		11
8.70-8.75		11
8.75-8.80		9
8.80-8.85		11
8.85-8.90		11
8.90-8.95		13
8.95-9.00		12

* Very Hard Stratum



Table 2: COMPARISON OF RESULTS OF CONE PENETRATION TESTS AND EQUIVALENT SPT VALUES, AT DIFFERENT DEPTHS (No. OF BLOWS FOR EVERY 300 mm PENETRATION)

Project: The proposed Stilt + 4 Floors Building at Plot I- 2, Dr. VSI Estate, Thiruvanniyur, Chennai - 600 041

Depth (m)	Cone Penetration Resistance (CPR) = No. of blows for 300 mm penetration		Equivalent SPT Values	
	CPT-1	CPT-2	CPT-1	CPT-2
0.0-0.3	26	18	14	10
0.3-0.6	21	17	12	09
0.6-0.9	30	10	17	06
0.9-1.2	10	14	06	08
1.2-1.5	05	19	03	11
1.5-1.8	11	24	06	13
1.8-2.1	12	38	07	21
2.1-2.4	18	32	10	18
2.4-2.7	24	34	13	19
2.7-3.0	22	57	12	32
3.0-3.3	23	50	13	28
3.3-3.6	22	51	12	28
3.6-3.9	25	60	14	33
3.9-4.2	30	64	17	36
4.2-4.5	32	77	18	43
4.5-4.8	30	70	17	39
4.8-5.1	30	55	17	31
5.1-5.4	35	58	19	32
5.4-5.7	33	53	18	29
5.7-6.0	37	42	21	23
6.0-6.3	35	40	19	22
6.3-6.6	38	43	21	24
6.6-6.9	40	49	22	27
6.9-7.2	38	41	21	23
7.2-7.5	46	51	26	28
7.5-7.8	48	55	27	31
7.8-8.1	46	44	26	24
8.1-8.4	138 for 28 cm*	50	77 for 28 cm*	28
8.4-8.7		62		34
8.7-9.0		67		37
Date of test	27.10.2018			

* Very Hard Stratum

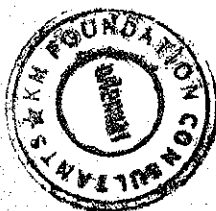


Table 3: COMPARISON OF SUBSOIL CONDITIONS AND CONE PENETRATION RESISTANCE (EQUIVALENT SPT VALUES) IN THE TWO BORE HOLES

Project: The proposed Stilt + 4 Floors Building at Plot I- 2, Dr. VSI Estate, Thiruvannmiyur, Chennai - 600 041

Date of Soil investigation: 27.10.2018

Ground water table was met with, at a depth of 4.5 m, in both the Bore Holes, during boring

Depth (m)	Visual identification of soil sample Bore Hole-1	Equivalent SPT Values CPT - 1	Visual identification of soil sample Bore Hole-2	Equivalent SPT Values CPT - 2
GL	Debris Filling		Debris Filling	
		14		10
0.3	Brown fine to medium sand with a little clay binder (SP + SC)		Brown sandy clay of medium plasticity (CI + SC)	
		12		09
0.6	-do-		Brown clayey sand (SC)	
		17		06
0.9	-do- little more clay binder (SP + SC)		Brown clayey sand with gravel (SC + G)	
		06		08
1.2	-do- less clay binder (SP + SC)		Brown sandy clay of high plasticity (CH + SC)	
		03		11
1.5	Dark brown or blackish sandy clay of high plasticity (CH + SC)		-do-	
		06		13
1.8	-do-		-do-	
		07		21
2.1	-do-		Blackish -do-	
		10		18
2.4	-do-		-do-	
		13		19
2.7	-do-		-do-	
		12		32
3.0	-do-		-do-	
		13		28
3.3	-do-		-do-	
		12		28
3.6	-do-		-do-	
		14		33
3.9	-do-		-do-	
		17		36



Table 3 Contd...

Depth (m)	Visual identification of soil sample Bore Hole-1	Equivalent SPT Values CPT - 1	Visual identification of soil sample Bore Hole-2	Equivalent SPT Values CPT - 2
4.2	Dark brown or blackish sandy clay of high plasticity (CH + SC)		Blackish sandy clay of high plasticity (CH + SC)	
		18		43
4.5	-do-		-do-	
		17		39
4.8	-do-		-do-	
		17		31
5.1	-do-			
		19		32
5.4				
		18		29
5.7				
		21		23
6.0				
		19		22
6.3				
		21		24
6.6				
		22		27
6.9				
		21		23
7.2				
		26		28
7.5				
		27		31
7.8				
		26		24
8.1				
		77 for 28 cm*		28
8.4				
				34
8.7				
				37
9.0				

* Very Hard Stratum



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Table 4: RESULTS OF LABORATORY SOIL TESTING

Project: The proposed Stilt + 4 Floors Building at Plot I- 2, Dr. VSI Estate, Thiruvanniyur, Chennai - 600 041

Bore Hole No.:1 Date of bore hole: 27.10.2018

Ground water table was met with, at a depth of 4.5 m in the Bore Holes, during boring

Depth of sample (m)	Type of sample (Type)	Visual Identification of soil	Liquid Limit	Plastic Limit	Plasticity Index	Gravel size fraction (4.75 mm) to 80 mm)	Coarse sand fraction (2.00 mm to 4.75 mm)	Medium sand fraction (0.425 mm to 2.00 mm)	Fine sand fraction (0.075 mm to 0.425 mm)	Silt size and clay size (less than 0.075 mm)
GL	DR	Debris Filling								
0.3	DR	Brown fine to medium sand with a little clay binder (SP + SC)								
0.6	DR	-do-				03	02	58	28	09
0.9	DR	-do- little more clay binder (SP + SC)								
1.2	DR	-do- less clay binder (SP + SC)								
1.5	DR	Dark brown or blackish sandy clay of high plasticity (CH + SC)								
1.8	DR	-do-	51	17	34					
2.1	DR	-do-								
2.4	DR	-do-								
2.7	DR	-do-								
3.0	DR	-do-								
3.3	DR	-do-								
3.6	DR	-do-	57	16	41					
3.9	DR	-do-								
4.2	DR	-do-								
4.5	DR	-do-								
4.8	DR	-do-								
5.1	DR	-do-	96	43	53					

GL = Ground Level,

DR = Disturbed but Representative soil samples



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Table 5: RESULTS OF LABORATORY SOIL TESTING

Project: The proposed Stilt + 4 Floors Building at Plot I-2, Dr. VSI Estate, Thiruvanniyur, Chennai - 600 041

Bore Hole No.:2

Date of bore hole: 27.10.2018

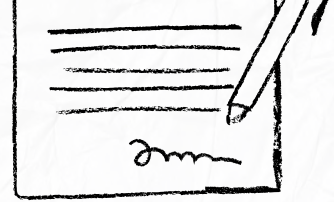
Ground water table was met with, at a depth of 4.5 m in the Bore Holes, during boring

Depth of sample (m)	Type of sample (Type)	Visual Identification of soil	Liquid Limit	Plastic Limit	Plasticity Index	Gravel size fraction (4.75 mm to 80 mm)	Coarse sand fraction (2.00 mm to 4.75 mm)	Medium sand fraction (0.425 mm to 2.00 mm)	Fine sand fraction (0.075 mm to 0.425 mm)	Silt size and clay size fraction (less than 0.075 mm)
GL	DR	Debris Filling								
0.3	DR	Brown sandy clay of medium plasticity (CI + SC)								
0.6	DR	Brown clayey sand (SC)								
0.9	DR	Brown clayey sand with gravel (SC + G)				20	11	15	18	36
1.2	DR	Brown sandy clay of high plasticity (CH + SC)								
1.5	DR	-do-								
1.8	DR	-do-								
2.1	DR	Blackish -do-	64	33	31					
2.4	DR	-do-								
2.7	DR	-do-								
3.0	DR	-do-								
3.3	DR	-do-								
3.6	DR	-do-	69	30	39					
3.9	DR	-do-								
4.2	DR	-do-								
4.5	DR	-do-								
4.8	DR	-do-	74	27	47					

GL = Ground Level,

DR = Disturbed but Representative soil samples





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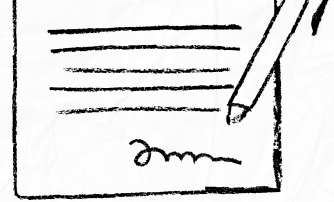
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